U. S. NUCLEAR REGULATORY COMMISSION
Region I

Report No. 50-352/84-42

Docket No. 50-352

License No. CPPR-106 Priority -- Category B

Licensee: Philadelphia Electric Company

2301 Market Street

Philadelphia, Pennsylvania 19101

Facility Name: Limerick Generating Station, Unit 1

Inspection At: Limerick, Pennsylvania

Inspection Conducted: July 26 - August 3, 1984

Inspector: D. J. Vito, Reactor Engineer — date: 9/21/84

Approved By: L. H. Bettenhausen, Chief, Test Programs Section, EPB, DETP — date: 9/21/84

Inspection Summary: Inspection on July 26-August 3, 1984 (Report Number 50-352/84-42)

Areas Inspected: Routine, unannounced inspection of the preoperational Containment Structural Integrity Test and Containment Integrated Leak Rate Test, including procedure review, test witnessing, test results review, and general tours of the facility. The inspection involved 69 hours onsite by one region based NRC inspector.

Results: No violations were identified.

Region I Form 12
(Rev. February 1982)

DETAILS

1. Persons Contacted

Philadelphia Electric Company

C. Endriss, Regulatory Engineer
J. Franz, Assistant Plant Superintendent
J. Kemper, Vice President, Engineering and Research, PECO
G. Louderback, Engineering and Research QA
A. MacAinsh, Electric Production QA Site Supervisor
M. McCabe, Leak Rate Test Engineer
F. Prawlocki, Engineering and Research QA
* J. Spencer, Startup Director
* C. Wyler, Integrated Systems Group Leader

Bechtel Power Corporation

K. Barry, Special Services and Testing
M. Fulkerson, Test Director, ILRT
P. Giffune, Structural Integrity Test Director
H. Hill, Special Services and Testing
W. McCullough, Project Startup Engineer
B. Patel, Special Services and Testing
A. Strait, Test Director, ILRT
H. Wilkerson, Special Services and Testing

Volumetrics

D. Peyvan

Hartford Steam Boiler (Authorized Nuclear Inspectors)

J. Warner
W. Norton

NRC Personnel

* R. Borchardt, Reactor Engineer, DPRP
S. Chaudhary, Senior Resident Inspector, Limerick

* Denotes those present at the exit meeting on August 3, 1984.

2. Primary Containment Structural Integrity Test (SIT)

2.1 Documents Reviewed

- Test Procedure 1A-59.2, Primary Containment Structural Integrity Test

- Specification 8031-C-112, Bechtel Specification for Primary Containment Structural Integrity Test for Limerick Generating Station, Units 1 and 2, 12/28/83

- Limerick Generating Station FSAR Section 3.8.7.1.1

- Drawings 8031-C-897, Revision 3 and 8031-C-898, Revision 1, Primary Containment/Installation of Deformation Measuring Equipment

- Drawing 8031-C-899, Revision 1, Primary Containment/Concrete Surface Crack Mapping Areas

- NRC Regulatory Guide 1.18

- ASME Boiler and Pressure Vessel Code, Section III, Division 2, Article CC-6000

- SIT Instrumentation Calibration Records

- Test log and data

- Crack Mapping Training Documentation

2.2 Scope of Review

The documents listed above were reviewed by the inspector to determine compliance with the preoperational test commitments delineated in the FSAR, with the guidelines of NRC Regulatory Guide 1.18 and the ASME Code, Section III, Division 2, and with station administrative guidelines. The inspector also witnessed portions of the test sequence and made several tours before, during and after the test to check instrument placement and function, penetration integrity, and crack mapping activities.

In addition, a drywell steam bypass test was performed during SIT depressurization while maintaining a drywell to wetwell differential pressure of 34.5 psid. The purpose of this test is to verify that no paths for gross leakage from the drywell to the suppression pool air space bypassing the pressure suppression feature exist. The inspector witnessed portions of this test and reviewed the test results.

