

SOUTHERN CALIFORNIA EDISON COMPANY

SAN ONOFRE NUCLEAR GENERATING STATION

UNIT 2

REACTOR CONTAINMENT BUILDING

INTEGRATED LEAK RATE TEST

FINAL REPORT

FEBRUARY 1985 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 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 First 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 & 3, Procedure S023-V-3.12, Revision 1, Containment Integrated Leak Rate Test. The test method utilized is the absolute method described in ANSI/ANS-56.8-1981, Containment System Leakage Testing Requirements. The leakage rate was calculated using the Mass Point and Total Time formulae from this standard and Bechtel Topical Report, BN-TOP-1, Revision 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, Sections V.B.2, and ANSI/ANS 56.8-1981.

### 1.2 TEST SYNOPSIS

During pretest walkdown two valves on the secondary side of steam generators were found to be leaking. Valve S21301MU019 was leaking through the packing and S21301MU129 by the hinge pin. Repairs were made to the valves to minimize this leakage prior to the performance of the test.

The Primary Containment Integrated Leakage Rate Test (ILRT) was successfully completed on February 23, 1985 at the San Onofre Nuclear Generating Station, Unit 2. All ILRT requirements of the Technical Specification were satisfied.

TEST SEQUENCE	START	COMPLETION
-----	-----	-----
PRESSURIZATION	2250 - 2/20/85	1515 - 2/21/85
STABILIZATION	1530 - 2/21/85	1930 - 2/21/85
TEST	1945 - 2/21/85	2200 - 2/22/85
VERIFICATION	2245 - 2/22/85	0345 - 2/23/85
BLOWDOWN	0615 - 2/23/85	1500 - 2/23/85

## 1.2 TEST SYNOPSIS (Continued)

Containment normal cooling fans and the Dome Air Circulators were energized during the pressurization and then secured when test pressure was achieved.

### MASS POINT ANALYSIS

Analysis of the measured data taken during the test resulted in a calculated leakage rate of 0.060%/day and a 95% probability upper confidence limit (UCL) leakage of 0.063%/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 0.001%/day Local Leak Rate penalty (See Section 6.0) yields an overall leakage rate of 0.064%/day of contained air mass per day which satisfies the acceptance criteria of being less than 0.075%/day.

### TOTAL TIME ANALYSIS

Analysis of the measured data taken during the test resulted in a calculated leakage rate of 0.043%/day and a 95% probability upper confidence limit (UCL) leakage of 0.052%/day using the Total Time calculation technique as recommended in ANSI/ANS 56.8-1981. The leakage rate at this upper confidence limit plus a 0.001%/day Local Leak Rate penalty yields an overall leakage rate of 0.053%/day of contained air mass per day 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 7.67 scfm. The Mass Point calculated leakage rate of 0.148%/day established during the verification test, was within the allowable limits of 0.132%/day to 0.182%/day. The Total Time calculated leakage rate of 0.117%/day was within the allowable limits of 0.114%/day to 0.164%/day.

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

## 1.0 INTRODUCTION (Continued)

### 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 and Reports along with Graphs and Plots of the data obtained during the test using SCE and BPC developed computer programs.
- 8) P&ID'S
- 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                          |

## 2.0 GENERAL DATA (Continued)

- 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) Mass Point per ANSI/ANS 56.8-1981
- 2) Total Time <24 hrs per BN-TOP-1  
≥24 hrs 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   | 95% UCL | 95% UCL + LL |
|------------------------------------|-------|---------|--------------|
| 1) Mass Point<br>(See Section 7.3) | 0.060 | 0.063   | 0.064        |
| 2) Total Time<br>(See Section 7.4) | 0.043 | 0.052   | 0.053        |

## 5.0 VERIFICATION TEST DATA SUMMARY

5.1	Verification Test leakage Rate	0.0974%/day (7.67 scfm)	
5.2	Verification Test Results	Leakage Rate (wt. %/day)	
		<u>Limit</u>	<u>Rate</u>
	1) Mass Point	0.132-0.182	0.148
	2) Total Time	0.114-0.164	0.117

## 6.0 LOCAL LEAK RATE TEST DATA SUMMARY

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.

