SOUTHERN CALIFORNIA EDISON COMPANY

SAN ONOFRE NUCLEAR GENERATING STATION

UNIT 2

REACTOR CONTAINMENT BUILDING

INTEGRATED LEAK RATE TEST

FINAL REPORT

OCTOBER 1991 TEST

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1.0 INTRODUCTION

1.1 GENERAL

The reactor containment building Integrated Leakage Rate Test (Type A) was performed to demonstrate that the overall leakage rate through the primary reactor containment system does not exceed the allowable leakage rate as specified in the Unit 2 Technical Specification, Section 3.6.1.2. The test was performed as part of the Unit 2 Cycle 6 refueling outage.

The successful Type A and supplemental verification tests were performed in accordance with the requirements of San Onofre Nuclear Generating Station, Unit 2, Procedure SO2-V-3.12, Revision 1, Containment Integrated Leak Rate Test. The test method utilized was the absolute method described in ANSI N45.4-1972, "American National Standard Leakage-Rate Testing of Containment Structures for Nuclear Reactors"; and ANSI/ANS-56.8-1987, "Containment System Leakage Testing Requirements". The leakage rate was calculated using the Total Time formulae and Mass Point method from these standards. Test duration was determined from these standards and from Bechtel Topical Report BN-TOP-1, Testing Criteria for Integrated Leakage Rate Testing of Primary Containment Structures for Nuclear Power Plants. The test results are reported in accordance with the requirements of 10CFR50, Appendix J, Section V.B.3, and ANSI/ANS 56.8-1987.

1.2 TEST SYNOPSIS

Containment pressurization commenced at 1510 on 10-23-91 and test pressure was obtained at 0635 on 10-24-91. Air mass stabilization began at 0635 on 10-24-91 and was achieved in eight and three quarter hours, ending at 1515 on 10-24-91. The test began at 1515 on 10-24-91 with a test duration of twelve and one half hours, ending at 0345 on 10-25-91. Verification commenced at 0445 on 10-25-91 following a one hour stabilization and was completed at 1100 on 10-25-91. Containment depressurization started at 1115 on 10-25-91 and was completed at 1830 on 10-25-91.

The Primary Containment Integrated Leakage Rate Test (ILRT) was successfully completed at 1100, on 10-25-91 at the San Onofre Nuclear Generating Station, Unit 2. All ILRT requirements of the Technical Specifications were satisfied.

TEST SEQUENCE	START	COMPLETION
PRESSURIZATION	1510 10-23-91	0635 10-24-91
STABILIZATION	0635 10-24-91	1515 10-24-91
TEST	1515 10-24-91	0345 10-25-91
VERIFICATION		
(Stabilization)	0345 10-25-91	0445 10-25-91
(Test)	0445 10-25-91	1100 10-25-91
BLOWDOWN	1115 10-25-91	1830 10-25-91

TOTAL TIME ANALYSIS

Analysis of the measured data taken during the test resulted in a measured leakage rate of 0.0408 %/day, a calculated leakage rate of 0.0452 %/day and a 95% probability upper confidence limit (UCL) leakage of 0.0680 %/day using the Total Time calculation technique as recommended in ANSI 45.4-1972 and BN-TOP-1. The leakage rate at this upper confidence limit plus a 0.0007 %/day (as left) and a 0.0033 %/day (as found) Local Leak Rate penalty (See Section 6.0) yields an overall leakage rate of 0.0687 %/day (as left) and a 0.0713 %/day (as found) of contained air mass which satisfies the acceptance criteria of being less than 0.075 %/day.

MASS POINT ANALYSIS

This section is provided for information only and was not used to determine test acceptability as Mass Point Analysis is not used in BN-TOP-1 Short Duration Tests. Analysis of the measured data taken during the test resulted in a calculated leakage rate of 0.0429 %/day and a 95 % probability upper confidence limit (UCL) leakage of 0.0452 %/day using the Mass Point calculation technique as recommended in ANSI/ANS 56.8-1987. The leakage rate at this upper confidence limit plus a 0.0007 %/day (as left) and a 0.0033 %/day (as found) Local Leak Rate penalty (See Section 6.0) yields an overall leakage rate of 0.0459 %/day (as left) and a 0.0485 %/day (as found) of contained air mass which would satisfy the acceptance criteria of being less than 0.075 %/day.