2.3 Procedure Review

The purpose of the SIT is to demonstrate that the primary containment will respond in an acceptable manner to combinations of internal pressure loading as specified in the FSAR. The Limerick containment is an over-under reinforced concrete (Mark II) structure and was tested

as a non-prototype containment per the guidelines of NRC Regulatory Guide 1.18. The test procedure and test specification adequately specified, directly or by reference, all activities necessary to comply with the test objective. The inspector found these documents to be in compliance with the requirements of the ASME Code, Section III, Division 2 and with the guidelines of NRC Regulatory Guide 1.18 with a few exceptions. These exceptions were delineated in the FSAR and have been accepted by the NRC staff as indicated by SER approval of the test program. The exceptions to existing regulatory guidelines are as follows:

a. Test pressure was increased continuously rather than in increments. The data acquisition system allows the measurements at the extensometer locations to be made rapidly and recorded simultaneously. The pressurization rate was limited to 3 psi/hr to ensure response to the pressure load without time lag. Pressure was held constant at the 30 psig level and at maximum test pressure (63.25 psig) and at maximum differential pressure during the high pressure drywell bypass test for recording of crack patterns on the designated crack mapping areas.

b. One radial deflection measuring point was located 12 feet from the base mate instead of 18 feet (3 times the wall thickness) in order to properly predict the containment behavior near the base mat to wall connection.

c. Tangential deflections were not recorded. The magnitude of expected local tangential deformation as a result of test pressure conditions is negligibly small.

The approved copy of the test procedure was available at the data acquisition area. All test functions were performed in accordance with the approved procedure. No unacceptable conditions were identified.

2.3 Test Instrumentation

The inspector reviewed the calibration documentation and records for the 66 displacement transducers (extensometers) and two pressure gages used to record displacement and pressure readings during the test. The calibrations met applicable accuracy requirements and were traceable to the National Bureau of Standards. The extensometer calibrations were rechecked in the PECO Research and Engineering Office in Philadelphia and were again checked after installation to assure that voltmeter readings generated after extending the core rod were in accordance with the calibration sheets. The inspector also toured the interior and exterior of the containment drywell and suppression pool to verify proper placement of the extensometers and wires. No unacceptable conditions were identified.

2.4 Test Sequence/Witnessing

A major portion of the test sequence was witnessed by the inspector. Particular attention was given to test preparations, extensometer deflection data acquisition and analysis, and crack mapping activities. The test sequence was as follows:

7/28/84	1452	Commenced pressurization of containment
7/29/84	~0100	Reached 30 psig. Pressure held for crack mapping
	2300	Reached maximum test pressure (63.25 psig)
7/30/84	0000	Commenced depressurization of suppression pool for high pressure drywell bypass test
	0715	Commenced data collection for high pressure drywell bypass test. Drywell pressure - 70.923 psia, suppression pool pressure - 34.476 psia
	0915	Completed data collection for high pressure drywell bypass test. Drywell pressure - 68.500 psia, suppression pool pressure - 40.326 psia. Calculated bypass area $A/\sqrt{K}$ = 0.00187 ft^2 (Acceptance Limit < 0.046 ft^2)
7/30/84	1200	Equalized pressure in drywell and suppression pool at approximately 33 psia
	1600	Containment at 0 psig

2.5 Test Results Evaluation

a. Extensometer Data

Deflection data for each of the extensometers was recorded:

1. At 3 hour intervals for 24 hours prior to pressurization to determine instrument operability. All sensors were determined to be functional.
2. At the start of pressurization.
3. At 5 psig and psid changes during pressurization, depressurization of suppression pool for high pressure bypass test, and final depressurization.
4. At the beginning, end and at one hour intervals during 30 psig and 63.25 psig hold periods, and while in the high pressure differential condition.
5. At the completion of depressurization.

