U.S. NUCLEAR REGULATORY COMMISSION
REGION I

Report No. 50-289/84-18

Docket No. 50-289

License No. DPR-50 Priority - Category C

Licensee: GPU Nuclear Corporation
P. O. Box 480
Middletown, Pennsylvania 17057

Facility Name: Three Mile Island Nuclear Station, Unit 1

Inspection At: Middletown, Pennsylvania

Inspection Conducted: June 28 - July 13, 1984

Inspectors: P. C. Wen, Reactor Engineer — 9/7/84 date

Approved by: L. H. Bettenhausen, Chief
Test Programs Section, DETP — 9/7/84 date

Inspection Summary:
Routine, unannounced inspection of restart startup test program including review of test results of Reactor Coolant System Leak Verification Test. The inspection involved 43 inspection-hours onsite and 26 inspection-hours at NRC Regional office by one Region-based inspector.

Results: No violations were identified.

DETAILS

1. Persons Contacted

General Public Utilities (GPU) Nuclear Corporation

* J. J. Colitz, Plant Engineering Director
* R. F. Fenti, OQA Manager
* T. M. Hawkins, Manager, Startup and Test
* H. D. Hukill, Director, TMI-1
* R. E. Masoero, Plant Analysis Engineer
* V. P. Orlandi, Lead I & C Engineer
* F. W. Paulewicz, Senior Engineer
  J. J. Pfadenhauer, OQA Supervisor
* F. D. Piazza, Senior Engineer
* C. W. Smyth, TMI-1 Licensing Manager
* R. J. Toole, Operations and Maintenance Director
* R. A. Washick, Computer Applications Manager

U. S. Nuclear Regulatory Commission

* L. H. Bettenhausen, Chief, Test Program Section
* R. J. Conte, Senior Resident Inspector, TMI-1
* F. I. Young, Resident Inspector, TMI-1

* denotes those present at the exit interview of July 13, 1984.

The inspector also interviewed other licensee personnel during the inspection.

2. Restart Startup Test Program

The inspector reviewed the RCS Leak Rate Verification Test (TP 600/5) results. The test was performed from September 30 to October 4, 1983 and again on May 25, 1984 during hot functional testing (HFT). The details and findings of the review are discussed in the following sections.

2.1 RCS Leak Rate Surveillance Procedure and Verification Test

The TMI Unit 1 Technical Specifications require that surveillance be performed daily to determine leakage from the reactor coolant system (RCS). The surveillance procedure SP 1303-1.1, Reactor Coolant System Leak Rate, based on system mass inventory balance, is designed to fulfill this requirement. The purposes of the verification test (TP 600/5) are: 1) to verify the validity of the system mass inventory balance method used in the RCS leak rate determination and 2) to verify the consistency of three calculational methods which are included in the surveillance procedure SP 1303-1.1.

The system mass inventory balance method consists of measuring appropriate plant parameters such as RCS temperature, pressure, levels in pressurizer, makeup tank and reactor coolant drain tank. The leak rate is then determined based on a mass balance of system inventory changes over a prescribed time interval. Three calculational methods as described in SP 1303-1.1 may be used under the following circumstances:

Method	Case
Computer Calculation	Computer fully operable
Manual Calculation with Computer Data	Computer test inputs are operable, but RCS Leakage Program is not operable.
Manual Calculation with Patch Panel Data	Patch Panel Inputs

The computer calculation is the preferred method. When the computer program is initiated, data is taken automatically from the pre-selected plant data points. At the end of a specified time the computer executes the leak rate program and prints out the calculational result. Hand calculations are allowed as a backup when the computer is not available.

2.1.1 Superimposed Leak Rate Test

The unit was brought to a hot steady state conditions with RCS Tavg at 532°±3° F and pressure at 2155±25 psig. A normal RCS leak rate calculation was first conducted to establish a baseline value. The verification test was accomplished by introducing a known leak rate to the RCS. The validity of the RCS leak rate calculation method is judged by comparing the known leak rate to the calculated value determined from executing the computer-based leak rate program.

