UNIT 2/3 INTEGRATED PRIMARY CONTAINMENT LEAK RATE TEST

A. PURPOSE

The purpose of this procedure is to detail the steps necessary to determine the integrated primary containment leak rate (Type A Test).

B. REFERENCES

1. Dresden Nuclear Power Station, Units 2 & 3 Final Safety Analysis Report.

2. 10 CFR Part 50, Appendix J, January 1975 - Primary Reactor Containment Leakage Testing For Water-Cooled Power Reactors.

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

4. Bechtel Corporation Topical Report BN-TOP-1, Revision 1, November 1972 - Testing Criteria For Integrated Leakage Rate Of Primary Containment Structures For Nuclear Power Reactors.

5. Sargent and Lundy drawings:

   a. B-21, B-22, B-24, and B-26.

   b. M-7 and M-8.

6. Data Reduction & Error Analysis For The Physical Sciences, Phillip Bevington McGraw Hill.

C. PREREQUISITES

1. A signed and dated events log must be initiated by the responsible Tech Staff Engineer and will be kept up to date at all times by the Cognizant Engineer on shift.

2. A familiarization by Tech Staff personnel of all regulations, standards, and procedures applying to the IPCLRT including, but not limited to, those listed in REFERENCES.

3. All local leak rate tests on valves, seals, and penetrations of the primary containment must be completed before the IPCLRT can begin.

NOTE

Local leak rate tests must be done prior to <u>and</u> after any repair work being done on <u>any</u> penetration or associated isolation valve. In the special case of double gasketed seals, local leak rate tests must be done prior to opening the seal and after closing the seal.

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4. All pre-test checklist must be completed and returned to the responsible Tech Staff Engineer prior to the start of the test.

NOTE

> The work to be performed in these checklists involves various departments within the station. It also involves items which may be scheduled months or more in advance of the test. It is the responsibility of the cognizant Tech Staff Engineer to schedule the items and coordinate the work so as to facilitate the execution of the IPCLRT.

5. All instruments to be used for the IPCLRT will be calibrated over the full range of expected use prior to their placement in the primary containment for each test. The calibration must be in accordance with CECo Quality Procedures.

6. The pressure suppression chamber water level as monitored on LI-2(3)-1602-3 on panel 902-3(903-3) should indicate approximately -3.0 inches.

7. The reactor vessel water level as monitored on the WIDE RANGE GE-MAC (LI-2(3)-263-101), computer point F-286, should indicate approximately +30 inches.

8. Contact the NEL - PIA Insurance Co. prior to performing the test.

9. Load and save the computer program on the computer if it is to be used.

10. If it is desirable to have CPS available throughout the test, notify the Computer Systems Department at least two weeks in advance.

11. Prepare an instrumentation error analysis for the equipment used. See the example in Appendix A, attached.

D. PRECAUTIONS

1. Warning signs shall be posted at convenient locations around the periphery of the test area. All personnel not performing any required duties shall restrict their access beyond these points.

2. All station radiation protection and safety practices and rules will be strictly followed for this test.

3. All requests for equipment out-of-service for repairs during the test must be evaluated with respect to the fact that the primary containment will be under approximately 48 psig.

4. At no time during the period of pressurization, at test pressure, or depressurization of the primary containment will travel of the reactor building crane be allowed over the reactor cavity area.

5. Prior to performing any pressurization of the primary containment, isolation of pressure sensors is mandatory to prevent automatic actuation of ECCS Reactor Protection System trips.

6. If use of the shutdown cooling system is anticipated at anytime during the test. It shall be run for the entire duration of the test. This is to avoid transients in the vessel water level. A vessel water temperature of approximately 125°F shall be maintained.

NOTE

> This test should be conducted with the shutdown cooling system isolated. This, however, may not be possible, depending on decay heat. If this is not possible, one branch shall be put in service, but the vessel shell temperature shall not be allowed to drop below 120°F.

E. LIMITATIONS AND ACTIONS

1. The integrated leakage rate test will be conducted at the calculated maximum peak accident pressure of 48 psig. Time duration of the test pressure settings will be a minimum of 24 hours of continuous leakage rate measurements.

2. After the preoperational leakage rate tests, a set of three type A tests shall be performed, at approximately equal intervals during each ten year service period. The third test of each set shall be conducted when the unit is shutdown for the ten year inservice inspections.

3. Successful completion of this test will obtain all of the data necessary to demonstrate the integrity of the primary containment consistent with all station, license, and Nuclear Regulatory Commission requirements.

   a. The indicated leak rate shall be less than Lto (75% Lp).

   b. The upper 95% confidence limit of the indicated leak rate, which includes appropriate consideration for random measurement errors, shall be less than Lp.

4. Drywell pressurization will be discontinued if leakage above the maximum allowable rate is obvious or the drywell pressure cannot be increased. Repairs will be made and the test restarted.

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NOTE

Before terminating the test, a leak rate must be determined for reporting to the NRC if the leak rate is above Lp as defined in the Technical Specifications.

5. If the test is terminated, or if the test goes to normal completion and the calculated leak rate is above Lp, then a Reportable Occurrence must be issued.

6. During the period between the initiation of the containment inspection and the performance of this Type A test, no repairs or adjustments shall be made so that the containment can be tested in as close to the "as is" condition as practical.

7. During the period between the completion of one Type A test and the initiation of the containment inspection for the subsequent Type A test, repairs or adjustments shall be made to components whose leakage exceeds that specified in the Technical Specifications as soon as practical after indentification.

8. If during a Type A test, including the supplemental induced leakage test, potentially excessive leakage paths are identified which will interfere with satisfactory completion of the test, or which result in the Type A test not meeting the acceptance criteria, the Type A test shall be terminated and the leakage through such paths shall be measured using local leakage testing methods. Repairs and/or adjustments to equipment shall be made and the Type A test restarted. The corrective action and the change in leakage rate determined from the tests and overall integrated leakage determined from the local leak and Type A tests shall be included in the report submitted to the Commission.

9. Closure of containment isolation valves for the Type A test shall be accomplished by normal operation and without any preliminary exercising or adjustments. Repairs of maloperating or leaking valves shall be made as necessary. Information on any valve closure malfunction or valve leakage that requires corrective action before the test, shall be included in the report submitted to the Commission.

10. The containment test conditions shall stabilize for a period of four hours, and until the change in the average volume weighted primary containment temperature is less than 0.5°F per hour, prior to the start of the leakage rate test.

11. All vented systems shall be drained of water or other fluids to the extent necessary to assure exposure of the system containment isolation valves to containment air test pressure and to assure that they will be subjected to the post-accident

differential pressure. Systems that are required to maintain the plant in a safe condition during the test shall be operable in their normal mode, and need not be vented. Systems that are normally filled with water and operating under post-accident conditions, such as the containment heat removal system, need not be vented.

12. Results of the supplemental induced leakage test are acceptable provided that the difference between the supplemental test data and the Type A test data is within 0.25 Lp:

$$\left| L_{\left(\substack{\text{induced phase total}\\ \text{statistical leak rate}}\right)} - \left[L_{\left(\substack{\text{24 hr. phase}\\ \text{statistical leak rate}}\right)} + L_{\left(\substack{\text{actual induced}\\ \text{leak rate}}\right)} \right] \right| \leq .25\ Lp$$

If results are not within 0.25 Lp, the reason shall be determined, corrective action taken, and a successful supplemental test performed.

13. A general inspection of the accessible interior and exterior surfaces of the primary containment structure and components shall be performed prior to any Type A test to uncover any evidence of structural deterioration which may affect either the containment structural integrity or leak tightness. If there is evidence of structural deterioration, Type A tests shall not be performed until corrective action is taken. Such structural deterioration and corrective actions taken shall be reported as part of the test report.

14. If the shutdown cooling system is required due to the reactor decay heat, it shall remain in operation throughout the test. This will help prevent transients in reactor water level.

