

SOUTHERN CALIFORNIA EDISON COMPANY

SAN ONOFRE NUCLEAR GENERATING STATION

UNIT 2

REACTOR CONTAINMENT BUILDING

INTEGRATED LEAK RATE TEST

FINAL REPORT

OCTOBER 1987 TEST

8802080165 880201  
PDR ADOCK 05000361  
P PDR

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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 4 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 S02-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, BN-TOP-1, Revision 1, "Testing Criteria for Integrated Leakage Rate Testing of Primary Containment Structures for Nuclear Power Plants", and ANSI/ANS-56.8-1981, "Containment System Leakage Testing Requirements". The leakage rate was calculated using the Total Time formulae and Mass Point method from these standards. The test results are reported in accordance with the requirements of 10CFR50, Appendix J, Section V.B.3, and ANSI/ANS 56.8-1981.

### 1.2 TEST SYNOPSIS

Pressurization was commenced at 1720 on 10-28-87 and test pressure was obtained at 0803 on 10-29-87. Stabilization was achieved in approximately 24 hours, with the test commencing at 0800 on 10-30-87. The verification test was started at 0815, on 10-31-87. One hour was allowed for stabilization. At 1130 several temperature instruments experienced a step change in readings. The verification test was restarted at 1215 and completed at 1700 on 10-31-87. Depressurization was started at 1715, on 10-31-87 and completed at 0215, on 11-1-87.

The Primary Containment Integrated Leakage Rate Test (ILRT) was successfully completed at 1700, on 10-31-87 at the San Onofre Nuclear Generating Station, Unit 2. All ILRT requirements of the Technical Specifications were satisfied.

<u>TEST SEQUENCE</u>	<u>START</u>	<u>COMPLETION</u>
PRESSURIZATION	1720 10-28-87	0803 10-29-87
STABILIZATION	0815 10-29-87	0745 10-30-87
TEST	0800 10-30-87	0800 10-31-87

<u>TEST SEQUENCE</u>	<u>START</u>	<u>COMPLETION</u>
VERIFICATION	1215 10-31-87	1700 10-31-87
BLOWDOWN	1715 10-31-87	0215 11-1-87

#### TOTAL TIME ANALYSIS

Analysis of the measured data taken during the test resulted in a measured leakage rate of 0.044 %/day, a calculated leakage rate of 0.040 %/day and a 95 % probability upper confidence limit (UCL) leakage of 0.045 %/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 0.003%/day Local Leak Rate penalty (See Section 6.0) yields an overall leakage rate of 0.048 %/day of contained air mass which satisfies the acceptance criteria of being less than 0.075 %/day.

#### MASS POINT ANALYSIS

Analysis of the measured data taken during the test resulted in a calculated leakage rate of 0.041 %/day and a 95 % probability upper confidence limit (UCL) leakage of 0.042 %/day using the Mass Point calculation technique as recommended in ANSI/ANS 56.8-1981. The leakage rate at this upper confidence limit plus a 0.003%/day Local Leak Rate penalty (See Section 6.0) yields an overall leakage rate of 0.045 %/day of contained air mass which satisfies 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 7.86 SCFM. The Total Time measured leakage rate of 0.121 %/day and calculated leakage rate of 0.129 %/day was within the allowable limits of 0.115 %/day to 0.165 %/day. The Mass Point calculated leakage rate of 0.120 %/day established during the verification test was within the allowable limits of 0.116 %/day to 0.166 %/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 permanently installed plant instrumentation data taken for reference during 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 and Reports along with Graphs and Plots of the data obtained during the test using Southern California Edison and Bechtel Power Corporation developed computer programs.
- 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 Temperature              | 300.0 degrees F      |

3.4 Calculated Peak Accident Pressure (Pa) 55.7 psig

3.5 Calculated Peak Accident Temperature 287 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 56.8-1981

4.3 Test Pressure 57.7 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 + LL*
Total Time	0.044	0.040	0.045	0.048
Mass Point		0.041	0.042	0.045

\*LL = Local Leak Rate Penalty

#### 5.0 VERIFICATION TEST DATA SUMMARY

5.1 Verification Test Leakage Rate .1%/day (7.86 scfm)

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

1) Total Time 0.115-0.165 0.129

2) Mass Point 0.116-0.166 0.120

#### 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 S023-V-3.13, "Containment Penetration Leak Rate Testing", are given below and are added to the ILRT results.