The inspector noted the test results as follows:

Test No (Date)	Condition	Reference Temperature	Leakage+Losses (gpm)	Gross L.R. (gpm)	Unidentified L.R. (gpm)
1	Baseline	Tavg	0.2998	0.1382	-0.0761
1 (9/30-10/1/84)	Superimposing (0.730 gpm)	Tavg	2.0459	1.8920	1.6778
	Computer Calculated Superimposed Leak Rate = 1.6778-(-0.0761)= 1.7539 Measured Superimposed Leak Rate Adjusted to "Hot" Conditions = 0.730 x 1.3 = 0.949 Difference = 1.7539 - 0.949 = 0.8049 gpm Where the constant 1.3 is the ratio of water density at 68°F to that at 533°F.				
2	Baseline	Tavg	0.2388	0.0138	-0.2254
2 (10/4/83)	Superimposing (0.90 gpm)	Tavg	2.2278	2.0408	1.8018
	Computer Calculated Superimposed Leak Rate = 1.8018-(-0.2254)= 2.0272 Measured Superimposed Leak Rate Adjusted to "Hot" Conditions = 0.90 x 1.3 = 1.17 Difference = 2.0272 - 1.17 = 0.8572 gpm				
3	Baseline	Std	3.2555	0.5196	0.3552
3 (5/25/84)	Superimposing (0.786 gpm)	Std	3.9171	1.2047	1.0403
	Computer Calculated Superimposed Leak Rate = 1.0403 - 0.3552 = 0.6851 Measured Superimposed Leak Rate = 0.786 Difference = 0.6851 - 0.786 = -0.1009 gpm				

The calculated leak rate did not agree with the imposed leak rate in the first two tests by a margin appropriately of 0.8 gpm (based on "Hot" conditions). Normally, leakage in such order of magnitude would be detected by the plant surveillance program. However, the results from both baseline tests indicated that no abnormality existed during the test. Licensee Plant Engineering and Technical Functions did extensive review on these two tests. The discrepancy was attributed to unexpected valve leakage in the letdown sample line. Through the suspected leaking valve, portions of the superimposed leak rate were bypassed to the Auxiliary Building Sump. The level in the sump was not monitored during the test. These two tests were therefore declared "Unsatisfied". A third test with some modifications was then planned and performed on May 25, 1984. The major differences among these 3 verification tests are included in the following:

Test NO./TEST Date	Method to Determine Flow Tapping Location	Superimposed Flow Rate
1 (10/1/83)	Letdown Sample Line	Measure the time required to fill a 4000 ml collector every 30 minutes.
2 (10/4/83)	Letdown Sample Line	Measure the time required to fill a 1000 ml collector every 30 minutes.
3 (5/25/84)	Makeup Tank Sample Line	Water mass was collected in the drum and weighed to determine the average leak rate.

The results from Test No.3 indicated that the calculated leak rate was in agreement with the known imposed leak rate with variation of only about 0.1 gpm. This test demonstrated that the mass balance method used in SP 1303-1.1 is capable of detecting RCS leakage in the order of about 1 gpm with a 0.1 gpm variation.

2.1.2 Leak Rate Determination Methods

All three methods of measuring leakage were verified against each other in the TP 600/5 Test. The results indicated that good consistency exists among the three methods. The following summary shows all test results recorded during the TP 600/5 test.

BASELINE TESTING (9/30/83)

Parameter Calculated (gpm)	Computer Calculation	Manual Calculation with Computer Data	Manual Calculation with Patch Panel Data
Leakage Plus Losses	0.2998	0.297	0.2518
Gross Leakage	0.1382	0.113	0.1088
Unidentified Leakage	-0.0761	-0.101	-0.1059

SUPERIMPOSED LEAK TESTING (10/1/83)

Parameter Calculated (gpm)	Computer Calculation	Manual Calculation with Computer Data	Manual Calculation with Patch Panel Data
Leakage Plus Losses	2.0459	2.0269	2.0323
Gross Leakage	1.8920	1.8582	1.832b
Unid itified Leakage	1.677E	1.6439	1.6183

BASELINE TESTING (10/4/83)

Parameter Calculated (gpm)	Computer Calculation	Manual Calculation with Computer Data	Manual Calculation with Patch Panel Data
Leakage Plus Losses	0.2388	0.2290	0.2180
Gross Leakage	0.0138	-0.0007	0.0165
Unidentified Leakage	-0.2254	-0.2186	-0.2014

SUPERIMPOSED LEAK TESTING (10/4/83)

Parameter Calculated (gpm)	Computer Calculation	Manual Calculation with Computer Data	Manual Calculation with Patch Panel Data
Leakage Plus Losses	2.2278	2.1208	2.16
Gross Leakage	2.0408	1.9370	1.9812
Unidentified Leakage	1.8018	1.7191	1.7633

BASELINE TESTING (5/25/84)