VERIFICATION TEST

Following the completion of the ILRT measurements, a successful verification test was performed with an imposed leakage rate of 7.9 SCFM. The Total Time measured leakage rate of 0.1346 %/day and calculated leakage rate of 0.1292 %/day were within the allowable limits of 0.1206 %/day to 0.1706 %/day. The Mass Point calculated leakage rate, presented for information only, of 0.1300 %/day established during the verification test was within the allowable limits of 0.1182 %/day to 0.1682 %/day.

The leakage rates for this Primary Containment ILRT demonstrates that leakage through the primary reactor containment, systems and components penetrating primary containment do not exceed the allowable leakage rate specified in the SONGS 2 Technical Specifications.

1.3 DOCUMENTS AND TEST INFORMATION RETAINED AT SONGS

The following documents and test information are available for review at the San Onofre Nuclear Generating Station:

1) A listing of all containment penetrations, penetration size, and functions.

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

3) A system lineup (at the time of the test) showing required valve positions and status of piping.

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

5) Documentation of instrumentation calibrations and standards.

6) The official test copy of the test procedure with sign-off of procedural steps.

7) Computer printouts of Integrated Leakage Rate Test data reports, graphs and plots obtained during the test using the Southern California Edison developed computer program.

8) P&IDs

9) Local Leak Rate Test History Files

2.0 GENERAL DATA (PLANT INFORMATION)

2.1	Owner	Southern California Edison
2.2	Docket No.	50-361
2.3	Plant	San Onofre Nuclear Generating Station, Unit 2
2.4	Location	San Onofre, California
2.5	Containment Type	Post-tensioned concrete, hemispherical dome
2.6	NSSS Supplier	Combustion Engineering, PWR

3.0 TECHNICAL DATA

3.1	Containment Net Free Air Volume	2,305,000 cubic feet
3.2	Design Pressure	60.0 PSIG
3.3	Design Metal Temperature	300.0 degrees F
3.4	Calculated Peak Accident Pressure (Pa)	55.7 PSIG
3.5	Calculated Peak Vapor Accident Temperature	287.0 degrees F

4.0 TEST DATA SUMMARY

4.1	Test Method	Absolute Method
4.2	Data Analysis Techniques	
	1) Total Time	per ANSI N 45.4-1972 and BN-TOP-1, Rev. 1
	2) Mass Point	per ANSI/ANS 56.8-1987
4.3	Test Pressure	57.7 PSIG + 0.2, -0.0 PSIG

4.4 Maximum Allowable Leakage Rate (La) 0.100%/day

4.5 ILRT Results Leakage Rate (wt. %/day)

	Lam	Lcalc	95% UCL	95% UCL + LLaf*	95% UCL + LLal*
Tot Time	0.0408	0.0452	0.0680	0.0713	0.0687
Mass Pt		0.0429	0.0452	0.0485	0.0459

*LLaf/al = Local Leak Rate Penalty (as found/as left)

5.0 VERIFICATION TEST DATA SUMMARY

5.1 Verification Test Leakage Rate .1004%/day (7.9 SCFM)

5.2 Verification Test Results Leakage Rate (wt. %/day)

		Limits	Calculated
1)	Total Time	0.1206 to 0.1706	0.1292
2)	Mass Point	0.1182 to 0.1682	0.1300

6.0 LOCAL LEAK RATE TEST DATA SUMMARY

6.1 PENETRATIONS NOT ALIGNED TO SIMULATE POST-ACCIDENT CONDITIONS

During the ILRT, the penetrations listed below were not aligned to simulate the configuration after a postulated accident. The measured local leakage rates obtained from Test procedure SO2-V-3.13, "Containment Penetration Leak-Rate Testing", are given below and are added to the ILRT results as the As Left penalty and as a portion of the As Found penalty.

PEN #	DESCRIPTION	VALVE #
10B	ILRT PRESSURE SENSOR	S21500MU038 S21500MU039
23C	ILRT FLOW CONNECTION	N/A
34	ILRT TEST CONNECTION	N/A
42	COMPONENT COOLING WATER	2HV-6211 2HV-6223

PEN #	DESCRIPTION	VALVE #
43	COMPONENT COOLING WATER	2HV-6216 2HV-6236
45	NORMAL A/C CHILL WATER	2HV-9900 2HV-9920
46	NORMAL A/C CHILL WATER	2HV-9921 2HV-9971

LLRT PENALTY = 0.0007 %/day (use 0.0007 %/day as the As Left penalty)