<u>PEN#</u>	<u>DESCRIPTION</u>	<u>VALVE#</u>
10B	ILRT PRESS SENSOR	S21500MU038/ S21500MU039
23C	ILRT FLOW	FLANGE
34	ILRT PRESS CONNECTION	FLANGE
42	NON-CRIT CCW INLET	2HV6211/2HV6223
43	NON-CRIT CCW OUTLET	2HV6216/2HV6236
45	CTMT NORMAL INLET	2HV9900/2HV9920
46	CTMT NORMAL OUTLET	2HV9971/2HV9921

LLRT PENALTY                      0.00063516 % / day

## 6.2 AS FOUND LLRT PENALTY

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

<u>PEN #</u>	<u>DESCRIPTION</u>	<u>VALVE #</u>
4	HOT LEG SAMPLE	2HV0508/2HV0517/ 2HV0509
12	PZR SURGE LINE SAMPLE	2HV0512/2HV0513
16-A	CONTAINMENT AIR SAMPLE	2HV0500/2HV0501
16-B	CONTAINMENT AIR SAMPLE	2HV0502/2HV0503
18	CONTAINMENT PURGE	2HV9821/2HV9823/ 2HV9948/2HV9949
19	CONTAINMENT PURGE	2HV9824/2HV9825/ 2HV9950/2HV9951
30-A	CONTAINMENT AIRBORNE RADIATION MONITOR	2HV7802/2HV7803
30-B	CONTAINMENT AIRBORNE RADIATION MONITOR	2HV7801/2HV07800/ 2HV7816
42	NON-CRIT CCW INLET	2HV6211/2HV6223
43	NON-CRIT CCW OUTLET	2HV6216/2HV6236
68	CHARGING BYPASS	S21208MU129/ S21208MU130
70	AUXILIARY STEAM	S21312MU037/ S21312MU038
2C203	ESCAPE LOCK	
2C406	PERSONNEL HATCH	
2C501	EQUIPMENT HATCH	

AS FOUND PENALTY = 0.0015257 %/DAY

The total LLRT penalty is the sum of the values in sections 6.1 and 6.2. In order to be consistent with the ILRT significant figures and rounding conservatively the total LLRT penalty is:

$$\text{TOTAL LLRT PENALTY} = 0.003 \text{ \%/DAY}$$

## 7.0 ANALYSIS AND INTERPRETATION

### 7.1 PRESSURIZATION

Pressurization started at 1720 on 10-28-87. The test pressure of 57.2 psig was achieved at 0803 on 10-29-87. The average pressurization rate was 3.89 psi/hr over the 14.7 hour period using a 10,500 CFM diesel air compressor system.

### 7.2 CONTAINMENT ATMOSPHERE STABILIZATION

The acceptance criteria for containment atmosphere stabilization at test pressure is that the rate of change of the containment temperature (weighted average of RTD sensors) is less than 1.0 degrees F averaged over the last two hours; or, the rate of change of temperature changes is less than 0.5 degrees F / hour / hour averaged over the last two hours; and that the containment atmosphere has been at test pressure for at least four hours.

Temperature stabilization commenced at 0815 and was achieved at 1215.

Based on analysis of the test data, during stabilization, it was determined that an abnormal trend existed, regarding containment air mass. Field walkdowns of all penetrations subject to Local Leakage Rate Testing and the Main Steam Stop Valves were conducted. These walkdowns revealed leakage in to the Emergency Escape Lock, Penetration 19 Containment Purge Exhaust, and Steam Generator E089. Evaluation of the leakage into the Emergency Escape Lock and Penetration 19 determined that only the inner seal for each of these penetrations was leaking. In an effort to minimize the time required for these penetrations to stabilize, service air was ported to the penetrations at two psi less than the prevailing containment pressure. Through out the remainder of the test, the penetrations pressure continued to rise.

A precision pressure gauge was installed to trend the pressure rise on E089. When the pressure reached an asymptotic level the test was commenced.



### 7.3 ILRT (Total Time)

The acceptance criteria for the ILRT is that the total leakage rate measured (the sum of the 95% UCL value for the Total Time calculated method, the measured leakage rate of penetrations not included in the ILRT and the local leakage rate As Found Penalty) must be less than 75% of the allowable leakage rate (La) at the peak accident pressure (Pa).