15. The Integrated Primary Containment Leak Rate Test will consist of five phases. Each phase will have a definite starting and ending point and is so defined because of the different types of activities that will occur in each.

a. The preparation phase.

b. The pressurization phase.

c. The 24 hour leakage rate at 48 psig phase.

d. The induced leakage phase at 48 psig.

e. The depressurization phase.

NOTE

The signed and dated events log started by the reponsible Tech Staff Engineer will be kept up to date at all times by the Cognizant Engineer on shift during all phases of the test.

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F. PROCEDURE

1. *Test Preparation.*

a. Prior to sealing the drywell and pressure suppression chamber for pressurization, the pre-test portion of the following checklists must be completed:

CHECKLIST	DEPARTMENT	VERIFIED
1	Maintenance	______
2	Operations	______
3	Instrument Mechanics	______
4	Technical Staff	______

Pre-test preparation complete. ______

2. Pressurization.

a. Begin pressurizing the drywell and pressure suppression containment.

b. After the system is at 2 psig, inspect all appropriate penetrations and valves for excessive leakage. Special attention should be paid to the drywell to torus vacuum breakers electrical penetrations, and small penetrations which cannot be local leak rate tested.

c. If sources of leakage are found or the primary containment instrumentation indicates excessive leakage, pressurization should be stopped and this leakage should be estimated. If repairs cannot be achieved without depressurization, the drywell and pressure suppression chamber should be vented to facilitate repairs.

NOTE

The results of the local leak rate test or the estimated leakage rate from all <u>repaired</u> leaks must be totaled and added to the results of the 24 hour leak rate calculation to determine a leakage rate at the beginning of the test. If this resultant leak rate is above Lp, an Reportable Occurrence must be initiated.

d. When at 15 psig, hold for review of the leak rate as referenced by pressure decay indications.

e. Resume pressurizing the containment until a pressure of 48 psig is obtained.

f. The pressurization phase is complete when the average volume weighted containment temperature is found to change less than 0.5°F in one hour period with the primary containment pressure at 48 psig. Temperature stabilization may require additional pressurization until a balance is achieved. A minimum four hour stabilization period is required.

NOTE

A continuous monitoring of the containment penetrations should be maintained during the pressurization phase. If any leaks are found, an estimate of the leakage rate must be made before any repairs are attempted.

Test pressurization complete. ______________

3. 24 Hour Leak Rate at 48 psig.

a. Check all accessible primary containment penetrations that exhibited leakage at 2 psig with soap solution before the start of data taking.

b. Record the following data at least once every hour:

(1) Time and data.

(2) Ambient temperature, pressure and relative humidity of the reactor building.

(3) Absolute pressure of the primary containment.

(4) Air temperatures inside the drywell and pressure suppression chamber.

(5) Dew point temperatures inside the drywell and pressure suppression chamber.

(6) Reactor water temperature (computer point W2(3)26 or W2(3)28).

(7) Reactor water level (computer point F2(3)86).

(8) Torus water level (LI-2(3)-1602-3 panel 902-3(903-3).

c. Calculate, using either the hand method (an example of which is in Appendix B attached) or with the aid of a computer, the following information at least once every hour.

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(1) Average temperature by volume (^{o}F).

(2) Average vapor pressure by volume (psi).

(3) Average containment volume weighted temperature (^{o}F).

(4) Average containment volume weighted vapor pressure (psi).

(5) Primary containment dry air pressure (psia).

(6) Mass of contained dry air (lbs).

(7) Measured leak rate (weight %/day).

(8) Linear least squares fit leak rate (weight %/day).

d. Record the information calculated in F.3.b. and F.3.c. on data sheets of the type found in Checklist 6, attached.

e. Plot the information in F.3.c. as a function of time during the test.

f. Leakage rate measurements will be made at an average containment pressure (over the time period of the test) of at least 48 psig. Data taking will continue for at least 24 consecutive hours.

g. From the third data set through the 24th hour, the mass versus time data will be linear least squares fitted. The result is called the statistically average leak rate. (See Appendix B, attached, for hand method of calculation.)

h. Compare the 24 hour leakage rate to Lto (1.2% per day) and Lp (1.6% per day). If the leakage rate approaches Lto, every effort should be made to find the source of leakage and repairs made to stop it. The 24 hour phase should then be restarted.

Phase 3 ends with the calculation of the 24th hourly set of information. If the leakage rate is below Lto, phase 4 can begin immediately. If not, the responsible leaks must be repaired and the 24 hour phase repeated.

48 psig test phase successfully completed.

24 Hr. Indicated Leak Rate ______________%/Day

Verified ______________________________

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4. 48 psig Induced Leak Rate Phase.

Phase 4 is the induced leakage portion of the IPCLRT. During this test, a deliberate leak of known magnitude will be superimposed on the leakage rate already calculated during the 24 hour phase. This will provide reassurance against any uncertainties associated with the performance of the leak rate test. This leak should be of the same size as the allowable maximum leak rate Lt. The new leakage rate is then calculated and should approximately equal the 24 hour leakage rate plus the induced leakage rate. This phase then acts as a verification of the accuracy of the data obtained in phase 3.

a. The suction to the flowmeter for the induced leakage should be taken from the suction line to the CAM monitor. The charcoal moisture absorber should remain in the line and if desirable, a dehydrator and particulate filter can also be installed. The flowmeter discharge shall be vented to the reactor building.

b. Request the Radiation Protection Department to obtain a drywell air sample. This can be obtained from the discharge of the IPCLRT flowmeter. While obtaining the sample, maintain a flow rate approximately equal to Lto and allow for a stabilization period of approximately one hour. (See Checklist #5, attached).

c. After the air sample has been taken, begin recording data as in step F.3.b. at least once every hour. In addition to the above data, also record the induced leakage flow rate.

d. Perform the calculations listed in step F.3.c. at least once every hour.

e. Repeat steps F.4.c. and F.4.d. until the induced leakage can accurately be detected as defined in step E.12.

f. If the induced leakage cannot be accurately detected, an investigation of the cause should be made, corrective actions taken, and the induced leakage phase restarted following repressurization to 48 psig. An evaluation and the corrective actions should be included in the report to the NRC.

entire test ?

Induced leakage successfully detected.

Actual Induced Leak Rate ________________ %/Day

Indicated Leak Rate ________________ %/Day

Verified ________________

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5. Depressurization.

Phase 5, the depressurization phase, can begin with the end of the successful completion of the induced leakage phase.

a. CLOSE valves AO-2(3)-9207A and AO-2(3)-9207B to isolate the IPCLRT flowmeter.

b. Verify that the results of the air sample taken in step F.4.b. are below the allowable activity limits.

c. Verify that valve AO-2(3)-1601-63 is in the CLOSED position.

d. OPEN valves AO-2(3)-1601-24 and AO-2(3)-1601-62 and vent the drywell through the drywell purge fan system. When the primary containment pressure has decayed to less than 15 psig, OPEN valve AO-2(3)-1601-61.

e. After depressurization is complete, normal station drywell entry procedures should be followed for the initial drywell entry. One torus access hatch should be removed for torus entry.

f. With the approval of the Rad Protection Department, the first subsequent drywell entry will be by Technical Staff personnel. The purpose of this entry is to note any deviation from original position of any instrumentation or fans used for the test. Any deviations found will be noted and accounted for in the log book.

g. Only after the Technical Staff inspection will the Instrument Mechanics remove all test equipment from the primary containment.

h. The responsible Tech Staff Engineer should notify the Shift Engineer of satisfactory completion of the test so that all valves with altered position status can be returned to normal.

i. CLOSE the torus access hatch after the removal of all instrumentation. Tech Staff shall perform a final local leak rate test of that penetration.