PEN #	DESCRIPTION	VALVE #	LEAKAGE RATE %/day
-----			
10B	ILRT PRESS SENSOR	S21500MU038 & S21500MU039	0.00000092
23C	ILRT FLOW	FLANGE	0.00000230
34	ILRT PRESS CONNECTION	FLANGE	0.00002074
42	NON-CRIT CCW INLET	2HV6211 & 2HV6223	0.00003688
43	NON-CRIT CCW OUTLET	2HV6216 & 2HV6236	0.00027752
45	CTMT NORMAL INLET	2HV9900 & 2HV9920	0.00011525
46	CTMT NORMAL OUTLET	2HV9971 & 2HV9921	0.00002950
TOTAL LLRT Penalty			----- 0.00048311

NOTE: An ILRT penalty of 0.001%/day was used throughout this report to provide a change to the reported value. The actual value would not have reflected a change in the reported quantity.

## 7.0 ANALYSIS AND INTERPRETATION

7.1 PRESSURIZATION

Pressurization started at 2250 February 20, 1985 and test pressure of 71.9 psia was achieved at 1515 February 21, 1985. The average pressurization rate was 3.50 psi/hr over the 16.4 hour period using 9000 cfm diesel 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) averaged over the last hour shall not deviate by more than 0.5 degrees F per hour from the rate of change averaged over the last four hours, and the containment atmosphere has been at test pressure for at least four hours.

Temperature stabilization commenced at 1530 and was achieved at 1930. The deviation between the averages at that time (1930) was 0.282 degrees F.

## 7.3 ILRT (Mass Point)

The acceptance criteria for a 24 hour ILRT is that the leakage rate determined using the 95% UCL value for Mass Point calculated leakage rate plus the sum of the measured LLRT rates for penetrations not included in the ILRT must be less than 75% of the allowable leakage rate ( $L_a$ ) at the peak accident pressure ( $P_a$ ).

- \* The Mass point Leakage Rate calculated with a 95% probability UCL is 0.063%/day.

$$95\% \text{ UCL} = 0.063\%/\text{day}$$

- \* The LLRT for penetrations not included in the ILRT is 0.001%/day. (See Section 6.0).

$$LL = 0.001\%/\text{day}$$

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

$$75\% L_a = 0.075\%/\text{day}$$

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

$$\begin{aligned} 95\% \text{ UCL} + LL &< .75 L_a \\ 0.063\%/\text{day} + 0.001\%/\text{day} &< 0.075\%/\text{day} \\ 0.064\%/\text{day} &< 0.075\%/\text{day} \end{aligned}$$



#### 7.4 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 sum of the measured LLRT rates for penetrations not included in the ILRT, must be less than 75% of the allowable leakage rate (La) at the peak accident pressure (Pa).

- \* The test duration was 26.25 hours.
- \* 106 data points were used in the calculations.
- \* Data was collected at fifteen (15) minute intervals.
- \* The upper bound 95% probability value for the calculated leak rate using the Total Time technique was 0.052%/day.
- \* The LLRT for penetrations not included in the ILRT is 0.001%/day LL = 0.001%/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 test using the Total Time technique is satisfied, i.e.,

$$\begin{aligned} 95\% \text{ UCL} + \text{LL} &< .75 \text{ LA} \\ 0.052\%/day + 0.001\%/day &< 0.075\%/day \\ 0.053\%/day &< 0.075\%/day \end{aligned}$$

#### 7.5 Imposed Leakage Rate Verification Test (Mass Point)

The acceptance criteria for the imposed leakage verification test is that the calculated leakage during the verification test shall be greater than the sum of 0.75 of the imposed leakage rate plus the calculated ILRT leakage rate, and less than the sum of 1.25 of the imposed leakage rate plus the calculated ILRT leakage rate. The imposed leakage rate shall be between 0.75 and 1.25 of the maximum allowed leakage rate of 0.100%/day. The calculations shall utilize at least 10 data points, recorded over a time span of at least 4 hours.