The inspector reviewed the extensometer data taken during the test and found that only two of the 66 transducers exhibited deflections greater than 10% of deflection values predicted by the Architect-Engineer (Bechtel). The predicted deflections themselves were fractions of the maximum allowed deflections (Radial displacement limit <0.537 in., Vertical displacement limit <0.574 in.). The inspector concluded that the displacements exhibited by the extensometers were well within the acceptance criteria. The Bechtel test engineers also indicated that the magnitude of the displacements were, for the most part, less than those measured at Susquehanna Unit 1, the prototype containment for Limerick 1.

b. Deflection Recovery

ASME Section III, Division 2, Article CC-6213(c) states that deflection recovery of measured deflections in reinforced concrete structures shall be 70% or more within 24 hours after complete depressurization. Analysis of data after depressurization indicated that the deflection recovery criterion was met during depressurization. As such, deflection (displacement) data was not taken after the completion of depressurization.

c. Crack Mapping

Crack mapping of the five (5) prepared crack mapping areas was performed before pressurization, at the 30 psig and 63.25 psig hold points, at the high differential pressure condition, and after depressurization. The crack mapping areas were located in accordance with the guidelines of NRC Regulatory Guide 1.18. Crack mapping is performed in order to directly measure crack widths as they change with pressure during the performance of the test. ASME Section III, Division 2, Article CC-6233 and NRC Regulatory Guide 1.18 state that cracks exceeding 0.01 inches in width shall be mapped before, during and after the test. The procedure acceptance criterion was that no crack width would increase by more than 0.06 inches.

The inspector witnessed crack mapping activities at several of the designated areas during the pressure hold points and reviewed the complete crack mapping test data package at the completion of the test. Two of the five crack mapping areas showed little or no change during the test period. The other three areas exhibited crack increases of less than the allowed limit. No unacceptable conditions were identified.

Crack mapping was monitored by Bechtel QA personnel. Optical comparators were used for the measurement of the concrete surface cracks. The crack mappers performed their function in accordance with the procedure and appeared be appropriately trained and thorough in the recording and analysis of results.

The inspector expressed a concern regarding the suitability of the crack mapping area on the 283' level. ASME Section III, Division 2, Article 6233 states that each mapping location should have an area of at least 40 ft^2. The 283' level crack mapping area was a narrow portion of the containment wall at the end of the regenerative heat exchanger room. The mapped area was traversed with a number of pipes and pipe brackets and most of the rest of the containment wall was taken up by a large penetration and a metal platform. The other areas were largely free of obstruction. The inspector commented that it was difficult to account for 40 $ft.^2$ in the mapped area and that it would have been difficult to expand the area if required. Bechtel representatives stated that an area of 44 $ft.^2$ had been calculated for the crack mapping area in question. The inspector did not challenge the existence of a sufficient amount of surface area but did question the difference in appearance between this area and the others. This is designated as an Inspector Followup Item (50-352/84-42-01) and will be reviewed by NRC in conjunction with review of the SIT test report.

3. Containment Integrated Leak Rate Test (CILRT)

3.1 Documents Reviewed

- Procedure 1P-59.2, Preoperational Primary Reactor Containment Integrated Leak Rate Test, Revision 0
- Limerick Generating Station FSAR Section 6.2.6.5.1
- CILRT Instrumentation Calibration Records
- Bechtel CILRT Computer Program and Verification
- Limerick Containment Volume Fraction Calculations for CILRT Instrumentation
- Selected Piping and Instrument Drawings
- CILRT Test Log
- CILRT Test Data and Results

3.2 Scope of Review

The inspector reviewed the test procedure and related documents for technical adequacy and to determine compliance with the regulatory requirements of Appendix J to 10 CFR 50 and applicable industry standards and with station administrative guidelines. The inspector witnessed a large portion of the CILRT testing activities including pre-test inspections, test performance and data acquisition, supplemental verification test performance, and post-test inspections. In addition, a low pressure drywell bypass test was performed subsequent to the CILRT verification test at a differential pressure approximately corresponding to the submergence of the downcomer vents (suppression pool level minus the level of the bottom of the downcomer converted to psi). The inspector also performed an independent calculation of the test results.

3.3 Review of CILRT Procedure and Related Documents

The inspector reviewed the "as-run" copy of the CILRT procedure with related changes, attachments, and test log for technical adequacy and for consistency with regulatory requirements, guidance, and licensee commitments. Review of procedure acceptance criteria, test methods, and references indicated adequate conformance with Appendix J to 10 CFR 50. The procedure referenced and was in general conformance with industry standard ANSI/ANS 56.8-1981, Containment System Leakage Testing Requirements. The CILRT valve lineups were reviewed to ensure that systems were properly vented and drained to expose the containment isolation valves to containment atmosphere and test differential pressure with no artificial boundaries. Valve lineups were verified by the inspector during tours taken before and during the test, both inside and outside of containment.