Verified ______________________________

G. CHECKLISTS

1. DTS 1600-7, Maintenance Department, Checklist 1, attached.

2. DTS 1600-7, Operating Department, Checklist 2, attached.

3. DTS 1600-7, Instrument Maintenance Department, Checklist 3, attached.

4. DTS 1600-7, Technical Staff, Checklist 4, attached.

5. DTS 1600-7, Radiation Protection, Checklist 5, attached.

6. DTS 1600-7, Data Record, Checklist 6, attached.

H. TECHNICAL SPECIFICATION REFERENCES

1. Section 4.7.A.2.

2. Section 3.6.B.2.

A. Pretest Requirements

1. CLOSE equipment hatch and notify the Tech Staff to perform a local leak rate test.

Verified ______________________________

2. If fans are required in the torus and/or drywell, install them at the locations determined by the Tech Staff Engineer.

Verified: ____________ installed ____________ not required

3. CLOSE both torus access hatches after verifying that the Instrument Mechanics have installed all the required instrumentation. Notify Tech Staff to perform local leak rate tests.

Verified ______________________________

4. Dry filtered air shall be supplied by air compressors to the drywell and pressure suppression chamber at penetration number X-150A. Install the air compressors in parallel including piping, manifolds, afterfilters and dryers (or equivalent) to existing penetrations as per Figure 1, attached.

Verified ______________________________

5. OPEN two sets of two suppression chamber to drywell vacuum breaker valves (total 4) connecting the drywell & pressure suppression chamber. Vacuum breaker valves shall be secured so as to remain in the OPEN position.

Verified ______________________________

6. Install the multiplexer unit inside the drywell.

Verified ______________________________

B. Post Pressurization Requirement

1. Upon notification by the cognizant Tech staff person on shift, disconnect the 4" compressor discharge line and reinstall the regular drain piping and flange at penetration X-150A.

Verified ______________________________

C. Post Test Requirement

1. After drywell entry has been made, return all open vacuum breakers to their normally CLOSED position.

Verified ______________________________

2. OPEN one torus access hatch.

Verified ______________________________

3. Disassemble all the air compressor manifold piping.

Verified ______________________________

4. Upon the removal of all test instrumentation, CLOSE the open torus access hatch and request Tech Staff to perform a local leak rate test.

Verified ______________________________

5. Remove the multiplexer from drywell.

Verified ______________________________

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A. Pretest Requirements

1. The following items will be done in preparation for startup:

   a. Reactor recirculation loop, System A, vented and water filled.

      Verified ______________________

   b. Reactor recirculation loop, System B, vented and water filled.

      Verified ______________________

   c. Reactor recirculation loop cross tie header vented and water filled.

      Verified ______________________

2. Prepare the following primary containment isolation valves by positioning them as indicated and hanging caution cards.

   NOTE

   Closure of the containment isolation valves will be done by the normal mode of operation without preliminary exercising.

   Verified ______________________

3. The reactor drywell equipment drain sump shall be pumped down below pump suction level to allow for a vent path. All associated drain piping discharging into this sump shall be drained and without flow.

   Verified ______________________

4. The reactor drywell floor drain sump shall be pumped down below pump suction level to allow for a vent path. All associated drain piping discharging into this sump shall be drained and without flow.

   Verified ______________________

5. Isolation of the scram and ECCS pressure sensors is mandatory to prevent automatic actuation. Verify that the following sensor root valves are closed and tagged Out-Of-Service.

Sensor	Verification
PS-2(3)-1621A	______________________
PS-2(3)-1621B	______________________

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Sensor	Verification
PS-2(3)-1621C	______
PS-2(3)-1621D	______
PS-2(3)-1632A	______
PS-2(3)-1632B	______
PS-2(3)-1632C	______
PS-2(3)-1632D	______
PS-2(3)-1628A	______
PS-2(3)-1628B	______
PS-2(3)-1629A	______
PS-2(3)-1629B	______

6. Insure that the internal vessel atmosphere is vented to the drywell and interconnecting pressure suppression containment by OPENING 2(3)-220-48 and 2(3)-220-49 as a path to the drywell equipment drain sump. Ensure that the refueling bellows and bulkhead hatches are open.

Verified ______________________

7. Isolate the jockey pump from the appropriate LPCI loop by CLOSING the following valves:

Unit 2	Unit 3
MO-2-1501-32A	Mo-3-1501-32B
2-1501-66A	3-1501-66A

Notify the maintenance department in order that the containment spray header flange can be changed to accommodate the air line.

Verified ______________________

8. Check that the TIP detectors are in their shields with each TIP drive mechanism primary power connector J-4 removed and logged in the Jumper Log. The TIP ball valves should be closed.

Verified ______________________

9. Verify that both core spray loops are filled with water.

Verified ______________________

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10. Turn both CRD pumps off.

Verified ____________________

11. If the reactor vessel water temperature can remain at approximately 125°F without the use of the shutdown cooling throughout the test duration, this system shall be isolated; otherwise, one loop shall be put into operation using both suction and discharge lines.

Verified: ______________ ______________
SDC required SDC not required

12. Immediately prior to pressurizing the primary containment, make a general announcement over the plant public address system stating that the IPCLRT is about to begin.

Verified ____________________

13. OPEN the VALVE 2-1501-28A(3-1501-28B) for containment pressurization.

Verified ____________________

14. Turn off all drywell coolers if they are not to be used.

Verified ____________________

Performance of this checklist will put the systems affecting primary containment in the following configuration:

SYSTEM	CONDITION
Main Steam	Isolated, Drained, Vented
Reactor Feedwater	Isolated
Reactor Building Closed Cooling Water to Drywell	Supply closed, Return Open
Pressure Suppression	Isolated, Vented
Core Spray	Isolated
Low Pressure Coolant Injection	Isolated
High Pressure Coolant Injection	Isolated
Reactor Cleanup	Isolated. Filter demin ready for service.
Shutdown Cooling	Isolated, unless operation required to maintain 125°F reactor vessel water temperature.
Clean [illegible] to Drywell	Isolated
Drywell [illegible] & Equipment Drains	Isolated, Vented
Service [illegible] to Drywell	Isolated
Drywell [illegible]eumatic	Isolated. Vented
Isolation Condenser	Isolated, Vented
Reactor Recirculation	Filled, Pumps Off
Head Cooling	Isolated, Vented
CRD Return	Isolated

OC B. Post Pressurization Requirements

1. CLOSE VALVE 2-1501-28A(3-1501-28B) upon notification from the Tech Staff.

Verified ______________________________

2. From now until the end of the test, maintain as constant as possible a vessel level of +30 inches and a water temperature of 125°F.

NOTE

Once a suitable shutdown cooling flow rate is established, the 2(3)-1001-4 valves are not to be throttled. All temperature control is to be done with the 2(3)-3704 valve and/or the appropriate RBCCW manual shutdown cooling heat exchanger inlet valve.

Verified ______________________________

3. After the Maintenance Department removes the temporary flange from the containment spray line, OPEN the following valves:

UNIT 2	UNIT 3
MO-2-1501-32A	MO-3-1501-32B
2-1501-66A	3-1501-66A

Verified ______________________________

C. Post Test Requirements

1. Return all previously altered equipment back to its normal state.

Verified ______________________________

ID	PENT. NO.	LOCATION ELEV.	AZI.	LINE SIZE	VALVE NUMBER	POSITION	DESCRIPTION
25(356)	x-131A	528-0	110	3/4	2(3)-1601-4A	C	ECCS & AUTO BLOWDO
	x-131B		115		2(3)-1601-4B	C	
	x-131C		290		2(3)-1601-4C	C	
	x-131D		295		2(3)-1601-4D	C	
20(353)	x-123	513-9	45	6	MO-2(3)-3702	C	RBCCW INLET
20(353)	x-124	513-9	48	6	MO-2(3)-3703	O	RBCCW OUTLET
					MO-2(3)-3706	O	
29(360)	x-116A	513-9	83	16	MO-2(3)-1501-22A	C	LPCI INJECTION
	x-116B		263		MO-2(3)-1501-22B	C	
29(360)	x-310A	509-0	118	14	MO-2(3)-1501-20A	C	LPCI TEST LINE
					MO-2(3)-1501-38A	C	
					MO-2(3)-1501-13A	C	
	x-310B		238		MO-2(3)-1501-20B	C	
					MO-2(3)-1501-38B	C	
					MO-2(3)-1501-13B	C	
29(360)	x-311A	509-0	120	6	MO-2(3)-1501-18A	C	LPCI TORUS SPRAY
					MO-2(3)-1501-19A	C	
	x-311B		240		MO-2(3)-1501-18B	C	
					MO-2(3)-1501-19B	C	
29(360)	x-145	547-6	210	10	MO-2-1501-27B	C	LPCI DW SPRAY (D2
					MO-2-1501-28B	C	
					MO-3-1501-27A	C	(D
					MO-3-1501-28A	C	
29(360)				24	MO-2(3)-1501-5A	C	LPCI SUCTION
					MO-2(3)-1501-5B	C	
					MO-2(3)-1501-5C	C	
					MO-2(3)-1501-5D	C	
					2(3)-1501-31A	O	
					2(3)-1501-31B	O	
					2(3)-1501-31C	O	
					2(3)-1501-31D	O	
14(347)	x-105A	517-6	5	20"	AO-2(3)-203-1A	C	PRIMARY STEAM
					AO-2(3)-203-2A	C	
				3/4"	2(3)-220-7A	C	(Gland Seal Leak
					2(3)-220-8A	C	(Gland Seal Leak
					2(3)-220-9A	C	(Vlv Body Drain)
					2(3)-220-10A	C	(Vlv Body Drain)
					—	C	(MSL Test Conn)

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P&ID	PENT. NO.	LOCATION ELEV.	LOCATION AZI.	LINE SIZE	VALVE NUMBER	POSITION	DESCRIPTION
14(347)	X-105B	517-6	10	20"	AO-2(3)-203-1B	C	PRIMARY STEAM
					AO-2(3)-203-2B	C	
				3/4"	2(3)-220-7B	C	(Gland Seal Leak-Off
					2(3)-220-8B	C	(Gland Seal Leak-Off
					2(3)-220-9B	C	(Vlv Body Drain)
					2(3)-220-10B	C	
					—	C	(MSL Test Conn)
14(347)	X-105C	517-6	350	20"	AO-2(3)-203-1C	C	PRIMARY STEAM
					AO-2(3)-203-2C	C	
				3/4"	2(3)-220-7C	C	(Gland Seal Leak-Off
					2(3)-220-8C	C	(Gland Seal Leak-Off
					2(3)-220-9C	C	(Vlv Body Drain)
					2(3)-220-10C	C	(Vlv Body Drain)
					—	C	(MSL Test Conn)
14(347)	X-105D	517-6	355	20"	AO-2(3)-203-1D	C	PRIMARY STEAM
					AO-2(3)-203-2D	C	
				3/4"	2(3)-220-7D	C	(Gland Seal Leak-Off
					2(3)-220-8D	C	(Gland Seal Leak-Off
					2(3)-220-9D	C	(Vlv Body Drain)
					2(3)-220-10D	C	
					—	C	(MSL Test Conn)
...347)	X-106	515-0	0	2"	MO-2(3)-220-1	C	MSL DRAIN
					MO-2(3)-220-2	C	
					MO-2(3)-220-3	O	
				3/4"	2(3)-220-5	C	(Test Conn)
					2(3)-220-6	C	
				2"	MO-2(3)-220-90A	O	
					MO-2(3)-220-90B	O	
					MO-2(3)-220-90C	O	
					MO-2(3)-220-90D	O	
					2(3)-3025-500	O	(MSL Drain Hose Con
					2(3)-3025-501	O	
14(347)	X-115B	513-9	275	3/4"	2(3)-220-11A	O	MSL FLOW INSTR
					2(3)-220-12A	O	
					2(3)-220-11B	O	
					2(3)-220-12B	O	
					2(3)-220-11C	O	
					2(3)-220-12C	O	
					2(3)-220-11D	O	
					2(3)-220-12D	O	

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P&ID	PENT. NO.	LOCATION ELEV.	AZI.	LINE SIZE	VALVE NUMBER	POSITION	DESCRIPTION
25(356)	x-126	513-0	332	18"	AO-2(3)-1601-21	C	N_2 PURGE LINE
					AO-2(3)-1601-22	C	
				4"	AO-2(3)-1601-55	C	
				18"	AO-2(3)-1601-56	C	
				3"	2(3)-8502-500	C	(Bypass Vlv - D3 Only
				1½"	MO-2(3)-1601-57	C	(N2 Makeup)
					AO-2(3)-1601-58	C	(N2 Makeup)
					AO-2(3)-1601-59	C	(N_2 Makeup)
				3/4"	—	C	(Test Conn)
					PS 8541-13 Root	O	N_2 Makeup Vent Path
25(356)	x-304	509-0	270	18"	AO-2(3)-1601-20A	C	TORUS VACUUM RELIEF
					AO-2(3)-1601-20B	C	(Note: Fail Open)
					—	C	(Test Conn: 1@)
25(356)	x-125	572-0	145	18"	AO-2(3)-1601-23	C	DRYWELL VENT
					AO-2(3)-1601-24	C	(To Exhaust Fans)
				2"	AO-2(3)-1601-62	C	(Bypass: Vent Relie
				6"	AO-2(3)-1601-63	C	(To Stby Gas)
				3/4"	—	C	(Test Conn El 570'0"
25(356)	x-318	509-0	95	18"	AO-2(3)-1601-60	C	TORUS VENT
				2"	AO-2(3)-1601-61	C	(Bypass: Vent Relief
				3/4"	—	C	(Test Conn El 510'0'
25(356)	x-309A	498-7	155	½"	FCV-2(3)-8501-1A	C	TORUS SAMPLE
					FCV-2(3)-8501-1B	C	
25(356)	x-204	532-6	190	1"	FCV-2(3)-8501-3A	C	SAMPLE RETURN
					FCV-2(3)-8501-3B	C	
25(356)	x-143	547-6	120	½"	FCV-2(3)-8501-5A	C	DRYWELL SAMPLE
					FCV-2(3)-8501-5B	C	
					FCV-2(3)-9205A	C	
					FCV-2(3)-9205B	C	
					FCV-2(3)-9206A	C	
					FCV-2(3)-9206B	C	
					2(3)-8507-500	C	
					2(3)-8507-501	C	
					2(3)-8507-502	C	
					2(3)-8507-503	C	
					2(3)-8507-504	C	
					2(3)-8507-505	C	
					2(3)-8507-506	C	
					2(3)-8507-507	C	
					2(3)-8507-508	C	
					2(3)-8507-509	C	
					2(3)-8507-510	C	

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P&ID	PENT. NO.	LOCATION ELEV.	AZI.	LINE SIZE	VALVE NUMBER	POSITION	DESCRIPTION
					2(3)-8507-511	C	
					2(3)-8507-512	C	
					2(3)-8507-513	C	
					2(3)-8507-514	C	
					2(3)-8507-515	C	
25(356)	x-112A&B	547-5	20	—	—	C	DW COOLER DAMPER CONT
26(357)	x-147	564-0	295	2½"	2(3)-205-2-3	O	Rx HEAD COOLING
					MO-2(3)-205-2-4	C	
				3/4"	2(3)-205-2-1	O	(Drain)
					2(3)-205-2-2	O	(Drain)
					2(3)-205-2-5	C	(Test Conn)
				1½"	—	C	(Test Conn El 560'0"
					— (4-Vlv)	C	(Drain El 560'0")
26(357)	x-135A	563-0	70	1"	2(3)-220-53	O	Rx VESSEL INSTR
	x-127A	560-0	70	1"	2(3)-263-2-10	O	
	x-128A	565-0	70	1"	2(3)-263-2-12B	O	
	x-128B			1"	2(3)-263-1-14B	O	
	x-129A	564-0	70	1"	2(3)-263-2-12A	O	
	x-129B			1"	2(3)-263-2-14A	O	
	x-129C			1"	2(3)-263-2-16A	O	
	x-129D			1"	2(3)-263-2-18A	O	
					2(3)-263-41A	O	
	x-129E			1"	2(3)-263-2-16B	O	
	x-129F			1"	2(3)-263-2-18B	O	
					2(3)-263-41B	O	
	x-142A	540-0	75	1"	2(3)-263-2-21A	O	
					2(3)-263-2-21B	O	
					2(3)-263-2-22A	O	
					2(3)-263-2-22B	O	
					2(3)-263-2-30 B thru K	O	
	x-142B		245	1"	2(3)-263-2-21C	O	
					2(3)-263-2-21D	O	
					2(3)-263-2-22C	O	
					2(3)-263-2-22D	O	
					2(3)-263-2-30 M thru W	O	
	x-131A	528-0	110	1"	2(3)-263-2-24	O	
	x-131B		115	1"	2(3)-263-2-26	O	
	x-131C		290	1"	2(3)-263-2-32	O	
	x-146	541-0	145	1"	2(3)-220-66 A thru D	O	
	x-208	530-0	205	1"	2(3)-220-66 E thru H	O	
	x-133A	510-0	90	1"	2(3)-220-15A	O	
	x-133B			1"	2(3)-220-16A	O	
	x-133C		270	1"	2(3)-220-15B	O	
	x-133D			1"	2(3)-220-16B	O	