Parameter Calculated (gpm)	Computer Calculation	Manual Calculation with Computer Data	Manual Calculation with Patch Panel Data
Leakage Plus Losses	3.2555	3.3532	3.3648
Gross Leakage	0.5196	0.5440	0.7436
Unidentified Leakage	0.3552	0.3796	0.5792

SUPERIMPOSED LEAK TESTING (5/25/84)

Parameter Calculated (gpm)	Computer Calculation	Manual Calculation with Computer Data	Manual Calculation with Patch Panel Data
Leakage Plus Losses	3.9171	4.0360	4.0069
Gross Leakage	1.2047	1.3030	1.4254
Unidentified Leakage	1.0403	1.1386	1.[illegible]610

The results of RCS Leak Rate calculation using the three methods are all close to each other and within the ±0.5 gpm licensee imposed acceptance criteria. Discrepancies among different methods can be attributed to slightly different readings in instrumentation and differences in the averaging process of initial and final test conditions. The number of data points averaged in the computer program is seven, taken at one minute intervals. However, both manual calculation procedures (either taken data from computer points or from patch panel) require only three data points at two minute intervals. The variability of RCS parameters thus has a small effect on the calculation.

2.2. RCS Leak Rate Surveillance Procedure (S.P. 1303-1.1)

Surveillance procedure 1303-1.1 is used by the licensee for TS RCS leak rate determination. The inspector reviewed the SP 1303-1.1, Rev. 14 for its technical adequacy. The inspector noted that the current procedure (Rev. 14) has been through many revisions since Rev.7. which was used prior to the 1979 plant shutdown. The major difference are:

ITEM	SP1303-1.1 (REV 7)	SP1303-1.1 (REV 14)
Δm Rx vessel & loop	Density is function of Tavg. Changes in RCS pressure are not taken into account.	Density is function of Tavg & RCS pressure.
Δm pressurizer	Mass change in pressurizer is function of level change only.	Calculate the initial & final pressurizer mass separately. The change in steam mass is included in the calculation.
Δm make-up tank	Mass change per unit level = 250 lbm/in	Mass change per unit level = 256.7 lbm/in
Conversion Factor from lbm to gallon	Based on Tavg.	Based on standard conditions.
Operator-Induced RCS or MU TK Mass change	No density correction	Not necessary since reference temperature is based on standard conditions.
Operator-Induced RCDT Mass change	No density correction	Not necessary since reference temperature is based on standard conditions.
Δm RCDT	Mass change per unit level = 295 lbm/in	Mass change per unit level = 292 lbm/in
Correction Factor for Evaporative Losses and RCP #3 Seal Purge	0.23 gpm	0.16 gpm
No. of data points at beginning and end of test	3 data points w'th 1 minute interval	7 data points with 1 minute interval
RCS pressure data point	Wide Range	Narrow Range
RCS Volume (excluding pressurizer)	10,673 ft^3	10,564 ft^3 (~1% OTSG tube plugging)
Provision for identifying OTSG leakage	No	Yes
Minimum Test Duration	1 Hr.	2 Hrs.

Previous reviews of surveillance procedure 1303-1.1, Rev. 7 identified several deficiencies such as, inconsistent densities used to convert mass of water to gallons of leakage, neglect of pressure change in RCS mass inventory calculation and omission of steam mass effects in pressurizer. These deficiencies have been corrected as evident in the tabulation comparison above. To further improve the confidence level of the overall RCS leak rate surveillance program, the inspector discussed the following items with cognizant licensee staff.

-- Mass Change in Pressurizer

Changes in pressurizer mass are calculated separately for initial and final conditions with both steam and liquid spaces taken into account. This represents a more accurate calculation than previous method (Rev.7). However, compensated pressurizer level was used as an input in the calculation. The inspector estimated the calculational uncertainty associated with level instrumentation to be about 0.1 gpm. This value was estimated based on level dp and temperature sensor measurement repeatabilities of 0.11 % and 0.173 % respectively. To further improve the calculational accuracy, a licensee representative stated that an uncompensated level which directly yields mass changes for the pressurizer will be examined for possible use in the calculation.