## 7.5 IMPOSED LEAKAGE

- \*  $Lo + Lcalc - .25 La < Lver < Lo + Lcalc + .25 La$   
where,  $Lo$  = imposed leakage rate in the range  
 $.75 La \leq Lo \leq 1.25 La$   
 $Lcalc$  = ILRT calculated leakage rate  
 $Lver$  = Verification test calculated leakage rate

Actual Test Data is as follows:

- \*  $Lo = 0.097\%/day (7.67 \text{ scfm})$
- \*  $0.25 La = 0.025\%/day$
- \*  $Lcalc = 0.060\%/day$
- \*  $Lver = 0.148\%/day (\text{Mass Point})$
- \* Data Points = 17

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

$$\begin{aligned} Lo + Lcalc - .25 La &< Lver < Lo + Lcalc + .25 La \\ 0.097 + 0.060 - 0.025 &< 0.148 < 0.097 + 0.060 + 0.025 \\ 0.132 &< 0.148 < 0.182 \end{aligned}$$

7.6 Imposed Leakage Rate Verification Test (Total Time)

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

Actual Test Data is as follows:

- \*  $Lo = 0.097$
- \*  $0.25 La = 0.025$
- \*  $Lcalc = 0.043$
- \*  $Lver = 0.117$
- \* Data Points = 17

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

$$L_o + L_{calc} - .25 L_a < L_{ver} < L_o + L_{calc} + .25 L_a$$

$$0.097 + 0.043 - 0.025 < 0.117 < 0.097 + 0.043 + 0.025$$

$$0.115 < 0.117 < 0.165$$

#### 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, 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 through penetration leakage for all penetrations exceed 0.06%/day.

Maximum leakage for all penetrations during Modes 1, 2, 3 or 4 operation, was 0.036%/day.

All Local Leak Rate Test failures were experienced during Unit outages. In all cases, actions were taken to repair the valve and a satisfactory test was performed prior to entering Mode 4 (requiring containment integrity).

The following are outage periods (Modes 5, 6 or defueled) during which penetrations were tested. Total Local Leak Rate Test leakage values at the start of testing and as left are listed below:

<u>DATES</u>	<u>START</u> (%/DAY)	<u>END</u> (%/DAY)
6/29/82 - 7/05/82	0.0347	0.0343
8/18/82 - 8/20/82	0.0343	0.0330
10/05/82 - 10/06/82	0.0330	0.0345
12/15/82 - 12/23/82	0.0346	0.0339
2/16/83 - 3/02/83	0.0343	0.0346
4/20/83 - 4/24/83	0.0346	0.0330
6/29/83 - 7/05/83	0.0347	0.0343
11/17/83 - 12/09/83	0.0425	0.0352
2/04/84 - 2/08/84	0.0352	0.0359
7/05/84 - 7/07/84	0.0344	0.0340
7/13/84 - 7/18/84	0.0340	0.0340
11/27/84 - 3/20/85	0.0338	0.0155

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 PENETRATIONS  
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 or 6.

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- 1.5 CHARGING PUMP HEADER DISCHARGE
- 1.6 FIRE PROTECTION
- 1.7 FUEL TRANSFER TUBE FLANGE GASKETS
- 1.8 CONTAINMENT PURGE EXHAUST

## 1.0 Introduction

Leakage Test Results of Penetration Tests 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 test was performed prior to establishment of containment integrity.

### 1.1 Fuel Transfer Tube Flange Gaskets

Subsequent to fuel loading, and prior to establishment of containment integrity, the flange/gaskets were reinstalled and a test performed on March 17, 1982. Test pressure could not be attained due to leakage through the gaskets.