P&ID	PENT. NO.	LOCATION ELEV.	LOCATION AZI.	LINE SIZE	VALVE NUMBER	POSITION	DESCRIPTION
	x-132A		90	1"	2(3)-262-24A	O	
	x-132B			1"	2(3)-262-23A	O	
	x-132C		270	1"	2(3)-262-24B	O	
	x-132D			1"	2(3)-262-23B	O	
	x-134A		90	1"	2(3)-220-13A	O	
	x-134B			1"	2(3)-220-14A	O	
	x-134C		270	1"	2(3)-220-13B	O	
	x-134D			1"	2(3)-220-14B	O	
26(357)	x-122	548-8	265	3/4"	AO-2(3)-220-44	C	Rx WATER SAMPLE
					AO-2(3)-220-45	C	
					2(3)-220-42	C	(Test Conn)
					2(3)-220-43	C	
27(358)	x-149A	564-9	20	10"	2(3)-1402-6A	O	CORE SPRAY
					MO-2(3)-1402-25A	C	
				3/4"	2(3)-1402-32A	C	(Test Conn)
					2(3)-1402-33A	C	
				16"	MO-2(3)-1402-3A	C	
				12"	2(3)-1402-2A	O	
27(358)	x-149B	564-9	155	10"	2(3)-1402-6B	O	CORE SPRAY
					MO-2(3)-1402-25B	C	
				3/4"	2(3)-1402-32B	C	(Test Conn)
					2(3)-1402-33B	C	
				16"	MO-2(3)-1402-3B	C	
					2(3)-1402-2B	O	
27(358)	x-310A	509-0	118	8"	MO-2(3)-1402-4A	C	CORE SPRAY TEST LI
	x-310B		238	8"	MO-2(3)-1402-4B	C	
28(359)	x-141A			14"	MO-2(3)-1301-1	C	ISOLATION COND
					MO-2(3)-1301-2	C	
				3/4"	2(3)-1301-34	C	(Test Conn)
					2(3)-1301-35	C	
					—	C	(Gland Seal Leak-O
				1"	2(3)-1301-21	O	
					2(3)-1301-22	O	
					2(3)-1301-27	O	
					2(3)-1301-28	O	
				3/4"	AO-2(3)-1301-17	O	
					AO-2(3)-1301-20	O	
28(359)	x-109A	547-10	178	12"	MO-2(3)-1301-3	C	ISOLATION COND
					MO-2(3)-1301-4	C	
				3/4"	2(3)-1301-32	C	(Test Conn)
					2(3)-1301-33	C	

[illegible]	PENT. NO.	LOCATION ELEV.	AZI.	LINE SIZE	VALVE NUMBER	POSITION	DESCRIPTION
30(361)	x-113	547-10	300	10"	MO-2(3)-1201-1	C	Rx CLEANUP
					MO-2(3)-1201-2	C	
					MO-2(3)-1201-3	C	
				3/4"	2(3)-1201-31	C	(Test Conn)
					2(3)-1201-32	C	
					—	C	(DW Test Connection)
32(363)	x-111A	530-8	25	16"	MO-2(3)-1001-1A	C	SHUTDOWN COOLING
				3/4"	2(3)-1001-45A	C	(Drain)
					2(3)-1001-46A	C	(Drain)
					2(3)-1001-47A	C	
					2(3)-1001-48A	C	
				14"	MO-2(3)-1001-2A	C	
					MO-2(3)-1001-2B	C	
				3/4"	2(3)-1001-92A	C	(Drain)
					2(3)-1001-92B	C	(Drain)
					2(3)-1001-88A		(Gland Seal Leak-Off)
32(363)	x-111B	530-8	70	16"	MO-2(3)-1001-1B	C	SHUTDOWN COOLING
				3/4"	2(3)-1001-45B	C	(Drain)
					2(3)-1001-46B	C	
					2(3)-1001-47B	C	
					2(3)-1001-48B	C	
				14"	MO-2(3)-1001-2C	C	
				3/4"	2(3)-1001-92C	C	(Drain)
					2(3)-1001-88B	C	(Gland Seal Leak-Off)
32(363)	x-116A	513-9	83	14"	MO-2(3)-1001-5A	C	SHUTDOWN COOLING
				3/4"	2(3)-1001-10A	C	(Gland Seal Leak-Off)
					2(3)-1001-14A	C	
32(363)	x-116B	513-9	263	14"	MO-2(3)-1001-5B	C	SHUTDOWN COOLING
				3/4"	2(3)-1001-10B	C	(Gland Seal Leak-Off)
					2(3)-1001-14B	C	
33(364)	x-130	581-0	340	1½"	2(3)-1101-1	O	SBLC
					—	C	(Test Conn: in DW)
					—	C	(Test Conn: out DW)
35(366)	x-119	527-6	275	1½"	2(3)-4327-500	C	WELL WATER
37(367)	x-121	527-6	283	1"	2(3)-1601-4B	O	DW PNEUMATIC SYSTEM
				2"	AO-2(3)-4722	C	
37(367)	x-139D	536-6	280	1"	AO-2(3)-4720	C	DW PNEUMATIC SYSTEM
					AO-2(3)-4721	C	
					2(3)-4771-500	O	Vent Path
					2(3)-4771-501	O	

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D	PENT. NO.	LOCATION		LINE SIZE	VALVE NUMBER	POSITION	DESCRIPTION
		ELEV.	AZI.				
38(368)	x-120	527-6	280	1"	2-46[illegible]-500	C	SERVICE AIR (D2 ONLY
					3-4640-500	C	(D3 ONLY
39(369)	x-118	512-3	45	3"	AO-2(3)-2001-5	C	DW EQUIP DRAIN
					AO-2(3)-2001-6	C	
					—	C	(Test Conn)
39(369)	x-117	512-3	185	3"	AO-2(3)-2001-105	C	DW FLOOR DRAIN
					AO-2(3)-2001-106	C	
					—	C	(Test Conn)
49				18"	MO-2(3)-7503	O	STBY GAS
51(374)	x-115A	513-9	97	10"	MO-2(3)-2301-4	C	HPCI
					MO-2(3)-2301-5	C	
				3/4"	2(3)-2301-16	C	(Test Conn)
					2(3)-2301-17	C	
				16"	MO-2(3)-2301-36	C	
				3/4"	2(3)-2301-93	C	(Drain)
					2(3)-2301-94	C	
				1"	SO-2(3)-2301-31	O	
					SO-2(3)-2301-29	O	
					SO-2(3)-2301-30	C	
					2(3)-2301-43	O	
					2(3)-2301-44	O	
51(374)	x-141A	542-6	160	3/4"	2(3)-2301-24	O	HPCI INSTR
					2(3)-2301-25	O	
57(374)	x-317A	509-10	190	3/4"	2(3)-2301-41A	C	HPCI (Test Conn)
					2(3)-2301-42A	C	
				1"	SO-2(3)-2301-28	O	
51(374)	x-312	497-0	200	3/4"	2(3)-2301-41B	C	HPCI (Test Conn)
					2(3)-2301-42B	C	
				1"	SO-2(3)-2301-32	C	
				2"	2(3)-2301-33	O	
					2(3)-2301-47	O	

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A. Pretest Requirements

1. Obtain and supply to the responsible Tech Staff Engineer calibration curves for the read-out of sensors LI-2(3)-263-101 and, TE-2(3)-261-8E or TE-2(3)-261-8F (computer outputs F-2(3)86 W-2(3)26, and W-2(3)28 respectively).