-- Evaporative Losses Term

A constant value of 2.24. lbm/min (0.27 gpm) was called an Evaporative Losses term and was subtracted from the gross leak rate for the determination of unidentified leak rate. The value was based on pre-operational test results TP 600/10, "RCS Hot Leakage Test", performed in 1974. Plant conditions such as packing, insulation and hardware modification in many instances have changed, however, the original test data were still being quoted in the present surveillance procedure. No further verification of this term has been performed since 1974 due to high radiation involved. More realistically, evaporative loss is RCS loss in a form of unidentified leakage. Since TMI-1 TS permits this term to be credited in the RCS leak rate calculation, it amounts to a Technical Specification value of 1.0 gpm plus losses; application of the term frequently leads to negative leak rates. NRC Region 1 and NRR will jointly evaluate application of this term.

2.3 RCS Leak Rate Computer Program

Independent calculations were performed with an NRC-developed leak rate computer program. The detailed methodology of this program is described in NUREG-0986, "RCSLK8: Reactor Coolant System Leak Rate Determination for PWRs; User's Guide". The results from the inspector's calculations agreed closely with the licensee's calculations for the TP 600/5 test results, with variation about 0.01 gpm. These comparisons are:

Test Date	Reference Temperature	Leak Rate	Licensee Calculation	Inspector Calculation
9/30/83	Tavg	Leakage plus losses	0.2398	0.30
		Unidentified L.R.	-0.0761	-0.07 *
10/4/83	Tavg	Leakage plus losses	0.2388	0.25
		Unidentified L.R.	-0.2254	-0.21 *
5/25/84	Std	Leakage plus losses	3.2555	3.26
		Unidentified L.R.	0.3552	0.36

* Due to different terminology used by the licensee, a correction factor of 1.37 lbm/min (Evaporative Losses and No. 3 Seal Purge) and appropriate OTSG leakage were adjusted for the inspector's result to have a consistent comparison.

At the end of the selected test time, the licensee's RCS leak rate computer program requests input data for operator-induced RCS, MU TK and RCDT inventory changes (D.S. 1303-1.1.5), the Identified Leakage (D.S. 1303-1.1.4), and OTSG Leakage (D.S. 1303-1 1.6). Correct usage of these terms is important in the RCS leak rate calculation. The inspector set up computer test runs to verify that the sign and engineering units are correct in the licensee's computer program. TP 600/5 test data, specifically Test No. 3, was used for this purpose. The superimposed leak rate in this case was treated as operator-induced Makeup Tank inventory change. The verification is shown in the following:

Test Date: 5/25/84

Parameter (gpm)	Superimposed Leak Rate Treated as Operator Induced MU TK Inventory Change (+ 94.32 gal)	Baseline Test Result
Leakage plus losses	3.1320	3.2555
Gross leakage	0.4199	0.5196
Unidentified leakage	0.2555	0.3552

The calculated results showed consistency with baseline test results. The minor difference between two cases was due to a slight change in test conditions. Another three verification runs were also made to verify RCDT, Identified Leak Rate, and OTSG Leakage inputs, respectively. All results show consistent output. No unacceptable conditions were identified by the inspector.

The inspector further verified the subcooled water properties used in the licensee's program (Subroutine VCPT). In the wide range printout (temperature: 500° - 600° F, Pressure: 2100 - 2300 psia), the results from this subroutine agree closely with ASME 1967 steam tables. In most cases, the deviations only occurred at the 5th decimal place, agreeing to better than 1 part in 10,000.

The inspector had no further questions.

3. Quality Assurance Audits

The inspector reviewed QA monitoring report JJP-934-84. QA not only covered major activities during TP 600/5 HFT, but did a thorough review on test data. Minor discrepancies in the test calculation were found by a QA auditor. Satisfactory resolutions were obtained in a reasonable period of time.

The inspector had no further questions.

4. Modification to Makeup Tank Level Sensing Lines

Due to the original tubing installation for the Makeup Tank Level Transmitter, condensation was allowed to buildup in a low point and could result in erroneous level indication. In order to eliminate this potential for erroneous level indication, the licensee modified the existing low side tubing (dry leg to transmitter). Original tubing was disconnected and capped. New tubing was tied into the existing Makeup Tank Pressure Transmitter, MU-17-PT. In addition the licensee added catch tanks in the lines at low points, which will collect any condensation that may build up. To verify this modification, the resident inspector reviewed Design Review Form(DRF) Package 011120, Rev 0, and conducted a system walkdown on July 13, 1984. The modification was found to as described in the work package.

5. Exit Interview

Licensee management was informed of the purpose and scope of the inspection at the entrance interview. The findings of the inspection were periodically discussed and were summarized at the conclusion of the inspection on July 13, 1984. Attendees at the exit interview are denoted in paragraph 1.

No written material was provided to the licensee by the inspector at any time during this inspection.