The inspector reviewed the Bechtel CILRT computer program and related verification and validation documentation and found them to be in accordance with the guidelines of ANS N45.4-1972, ANSI/ANS 56.8-1981, and Bechtel Topical Report BN-TOP-1.

The test log and test data were available and were maintained in accordance with the procedure.

No unacceptable conditions were identified.

3.4 Test Witnessing/Chronology

A large portion of the CILRT and related activities was witnessed by the inspector. Inspector observations of licensee test performance and test control are delineated in Section 3.5 of this report. The test chronology was as follows:

TEST CHRONOLOGY

7/31/84	1130	Commenced pressurization for CILRT at approximately 8 psi/hr.
	1920	Containment pressure at 31 psig.
	2003	Isolation transformer to data acquisition system (DAS) power supply failed. Volumetrics representative activated power supplies in DAS to restore lost dewcell indications.
8/1/84	~0100	Reached test pressure (44 psig).
	0600	Volumetrics DAS 5 volt power supplies failed. Only two (2) dewcells are operational and they are in the suppression pool.
	0800	In a temperature stabilization "holding pattern", waiting for new dewcell power supplies. Initiated leak searches.
	2300	Injected fibrous substance into the four (4) locked open 14" butterfly valves on Containment Atmosphere Control System - HV-113, HV-103, HV-122, HV-125 (drywell and suppression pool purge and exhaust valves.) An approved final disposition of these valves will have to be attained prior to full power operation. Discussed in Paragraph 3.5 of this report.
8/2/84	0200	Commenced temperature stabilization period.
	0600	Completed temperature stabilization period. Acceptance criteria met.
	1000	Commenced data collection for CILRT.
	1800	Completed data collection for CILRT. Initial test results, Measured Leak Rate = 0.208 wt%/day, 95% Upper Confidence Limit = 0.215 wt%/day. (Numbers do not include Type C addition for MSIV leakage or water level corrections). Acceptance criterion is 0.75 La = 0.375 wt%/day.
	1845	Imposed a leak of 5.74 SCFM (1.0 La) for verification test.
	1930	Discovered after several discussions with test personnel and analysis of initial data that the calibration curves for the two Volumetrics Flowmeters had been transposed. Error was verified by Volumetrics corporate representatives via telephone.
	2000	Imposed 1.0 La leak with correct calibration curve for flowmeter.

	2015	Commenced one hour stabilization period for verification test.
	2115	Commenced data collection for verification test.
8/3/84	0115	Completed verification test. Acceptance criteria met. Measured Leak Rate = 0.713 wt%/day. (Verification leakage plus actual containment leakage).
	~0900	Low pressure drywell bypass test completed and within acceptance criteria.

3.5 Test Performance and Control

The test was performed as delineated by the procedure and appropriate administrative guidelines were followed and approvals obtained for temporary changes. Test personnel exhibited logical and technically sound approaches to leak searches. A large number of small leaks were accounted for and the leakage reduced accordingly. The licensee recognized the importance of identifying specific leaks and generic problem areas during the preoperational CILRT so that these items could be be better controlled when more restrictive penetration repair and adjustment guidelines apply during future periodic tests. The licensee also recognized the importance of the administrative control of leakage through smaller, non-leak-testable lines. Related to this area, the licensee identified four (4) abandoned-in-place valves during the test which exhibited excessive packing leakage. The valves are 14" butterfly valves on the drywell and suppression pool atmosphere purge and exhaust lines (HV-113, HV-103, HV-122, HV-125). These valves are located close to the containment structure and are upstream of the containment isolation valves. For the CILRT, the valves were injected with a fibrous material to stop the packing leakage. Leakage out of these valves during power operation would have a compromising effect on the integrity of the containment isolation system. This represents a design problem which should be corrected prior to full power operation. This is identified as an Unresolved Item (50-352/84-42-02) pending licensee action on determination of the final disposition of these valves and consequent NRC/NRR approval thereof.