Verified ______________________

2. Obtain and supply to the responsible Tech Staff Engineer accuracy and repeatability error information on the temperature measuring device calibrated above.

Verified ______________________

3. Connect all instrumentation (includes both plumbing and electrical connections) both inside and outside the dry-well.

Verified ______________________

B. Test Requirements

1. During the full duration of the test, no surveillances shall be conducted that have the potential of causing a scram.

Verified ______________________

C. Post Test Requirements

1. Disconnect all IPCLRT temporary instrumentation.

Verified ______________________

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A. Pretest Requirements

1. Arrange for the calibration of the instrumentation to be used.

Verified ______________________

2. Make a survey of the primary containment for the purpose of establishing any tendencies for regional variations in temperature. This survey will be used in determining where to place the temperature sensing devices.

Verified ______________________

NOTE

Where testing experience with a given containment structure has previously established appropriate locations for temperature sensors, temperature surveys may be eliminated.

3. At the same time as the temperature survey, conduct a survey for the purpose of determining the placement of the humidity indicators so that a representative sampling of the primary containment air can be made.

Verified ______________________

NOTE

As in the case of the temperature survey, this humidity survey may be eliminated for a containment structure which has known and characteristic humidity patterns.

4. Determine the placement of all temperature and humidity sensing devices from the surveys in steps 2 and 3 above.

Verified ______________________

5. Obtain the instrument accuracies for all instruments and readout devices to be used in the IPCLRT. Perform an error analysis to verify that the accuracy of the collected data is consistent with the magnitude of the specified leakage rate. This analysis must be done prior to the placement of any instrumentation in the primary containment for the test. (See Appendix A, attached, for a sample calculation.)

INTERPRETATION

Specifically, the combined instrument repeatability error should be at least one order of magnitude less than the maximum allowable leak rate.

Verified ______________________

6. Arrange for the availability of the air compressors for use in pressurizing the containment.

Verified ______________________

7. Examine LLRT results for all tests and verify that all Technical Specification limits have been met prior to the start of the IPCLRT. Also, obtain the total calculated leakage from the primary containment penetrations both prior to and after repairs (in the case of double gasketed seals, before and after opening the seal). This information will be required when the results of the IPCLRT are analyzed.

Verified ______________________

8. Arrange with the Instrument Mechanics for placement of the calibrated instrumentation in the primary containment and its connection to read-out devices outside the primary containment. Verify the location and operability status of the instrumentation.

Verified ______________________

9. Verify the availability of instrumentation for the recording of atmospheric changes on-site and in the reactor building. These devices need only be of such accuracy that they will indicate gross barometric variations for correlation to test results.

Verified ______________________

10. Determine the volume of the primary containment associated with each temperature and humidity sensing device. This information will be used during the test for volume weighting the data.

Verified ______________________

11. Ensure that the air compressors, piping, manifolds and connections to the penetrations are installed by the Maintenance Department as required. Also verify proper operation of the compressors.

Verified ______________________

12. Conduct a thorough examination of the drywell and pressure suppression containment to remove any pressurized vessels, ga[illegible] pressure cylinders, sealed or semi-sealed containers, and anything which, in the judgement of the Test Director, could

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be damaged by the pressure test atmosphere or have a direct bearing on the results of the leakage rate measurement.

Verified ______________________________

13. Verify valve line-up of Operating Department Checklist prior to starting the test.

Verified ______________________________

14. Verify that the personnel air lock is closed and locked.

Verified ______________________________

15. Direct the Operations Department in the pressurizing of the primary containment.

Verified ______________________________

16. Initiate a dated log of events and pertinent observations. This log must be maintained for the duration of the IPCLRT.

Verified ______________________________

17. Prepare graph paper for the plotting of the appropriate data.

Verified ______________________________

18. Ensure that the following penetrations are closed and have been local leak rate tested.

Equipment Hatch
CRD Removal Hatch
Torus Access Hatches
Drywell Head

Verified ______________________________

B. Post Test Requirements

1. Verify that all temporary instrumentation is removed.

Verified ______________________________

2. Verify that the torus access hatch that was opened for the removal of instruments is again local leak rate tested upon final closure.

Verified ______________________________

1. Prior to any venting of the primary containment, an air sample must be taken for analysis.

Verified ______________________________

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UNIT ______ ______

DATA SH[illegible] 3

DEWPOINT READINGS

HOUR	DEWPOINT 1 (°F)	DEWPOINT 2 (°F)	DEWPOINT 3 (°F)	DEWPOINT 4 (°F)	DEWPOINT 5 (°F)	DEWPOINT 6 (°F)			

DATE ______________

UNIT ______________

DATA SHEET 4

DATA TABULATION

HOUR	AVERAGE AMBIENT TEMP. (°F)	AMBIENT PRESSURE (psia)	AMBIENT RELATIVE HUMIDITY (%)		REACTOR WATER TEMPERATURE (°F)	REACTOR WATER LEVEL (In above 0")	TORUS WATER LEVEL (In above 0")	FLOW RECORDER BY THE ROTOMETER (SCFM)	

DATE ______________

UNIT ______________

DATA SHEET 5
DATA TABULATION
REACTOR BUILDING TEMPERATURE SENSOR READINGS (°F)

HOUR	LOCATION 1	LOCATION 2	LOCATION 3	LOCATION 4	LOCATION 5	LOCATION 6

DATE ______

UNIT ______

DATA SHEET 6
CALCULATED INFORMATION FOR THE IPCLRT

HOUR	PRIMARY CONTAINMENT PRESSURE (psia)	PARTIAL PRESSURE OF H_2O IN P.C. (psia)	DRY AIR PRESSURE IN PRIMARY CONTAINMENT (psia)	AVERAGE TEMPERATURE IN PRIMARY CONTAINMENT (°F)

DATE ____________

UNIT ____________

DATA SHE 7
CALCULATED INFORM..ON FOR IPCLRT

UR	MEASURED CONTAINED DRY AIR MASS (lbs)	MEASURED LEAK RATE (%/Day)		STATISTICALLY AVERAGE LEAK RATE (%/Day)	95% LOWER CONFIDENCE LIMIT (%/Day)	95% UPPER CONFIDENCE LIMIT (%/Day)
		TOTAL	POINT			

A. INSTRUMENT ACCURACY ERROR ANALYSIS

Per ANSI N45.4-1972, the computation of the leak rate is given by the equation:

$$L(\%) = \left(\frac{24}{H}\right)(100)\left(\frac{W_1 - W_2}{W_1}\right) = \frac{2400}{H}\left(1 - \frac{T_1 P_2}{T_2 P_1}\right)$$

where L = primary containment leak rate (%/day)
H = time interval between data sets #1 & #2 (hours)
W_1 = weight of the contained dry air mass at test data set #1 (lbs)
W_2 = weight of primary containment temperature at test data set #2 (lbs)
T_1 = volume weighted primary containment temperature at test data set #1 (^oR)
T_2 = volume weighted primary containment temperature at test data set #2 (^oR)
P_1 = dry air absolute pressure at test data set #1 (psia)
P_2 = dry air absolute pressure at test data set #2 (psia)