- \* The test duration was 24 hours.
- \* 97 data points were used in the calculations.
- \* Data was collected at 15 minute intervals.
- \* The upper bound 95% probability value for the calculated leak rate using the Total Time technique was 0.045%/day.
- \* The LLRT penalty for penetrations not included in the ILRT is 0.00063516 %/day. (See Section 6.0).
- \* The LLRT penalty for as found leakage is 0.0015257 %/day (See Section 6.0).
- \* 75% of the allowable leakage rate of 0.10%/day is 0.075%/day.  
 $0.75La = 0.075\%/day.$

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

$$\begin{aligned} 95\% \text{ UCL} + \text{LL} &< .75 \text{ LA} \\ 0.045\%/day + 0.003\%/day &< 0.075\%/day \\ 0.048\%/day &< 0.075\%/day \end{aligned}$$

### 7.4 ILRT (Mass Point)

The acceptance criteria for a 24 hour ILRT is that the leakage rate determined using the 95% UCL value for the calculated leakage rate plus the local leak rate penalty must be less than 75% of the allowable leakage rate (La) at the peak accident pressure (Pa).

- \* The Mass Point Leakage Rate calculated with a 95% probability UCL is 0.042%/day.  
 $95\% \text{ UCL} = 0.042\%/day$
- \* The LLRT penalty for penetrations not included in the ILRT is 0.00063516 %/day.
- \* The LLRT penalty for as found leakage is 0.0015257 %/day.

- \* 75% of the allowable leakage rate of 0.10%/day is 0.075%/day.

$$75\% La = 0.075\%/day$$

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

$$\begin{aligned} 95\% \text{ UCL} + \text{LL} &< .75 La \\ 0.042\%/day + 0.003\%/day &< 0.075\%/day \\ 0.045\%/day &< 0.075\%/day \end{aligned}$$

## 7.5 IMPOSED LEAKAGE RATE VERIFICATION TEST

During the verification test a step change occurred in several temperature instrument readings at 1130. This step change affected the test data to such an extent as to require a test restart which occurred at 1215. The reason for this aberration is unclear. The instruments that were affected were located above the polar crane in the same general vicinity. Following the step change, the readings of the affected instruments returned to the same trend as observed prior to the step change. The postulated reasons for the step change were operator action in the form of starting/stopping containment fans, or containment light bulbs bursting. Review of operator logs and discussions with control room personnel revealed that no operator action that could have caused this event took place during the requisite time period. Several of the containment light bulbs above the polar crane had burst, yet it is unknown when their failure had occurred.

### 7.5.1 TOTAL TIME CALCULATIONS

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

$$Lo + Lcalc - .25 La < Lver < Lo + Lcalc + .25 La$$

where,  $Lo$  = imposed leakage rate which must be in the range

$$.75 La \leq Lo \leq 1.25 La$$

$Lcalc$  = ILRT calculated leakage rate

$Lver$  = Verification test calculated leakage rate

Furthermore, the calculations shall utilize at least 10 data points, recorded over a time span of at least 4 hours.

Actual Test Data is as follows:

Lo = 0.100%/day (7.86 scfm)  
 0.25 La = 0.025%/day  
 Lcalc = 0.040%/day  
 Lver = 0.129%/day (Total Time)  
 Data Points = 18

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

$$\begin{aligned} Lo + Lcalc - .25 La &< Lver < Lo + Lcalc + .25 La \\ 0.100 + 0.040 - 0.025 &< 0.129 < 0.100 + 0.040 + 0.025 \\ 0.115 &< 0.129 < 0.165 \end{aligned}$$

#### 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 = 0.100%/day (7.86 scfm)  
 0.25 La = 0.025%/day  
 Lcalc = 0.041%/day  
 Lver = 0.120%/day (Mass Point)  
 Data Points = 18

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

$$\begin{aligned} Lo + Lcalc - .25 La &< Lver < Lo + Lcalc + .25 La \\ 0.100 + 0.041 - 0.025 &< 0.120 < 0.100 + 0.041 + 0.025 \\ 0.116 &< 0.120 < 0.166 \end{aligned}$$

#### 8.0 LOCAL LEAK RATE TESTING SUMMARY

Penetration (Type B and C) testing was accomplished in accordance

with the requirements of the Technical Specification 3/4.6.1 and per S023-V-3.13. The penetrations were tested using the pressure decay method, make up method, and local test panels. The allowable leakage for all penetrations is 0.06%/day (0.6 La) of the mass of air in the containment at 55.7 psig.

At no time during Modes 1, 2, 3 or 4 did the allowable leakage for all penetrations exceed 0.06%/day for through penetration leakage. The following is an Operational History of Unit 2 since the previous ILRT (conducted in February 1985) and the through penetration leakage expressed in %/day.