The inspector commented that although test control requirements are not as rigorously applied during the preoperational CILRT as during future tests, the licensee should be wary of changes in test conditions as they may effect the statistical accuracy of the data taken. At one point during the test, back pressure on the MISV's was increased slightly to further minimize leakage. Although the test data did not appear to be effected, the inspector commented that such changes were not a good practice. The licensee acknowledged this and stated that every effort would be made in the future to maintain an unaltered test condition.

The inspector also commented that, at times, there seemed to be too many people in the area of the data acquisition system and related test equipment. The licensee stated that more restrictive access controls will be considered for future tests. The inspector had no further questions with regard to test performance and control.

3.6 Test Instrumentation

The inspector reviewed the calibration records for the resistance temperature detectors, dewcells, precision pressure detectors, flowmeters, and real time clock. The calibrations met applicable accuracy requirements and were traceable to the National Bureau of Standards. The inspector verified that the instrument calibration errors and weighting factors were properly incorporated into the computer program for integrated leak rate calculations. In addition, the placement of the RTD's and dewcells within containment was observed by the inspector during a pre-test inspection of containment. After subsequent review of the volume fraction calculations performed by Bechtel, the inspector concluded that the containment was adequately modeled by the placement of the instrumentation and that the volume fractions were consistent with instrument placement. No unacceptable conditions were identified.

3.7 Test Results Review

The CILRT measured leak rate was 0.208 wt.% per day with a 95% upper confidence limit (UCL) of 0.215 wt.% per day. The inspector performed an independent calculation of the test results using a sample of raw data from the test to estimate the accuracy of the licensee's leak rate calculations. The results were as follows:

	L_{am} (Mass Point)	UCL (Mass Point)
Limerick 1	.208	.215
NRC	.204	.215

The inspector concluded that the licensee's calculations were appropriately performed and accurate. Final computation of the total integrated leak rate is dependent upon the addition of local leakage values from the MSIV's and other Type C penetrations, and of water level corrections.

After completion of the CILRT, a technically accurate and successful leakage verification test was done using an imposed leak of 1.0 L_a (5.74 SCFM). The containment was then depressurized to a pressure of 19.35 psia followed by depressurization of the suppression pool to atmospheric pressure for performance of the low pressure drywell bypass test. A successful bypass test was then performed with a resulting equivalent bypass area ($A/\sqrt{K}$) of 0.00026 ft.^{2}. The acceptance criterion is 0.046 ft.^{2} or smaller.

No unacceptable conditions were identified.

3.8 "As-Found" vs. "As-Left"

After the completion of the CILRT, the inspector inquired as to how the licensee planned to determine the integrated leak rate during periods of plant operation. Although the licensee does perform local leak rate tests both before and after repairs and records the results, the inspector could not find evidence of the employment of these "As-Found" and "As-Left" leakages in determining consequent degradation (increased leakage) in the containment isolation system and calculation of operational "As-Found" leakage. The inspector explained that this type of calculation is necessary unless the licensee can demonstrate the use of a quantitative continuous containment overall leakage monitoring system. This is an Unresolved Item (50-352/84-42-03) pending licensee clarification of the method which will be used for quantification of operational containment overall leakage.

4. QA/QC Involvement in SIT/CILRT

Both Structural Integrity Test and Containment Integrated Leak Rate Test activities were monitored by Bechtel and PECO QA/QC personnel. Bechtel QC, in particular, was actively involved in the performance and recording of crack mapping data during the SIT. The inspector verified by observation and by review of documentation that QA/QC personnel were involved in procedure review and monitoring of test related activities. The inspector concluded that QA/QC coverage of SIT/CILRT activities was adequately planned and documented.

The inspector also observed the monitoring activities performed by the Authorized Nuclear Inspectors (ANI) assigned to the test. This monitoring is required by the ASME Code, Section III, Division 2, Article CC-6251 and by the Pennsylvania State Industrial Board.

5. Tours

The inspector made several tours of various areas of the site to observe SIT/CILRT test activities, other work in progress and general housekeeping. No unacceptable conditions were identified.

6. Exit Interview

A management meeting was held on August 3, 1984 to discuss the scope and findings of the inspection as detailed in the report. No written information was provided to the licensee at any time during the inspection.