The standard variation on L due to the uncertainties in the measured variables is given by:

$$\delta(L) = \frac{2400}{H}\left[\left(\frac{\partial L}{\partial P_1}\delta(P_1)\right)^2 + \left(\frac{\partial L}{\partial P_2}\delta(P_2)\right)^2 + \left(\frac{\partial L}{\partial T_1}\delta(T_1)\right)^2 + \left(\frac{\partial L}{\partial T_2}\delta(T_2)\right)^2\right]^{\frac{1}{2}}$$

substituting H = 24 hours

$$\frac{\partial L}{\partial P_1} = \frac{T_1\, P_2}{T_2\, P_1^2} \approx \frac{1}{P_1}$$

$$\frac{\partial L}{\partial P_2} = -\frac{T_1}{T_2\, P_1} \approx -\frac{1}{P_1}$$

$$\frac{\partial L}{\partial T_1} = -\frac{P_2}{T_2\, P_1} \approx -\frac{1}{T_2}$$

$$\frac{\partial L}{\partial T_2} = \frac{T_1\, P_2}{T_2^2 P_1} \approx \frac{1}{T_2}$$

assuming $P_1 = P_2 = \overline{P}$ and $T_1 = T_2 = \overline{T}$.

where $\overline{P}$ = average absolute dry air pressure (psia)
$\overline{T}$ = average volume weighted primary containment absolute temperature (^oR)

Therefore,

$$\delta(L) = 100\left[2\left(\frac{\delta(\overline{P})^2}{\overline{P}}\right) + 2\left(\frac{\delta(\overline{T})^2}{\overline{T}}\right)\right]^{\frac{1}{2}}$$

1. Calculation of $\delta(\overline{T})$

$$\overline{T} = \sum_{j=1}^{NVOL} (VF_j)(Tave,_j)$$

where VF_j = the volume weighting factors

NVOL = the number of containment subvolumes

$Tave,_j$ = the average absolute temperature in the jth subvolume

$$Tave,_j = \sum_{i=1}^{N_j} \frac{Ti,j}{Nj}$$

where Ti,j = the absolute temperature of the ith RTD in the jth subvolume

Nj = number of RTD's in the jth subvolume

Now, $\delta(\overline{T})$ is calculated from

$$\delta(\overline{T}) = \sum_{j=1}^{NVOL} \frac{\partial\overline{T}}{\partial Tave,j}\ \delta(Tave,j)$$

where $\frac{\partial\overline{T}}{\partial Tave,j} = VFj$

$$\partial(Tave,j) = \frac{\text{RTD accuracy}}{(N_j)^{\frac{1}{2}}}$$

Therefore,

$$\delta(T) = \sum_{j=1}^{NVOL} (VFj)\left(\frac{\text{RTD accuracy}}{(Nj)^{\frac{1}{2}}}\right)$$

2. Calculation of $\delta(\overline{P})$

$$\delta(P) = [\delta(P_T)^2 + \delta(P_V)^2]^{\frac{1}{2}}$$

where PT = total absolute primary containment pressure
Pv = partial pressure of water vapor in the primary containment

substituting $\delta(PT) = \frac{\text{PPG accuracy}}{(\text{\# of PPG's})^{\frac{1}{2}}}$

$$\delta(P_V) = \sum_{j=1}^{NVOL} (VFj)\left(\frac{\text{dewcell accuracy}}{(Nj)^{\frac{1}{2}}}\right)$$

where PPG = precision pressure gage

Nj = number of dewcells in the jth subvolume

Therefore,

$$\delta(P) = \left[\left(\frac{\text{PPG accuracy}}{(\text{\# of PPG's})^{\frac{1}{2}}}\right)^2 + \left(\sum_{j=1}^{NVOL} (VFj)\left(\frac{\text{dewcell accuracy}}{(Nj)^{\frac{1}{2}}}\right)\right)^2 \right]^{\frac{1}{2}}$$

3. Determine the appropriate variable quantities and perform the above analysis twice - once for the system accuracy and once for the system repeatability.

A. Average Subvolume Temperature and Vapor Pressure.

$$Tj = \frac{\Sigma(\text{all RTD's in } j\underline{th} \text{ subvolume})}{\text{Number of RTD's in the } j\underline{th} \text{ subvolume}} \quad {}^{o}F$$

$$D.P._j = \frac{\Sigma(\text{all dewcell in } j^{\underline{th}} \text{ subvolume})}{\text{Number of dewcells in } j\underline{th} \text{ subvolume}} \quad {}^{o}F$$

Pv,j = see vapor pressure table and convert D.P.j (°F) to Pv,j (psi)

where Tj = average temperature of the j<u>th</u> subvolume
D.P.j = average dewpoint of the j<u>th</u> subvolume
Pv,j = average vapor pressure of the j<u>th</u> subvolume

B. Primary Containment Temperature and Dry Air Pressure.

P_T = Absolute primary containment pressure

$$P_v = \sum_{j=1}^{NVOL} (VFj)(Pv,j) \quad psi$$

$P = P_T - P_v$
= primary containment dry air pressure psia

$$T = \sum_{j=1}^{NVOL} (VFj)(T_j) \quad {}^{o}F$$

where NVOL = number of primary containment subvolumes
VFj = volume weighting factor of the j<u>th</u> subvolume
T = volume weighted average primary containment tem

NOTE

If for any reason in either of the above equations a particular subvolume is void of sensors, the corresponding VFj is added to VFj+1, assuming the next subvolume contains a similar sensor.

C. Contained Dry Air Mass.

$$W = \frac{(28.97)(144)(P)[TOTVOL - (Level - 30)(28.635)]}{(1545.33)(T + 459.69)}$$

$$= 2.6995 \frac{(P)[TOTVOL - (Level - 30)(28.635)]}{T + 459.69}$$

where, P = absolute primary containment dry air pressure (psia)

T = average primary containment temperature (^oF)

TOTVOL = total primary containment free air volume (includes volume over water in vessel) (FT^3)

LEVEL = reactor vessel water level (inches)

D. Measured Leak Rates.

$$Lm(TOTAL) = \left(\frac{W\ Base - Wi}{ti}\right)\left(\frac{2400}{W\ Base}\right) \quad \%/Day$$

$$Lm(POINT) = \left(\frac{Wi-1 - Wi}{ti - t_{i-1}}\right)\left(\frac{2400}{W_{i-1}}\right) \quad \%/Day$$

where, W Base = mass of contained air at t=0 (lbs)
Wi = mass of contained air at t=i hrs (lbs)
ti = test duration at the ith data set (hrs)

E. Statistical Leak Rate and Confidence Limits.

LINEAR LEAST SQUARES FITTING OF THE IPCLRT DATA

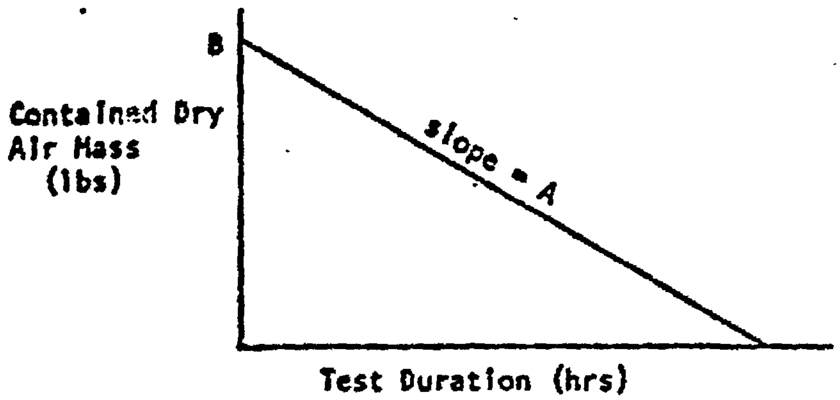
The method of "Least Squares" is a statistical procedure for finding the best fitting regression line for a set of measured data. The criterion for the best fitting line to a set of data points is that the sum of the squares of the deviations of the observed points from the line must be a minimum. When this criterion is met, a unique best fitting line is obtained based on all of the data points in the IPCLRT. The value of the leak rate based on the regression is called the statistically average leak rate.