The double gaskets were reworked and a Retest performed on April 11, 1982, with a leakage of 0.0000028%/day.

### 1.2 Containment Purge Exhaust (2HV9824, 2HV9825, 2HV9950, 2HV9951).

During testing of these values on July 2, 1982, test pressure could not be attained. This test failure was subsequent to a Maintenance outage where the valves were open for an extended period exposing the seating surfaces to a large volume of air and entrained particles. The failure is attributed to collection of foreign material on the valve seating surface. Due to the penetration design these valves must be tested in parallel. Therefore, through penetration leakage could not be determined.

These valves were retested on July 5, 1982, with a leakage of 0.002%/day.

### 1.3 Service Air (S22423MU055 & S22423MU017)

During testing of S22423MU055 on November 18, 1983, a leakage of 0.053%/day was measured. Testing of S22423MU017 on the same day resulted in a measured leakage of 0.01%/day, which would be the actual through penetration leakage for the penetration. Use of this value (0.01) in the Local Leak Rate Total would result in the total leakage being within allowable limits. Upon inspection of S22423MU055 rust particles were found in the valve. The valve was lapped and reassembled. Retest of S22423MU055 on November 22, 1983, resulted in a measured leakage of 0.0002%/day.

#### 1.4 Containment Waste Gas Vent (2HV7258 & 2HV7259)

During testing of 2HV7258 and 2HV7259 on November 21, 1983, leakage of 0.13%/day was measured. Due to the test method, through penetration leakage could not be determined. During disassembly of the 2HV7258, it was found that the gate and segment were pitted and scoured and the bonnet crushing seating service was deformed. The valve was reworked. No work was performed on 2HV7259. A retest was performed on December 1, 1983, with a measured leakage of 0.003%/day.

#### 1.5 Charging Pump Header Discharge (2HV9200)

During testing of 2HV9200 on November 30, 1983, test pressure could not be attained. Measured leakage through S21208MU122 (the outside containment isolation valve) was 0.012%/day during testing the same day. This represents the through penetration leakage for this time period. Use of this value (0.012%/day) would not have resulted in the total exceeding the allowable. Failure of the valve has been postulated as collection of particles on the seating surface. The initial test and subsequent stroking of the valve is credited with removal of this material and the successful retest. A retest was performed December 7, 1983, with a measured leakage of 0.003 %/day. It should be noted that this valve remains open during accident conditions as the boration flow path.

#### 1.6 Fire Protection (SA2301MU061)

During testing of SA2301MU061 on December 15, 1984, test pressure could be reached, but dropped so rapidly upon isolation that a test could not be performed. Measured leakage through 2HV5686, the outside isolation valve was 0.003%/day during a test on the same day. This represents the through penetration leakage for this time period. Use of this value (.003%/day) in the Local Leak Rate Total would result in the total being within the allowable. After disc replacement a retest was performed on February 16, 1985, with a resultant measured leakage of 0.0001 %/day for SA7301MU061.

#### 1.7 Fuel Transfer Tube Gaskets

Subsequent to fuel loading the flange/gaskets were reinstalled and a test performed on February 13, 1985, test pressure could not be attained due to leakage through the gaskets. After installation of a new gasket, a retest was performed on February 15, 1985, with a measured leakage of 0.000003 %/day.



1.8 Containment Purge Exhaust (2HV9824, 2HV9825, 2HV9950, 2HV9951)

During testing of these valves on February 19, 1985, a leak rate of 0.0695 was measured. This test was subsequent to a Maintenance outage where the valves were open for an extended period exposing the seating surface to a large volume of air and entrained particles. The failure has been attributed to collection of foreign material on the valve seating surface. Due to the penetration design, these valves must be tested to in parallel. Therefore, through penetration leakage could not be determined.

These valves were retested on February 20, 1985, with a leakage of 0.0012%/day.