6.2 AS FOUND / AS LEFT LLRT PENALTY

In accordance with IE information Notice No. 85-71, "Containment Integrated Leak Rate Tests", an As Found / As Left LLRT penalty was calculated and added to the ILRT results. The following penetrations were applicable to this calculation:

PEN #	DESCRIPTION	VALVE #
1	ESCAPE HATCH	SEALS
2	PERSONNEL AIRLOCK	SEALS
1	PZR VAPOR SAMPLE	2HV-0510/11
2	LETDOWN LINE	2TV-9267 2HV-9205
8	CHARGING LINE	S21208MU122 2HV-9200
14	FIRE PROTECTION	S22301MU061 2HV-5686
15	FUEL TRANSFER TUBE	BELLOWS/GASKET
26	RCDT DISCHARGE	2HV-7512/13
30C	RCDT GAS SAMPLE	2HV-0514/15/16
43	CCW OUTLET	2HV-6216/26
45	A/C CHILL WATER	2HV-9900/20
46	A/C CHILL WATER	2HV-9921/71
52	CTMT SPRAY INLET	S21206MU004 2HV-9367
71	HOT LET INJECTION	S21204MU158 2HV-9420

AS FOUND / LEFT PENALTY = 0.0026 %/DAY

The total as found LLRT penalty is the sum of the values in sections 6.1 and 6.2, or:

TOTAL AS FOUND LLRT PENALTY = 0.0033 %/DAY

7.0 ANALYSIS AND INTERPRETATION

7.1 PRESSURIZATION

Pressurization started at 1510 on 10-23-91. Test pressure of 72.8 PSIA was achieved at 0635 on 10-24-91. Average pressurization rate was 4.0 PSI/HR using a 12,000 SCFM diesel compressor system.

7.2 CONTAINMENT ATMOSPHERE STABILIZATION

The acceptance criteria for containment atmosphere temperature stabilization at test pressure is provided by ANSI/ANS 56.8-1987 and BN-TOP-1. These criteria ensure that the rate of change of the containment temperature is proportional to the rate of change of containment pressure and that the containment atmosphere has been at test pressure for at least four hours. An additional criteria for mass stabilization was also used. This required mass differentials to be trending towards a constant, negative value to ensure that temperature and pressure were moving together. Stabilization commenced at 0635 and was achieved at 1515. All ANSI/ANS 56.8-1987, BN-TOP-1 and mass stabilization criteria were met.

* The stabilization duration was 8.25 hours.
* 33 data points were used in the calculations.
* Data was collected at 15 minute intervals.
* The rate of change of average temperature was less than 1.0 F/hour averaged over the last two hours.
* The rate of change of temperature changes was less than 0.5 F/hour/hour averaged over the last two hours.
* Plots of average temperature and pressure versus time were maintained.
* Individual sensor plots were maintained and reviewed prior to completion of stabilization.

7.3 ILRT (Total Time)

The acceptance criteria for the ILRT is that the leakage rate determined using the 95% UCL value for Total Time calculated leakage rate plus the sums of the measured leakage rates for penetrations not included in

the ILRT with the difference between as found/as left leakage rates for all penetrations, must be less than 75% of the allowable leakage rate (La) at the peak accident pressure (Pa).

* The test duration was 12.5 hours.

* 51 data points were used in the calculations.

* Data was collected at 15 minute intervals.

* The double bound 95% probability value for the calculated leak rate using the Total Time technique was 0.0680%/day.

* The as left penalty is 0.0007 %/day and the as found penalty is 0.0033 %/day (See Section 6.0).

* 75% of the allowable leakage rate of 0.10%/day, or 75% La, is 0.075%/day.

* The 20 data point mean value = 0.0506 %/day.

The acceptance criteria for the test using the Total Time technique is satisfied, i.e.,

95% UCL + Penalty (as left or as found) < .75 LA
(as found) 0.0680%/day + 0.0033%./day < 0.075%/day
0.0713%/day < 0.075%/day
(as left) 0.0680%/day + 0.0007%./day < 0.075%/day
0.0687%/day < 0.075%/day

7.4 ILRT (Mass Point)

The acceptance criteria for a short duration ILRT does not recognize the use of the Mass Point Method. Data is supplied for information only purposes.

* The Mass Point Leakage Rate calculated with a 95% probability UCL is 0.0452%/day.

* The LLRT penalty for penetrations not included in the ILRT and for the as found/as left leakage is 0.0033 %/day (See Section 6.0).

* 75% of the allowable leakage rate, or 75% La, of 0.10%/day is 0.075%/day.