Since it is assumed that the leak rate is constant during the testing period; a plot of the measured contained dry air mass versus time would ideally yield a straight line with a negative slope (assuming a non-zero leak rate). Obviously, sampling techniques and test conditions are not perfect and consequently the measured values will deviate from the ideal straight line situation.

Based on this statistical process, the calculated leak rate is obtained from the equation:

$$W = At + B$$

where W =	contained dry air mass at time t	(lbs)
B =	calculated contained dry air mass at time t=0	(lbs)
A =	calculated leak rate	(lbs/hr)
t =	test duration	(hours)



The values of the constants A and B such that the regression line is best fitting to the IPCLRT data are

$$A = \frac{[N\Sigma(ti)(Wi)] - [(\Sigma ti)(\Sigma Wi)]}{[N\Sigma(ti)^2 - (\Sigma ti)^2]}$$

$$B = \frac{\Sigma W_i - A\Sigma t_i}{N}$$

In order to reduce the round-off error in the above calculations, the equations are rearranged such that:

$$A = \frac{\Sigma[(ti-\bar{t})(Wi-\bar{W})]}{[\Sigma(ti-\bar{t})^2]}$$

$$B = \frac{[(\Sigma(ti)^2)(\Sigma Wi)] - [(\Sigma ti)(\Sigma(ti)(Wi))]}{[N\Sigma(ti)^2] - (\Sigma ti)^2}$$

By definition, leakage out of the primary containment is considered positive leakage; therefore, the statistically average leak rate in weight percent per day is given by:

$$L_s = (-A)(2400)/(WBASE) \qquad \text{(weight \%/day)}$$

<u>Statistical Uncertainties</u>

In order to calculate the 95% confidence limits of the statistically average leak rate, the standard deviation of the least squares slope and the Student's T-Distribution function are used as follows:

$$\sigma = \{\frac{1}{(N-2)}[\frac{N\Sigma(Wi)^2-(\Sigma Wi)^2}{N\Sigma(ti)^2-(\Sigma ti)^2} - A^2]\}^{\frac{1}{2}}$$

$$LCL = L_s - \frac{\sigma(TE)(2400)}{WBASE}$$

$$UCL = L_s + \frac{\sigma(TE)(2400)}{WBASE}$$

where $TE = 1.645 + \frac{1.454}{(N-2)} + \frac{2.75}{(N-2)^2}$

N = number of data sets
ti = test duration at the ith data set
Wi = contained dry air mass at the ith data set
σ = standard deviation of least squares slope
TE = value of the single-sided T-Distribution function with 2 degrees of freedom
L_s = calculated leak rate in %/day
LCL = 95% lower confidence limit in %/day
UCL = 95% upper confidence limit in %/day
WBASE = contained dry air mass at time t=0

IPCLRT DEFINITIONS
(48 PSIG TEST PRESSURE)

Maximum Allowable Leakage Rate (L_p)

L_p = 1.6% of containment volume per day

= $(0.016)(275{,}481\ ft^3)/24$ hrs.

= $183.654\ ft^3/hr.$

= $183.654 \left(\frac{48 + 14.696}{14.696}\right)$ SCFH

= 783.504 SCFH

Maximum Allowable Operational Leakage Rate (L_t)

Lt = 75% of Maximum Allowable Leakage Rate

= (0.75)(783.504) SCFH

= 587.628 SCFH

1.2% = 9.79 acfm
.1% = .816 acfm

Maximum Allowable Leakage Rate for Double Gasketed Seals

(10%)(587.628) = 58.763 SCFH

Maximum Allowable Leakage Rate for all Testable Penetrations & Isolatio Valves

(30%)(587.628) = 176.288 SCFH

Maximum Allowable Leakage Rate for Any One Penetration or Isolation Valve except Main Steam Isolation Valves

(5%)(587.628) = 29.381 SCFH

Maximum Allowable Leakage for any One Main Steam Isolation Valve

11.5 scfh @ 25 psig test pressure

FIGURE 1

- SUGGESTED -

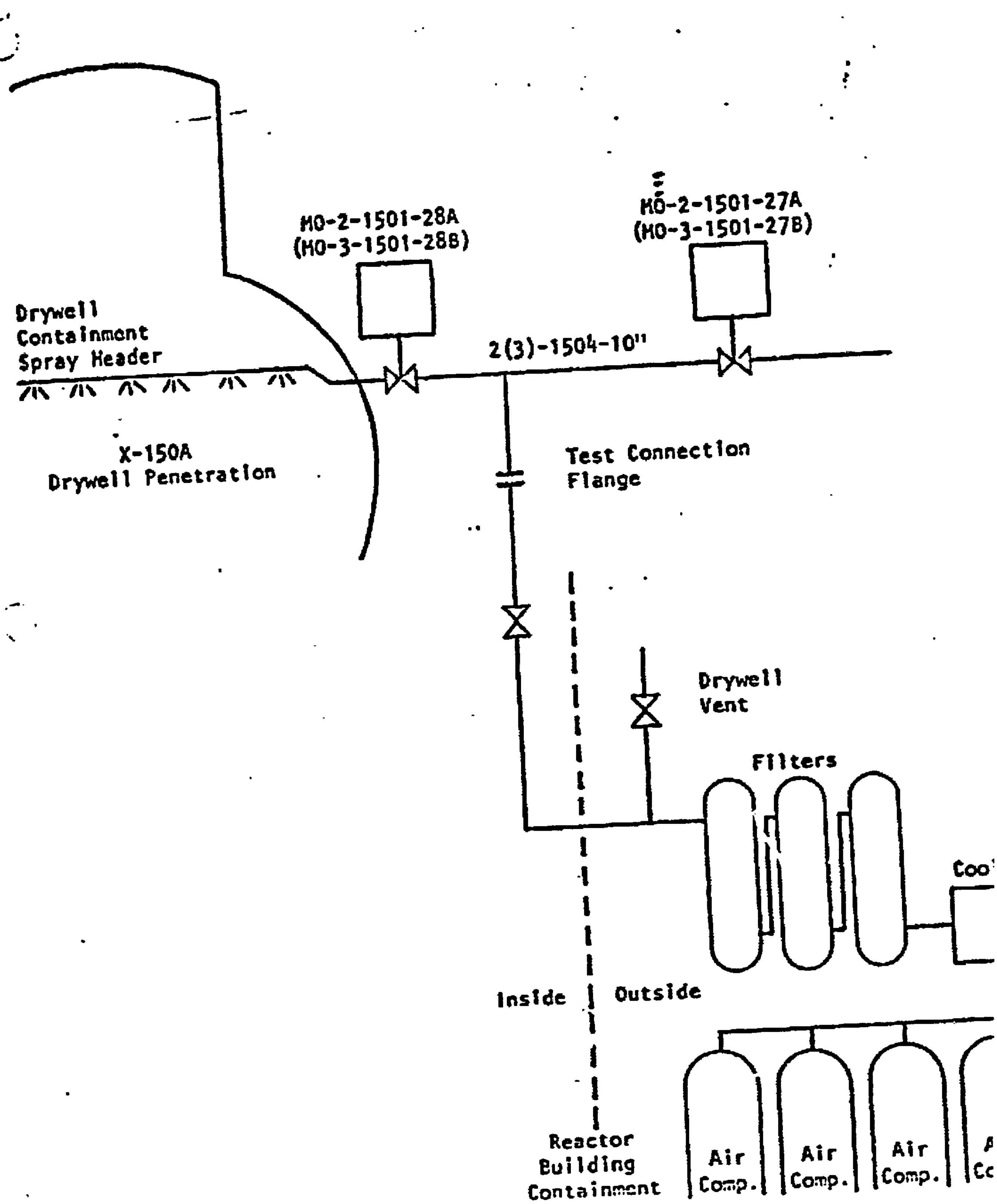


FIGURE 2
- SUGGESTED -
Pressure Related Instrumentation and
Piping Required for Pressure Test