Date	Description	%/day
3-19-85	Entered Mode 4	0.005
3-22-85	Entered Mode 5	0.005
3-29-85	Entered Mode 4	0.005
11-15-85	Entered Mode 5	0.005
12-01-85	Entered Mode 4	0.005
3-17-86	Entered Mode 5	0.005
5-30-86	Entered Mode 4	0.005
7-30-87	Entered Mode 5	0.005

All Local Leak Rate Test failures were experienced during Unit 2 outages (ie. Modes 5, 6 or defueled). In all cases, actions were taken to repair the component, followed by a satisfactory retest. Attachment I contains a description of each of the Local Leak Rate Test failures.

ATTACHMENT I

SOUTHERN CALIFORNIA EDISON COMPANY

SAN ONOFRE NUCLEAR GENERATING STATION

UNIT 2

LOCAL LEAK RATE TEST RESULTS OF THROUGH PENETRATION  
LEAKAGE WHICH CAUSED THE TOTAL LEAKAGE FOR ALL  
PENETRATIONS TO EXCEED 0.6 La (0.06%/DAY)\*

\* All failures occurred while the Unit was in Modes 5, 6, or Defueled.

## 1.0 Introduction

Leakage test results of penetrations which failed to meet acceptance criteria of 0.6 La (0.06%/day) are given below. The values given include an error value (calculated in accordance with ANSI 56.8) associated with instrument accuracy. In all cases, a satisfactory retest was performed prior to the establishment of containment integrity.

## 2.0 Fuel Transfer Tube Flange Gaskets

Subsequent to refueling during the Cycle 3 refueling outage, and prior to establishment of containment integrity, an LLRT was performed on the Fuel Transfer Tube Flange Gaskets (Pen 15). The LLRT performed on 5-2-86 failed because of an inability to obtain test pressure. The flange was loosened and retorqued. Another LLRT was performed on 5-5-86, resulting in a leakage of 10 SCCM or 4.401E-6%/day.

## 3.0 Containment Normal A/C Chill Water

During the Cycle 3 refueling, on 4-3-86, the initial LLRT of Pen 46 was unable to obtain test pressure. A maintenance order was initiated to adjust the stroke of the outboard containment isolation valve 2HV9921. Prior to the establishment of containment integrity, on 5-19-86, a successful post-maintenance LLRT was performed with a resultant leakage of 2,698 SCCM or 0.001248%/day.

## 4.0 Containment Normal Purge Exhaust

The containment purge penetrations have had a history of exhibiting leakage rates more than desired, following the initiation of normal containment purge during a plant outage. Almost invariably, this is a result of seat contamination of the main purge valves that are locked closed during operation in plant modes 1, 2, 3, and 4. The postulated source of the contamination is foreign material deposited on the valve seats during normal purge operation.

Prior to establishing containment integrity an LLRT was performed on Pen 19 on 1-29-85. The test result of 11309 SCCM or 0.00521 %/day was in excess of the maximum allowable leakage of 0.05La or 0.005%/day. The valves were stroked under test pressure and retested on the same date. The subsequent test resulted in a leakage of 1108 SCCM or 0.00051 %/day. It was postulated that stroking the valves at test pressure removed all foreign material from the valve seats cause by a month of containment purging.

Prior to establishing containment integrity an LLRT was performed on Pen 19 on 5-17-86. The test result of 1126455 SCCM or 0.5189 %/day was in excess of the maximum allowable leakage of 0.05La or 0.005%/day. Corrective Maintenance Orders were generated to adjust

the containment isolation valves as required. The stroke for all four containment isolation valves was adjusted. The subsequent retest, on 5-21-86, resulted in a leakage of 1028 SCCM or 0.0004736 %/day.

#### 5.0 Personnel Lock

Prior to establishing containment integrity an LLRT was performed on the Personnel Lock on 3-11-85. The test result of 64792 SCCM or 0.02986 %/day was in excess of the maximum allowable leakage of 0.05La or 0.005 %/day. A corrective maintenance order was generated to rework the exterior door control shaft seal. The subsequent retest, on 3-12-85, resulted in a leakage of 3970 SCCM or 0.001828 %/day.

Prior to establishing containment integrity an LLRT was performed on the Personnel Lock on 5-17-86. The test result of 32959 SCCM or 0.01518 %/day was in excess of the maximum allowable leakage of 0.05La or 0.005 %/day. The leakage path was an electrical conduit that was the result of a design change to the Personnel Hatch for the installation of a new electronic opening/closing mechanism. Following rework of the packing on the electrical conduit penetration an LLRT was performed as a retest. The subsequent retest, on 5-20-86, resulted in a leakage of 2901 SCCM or 0.001336 %/day.