The acceptance criteria for the ILRT leakage rate using the Mass Point technique, if allowed, is satisfied, i.e.,

95% UCL + Penalty (as left or as found) < .75 La

(as found)	0.0452%/day + 0.0033%/day	< 0.075%/day
	0.0485%/day	< 0.075%/day
(as left)	0.0452%/day + 0.0007%/day	< 0.075%/day
	0.0459%/day	< 0.075%/day

7.5 IMPOSED LEAKAGE RATE VERIFICATION TEST

7.5.1 TOTAL TIME CALCULATIONS

The acceptance criteria for the imposed leakage verification test is given by the following equation:

$$Lo + Lcalc - .25\ La \leq Lver \leq Lo + Lcalc + .25\ La$$

where,

- Lo = imposed leakage rate which must be in the range $.75\ La \leq Lo \leq 1.25\ La$
- Lcalc = ILRT calculated leakage rate at the end of the test
- Lver = Verification test calculated leakage rate

Addition criteria are:

* Calculations shall utilize at least 10 data points,
* The imposed leak shall be allowed to stabilize for one hour.
* Verification test duration shall be at least five hours which is approximately one half the test duration as required by BN-TOP-1.

Actual Test Data is as follows:

Lo	=	0.1004%/day (7.9 SCFM)
0.25 La	=	0.025%/day
Lcalc	=	0.0452%/day
Lver	=	0.1292%/day

Data Points = 26

Duration = 6.25 hours

The acceptance criteria for the Total Time technique of determining the imposed leakage rate is satisfied, i,e.,

$$L_o + L_{calc} - .25\,L_a \leq L_{ver} \leq L_o + L_{calc} + .25\,L_a$$
$$0.1004 + 0.0452 - 0.025 \leq 0.1292 \leq 0.1004 + 0.0452 + 0.025$$
$$0.1206 \leq 0.1292 \leq 0.1706$$

7.5.2 MASS POINT CALCULATIONS

The acceptance criteria for the imposed leakage verification test using the Mass Point technique is the same as Total Time technique defined in Section 7.5.

Actual Test Data is as follows:

Lo = 0.1004%/day (7.9 SCFM)

0.25 La = 0.025%/day

Lcalc = 0.0429%/day

Lver = 0.1300%/day

Data Points = 26

Duration = 6.25 hours

The acceptance criteria for the Mass Point technique of determining the imposed leakage rate is satisfied, i.e.,

$$L_o + L_{calc} - .25\,L_a \leq L_{ver} \leq L_o + L_{calc} + .25\,L_a$$
$$0.1004 + 0.0429 - 0.025 \leq 0.1300 \leq 0.1004 + 0.0429 + 0.025$$
$$0.1183 \leq 0.1300 \leq 0.1683$$

NOTE: 0.1183 and 0.1683 reflect round off error associated with using four significant figures, the program used to perform the ILRT used eight significant figures and did not get this error resulting in 0.1182 and 0.1682 being used as limits in the ILRT.

8.0 LOCAL LEAK RATE TESTING SUMMARY

Penetration (Type B and C) testing was accomplished in accordance with the requirements of the Technical Specification 4.3.1 and per SO2-V-3.13. the penetrations were tested using the pressure decay and make up methods. The allowable leakage for all penetrations is 0.060%/day (0.6 La) of the mass of air in the containment at 57.7 PSIG.

The following is an Operational History of Unit 2 since the previous ILRT (conducted in October 1987) and the through penetration leakage expressed in %/day.

DATE	DESCRIPTION	LEAKAGE (%/DAY)
12-2-87	ENTERED MODE 4	0.009
3-18-88	ENTERED MODE 5	0.009
4-1-88	ENTERED MODE 4	0.010
1-13-89	ENTERED MODE 5	0.010
2-5-89	ENTERED MODE 4	0.008
5-14-89	ENTERED MODE 5	0.008
6-1-89	ENTERED MODE 4	0.010
9-4-89	ENTERED MODE 5	0.010
11-20-89	ENTERED MODE 4	0.010
7-29-90	ENTERED MODE 5	0.008
8-24-90	ENTERED MODE 4	0.008
4-12-91	ENTERED MODE 5	0.008
5-1-91	ENTERED MODE 4	0.007
5-3-91	ENTERED MODE 5	0.007
5-5-91	ENTERED MODE 4	0.007
8-17-91	ENTERED MODE 5	0.007