

U. S. NUCLEAR REGULATORY COMMISSION  
REGION IV

NRC Inspection Report: 50-382/88-16

License: NPF-38

Docket: 50-382

Licensee: Louisiana Power & Light Company (LP&L)  
142 Delaronde Street  
New Orleans, Louisiana 70174

Facility Name: Waterford Steam Electric Station, Unit 3

Inspection At: Taft, Louisiana

Inspection Conducted: May 12-20, 1988

Inspectors: *Dwight D. Chamberlain for* *5/27/88*  
W. F. Smith, Senior Resident Inspector Date

*Dwight D. Chamberlain for* *5/27/88*  
T. R. Staker, Resident Inspector Date

Approved: *Dwight D. Chamberlain* *5/27/88*  
D. D. Chamberlain, Chief Date  
Reactor Project Section A

Inspection Summary

Inspection Conducted May 12-20, 1988  
(Report 50-382/88-16)

Area Inspected: The events which occurred and actions taken by LP&L personnel prior to, during and subsequent to the incident on May 12, 1988, when problems with refueling water level instruments twice resulted in a possible loss of shutdown cooling.

Results: A potential violation involving two examples of failure to implement procedures was identified. Also a potential deviation involving two examples of failure to implement commitments made in the licensee's response to Generic Letter 87-12.

DETAILS1. Persons ContactedPrincipal Licensee Employees

- \*R. P. Barkhurst, Vice President, Nuclear Operations
- \*N. S. Carns, Plant Manager, Nuclear
  - P. V. Prasankumar, Assistant Plant Manager, Technical Support
- \*D. F. Packer, Assistant Plant Manager, Operations and Maintenance
- \*T. P. Brennan, Nuclear Operations Construction Manager
- \*J. R. McGaha, Manager of Nuclear Operations Engineering
- \*D. E. Baker, Manager of Events Analysis Reporting & Responses
- \*R. S. Starkey, Operations Superintendent
- \*L. W. Laughlin, Site Licensing Support Supervisor

\*Present at exit interview.

In addition to the above personnel, the NRC inspectors held discussions with various operations, engineering, technical support, maintenance, and administrative members of the licensee's staff.

2. Follow-up on Near Loss of Shutdown Cooling Event (93702)Overview

On May 12, 1988, Waterford-3 was in Operational Mode 6, with the reactor shut down, depressurized, and at approximately 89°F. The second refueling had just been completed and the reactor head had been placed on the reactor vessel. Reactor Coolant System (RCS) draining operations were underway to lower RCS level in support of planned work on the steam generators and reactor coolant pump seals.

At about 6:15 a.m. and again shortly after 9:35 a.m., the in-service shutdown cooling pump, Low Pressure Safety Injection "A" (LPSI-A), exhibited signs of cavitation due to possible air intrusion or impending loss of suction. On both occasions, the operators apparently placed LPSI-B in service before the signs of cavitation on LPSI-A had degraded to the extent that a complete loss of shutdown cooling was experienced. LPSI-B showed no signs of cavitation. During this plant condition, Technical Specification 3.9.8.2 required both trains of shutdown cooling to be operable with one train in operation.

As the course of events progressed, the operators finally determined that the water level in the RCS was below the center line of the hot leg, about four feet lower than they thought. Therefore, the apparent cause of cavitation on LPSI-A was air vortexing where the shutdown cooling piping ties in to the RCS hot leg. Failure to be in control of RCS level was apparently caused by a series of personnel errors, training deficiencies and procedure deficiencies which are described in detail below.

Of particular significance is the fact that Waterford-3 had previously experienced a total loss of shutdown cooling due to RCS level instrument problems. On July 14, 1986, shutdown cooling was lost while the plant was in a similar condition for reactor coolant pump seal work. A series of level indication problems, personnel errors and procedure deficiencies resulted in a loss of control of RCS level. The actual level was low enough to cause air and/or steam binding of both LPSI pumps. By the time LPSI-B was filled, vented, and restored to service, RCS hot leg temperature had increased from 138° to 232° F. The details of this incident were reported in Licensee Event Report (LER) 86-015, dated August 13, 1986. By September 30, 1986, corrective actions committed in LER 86-015 were completed. The causes of loss of shutdown cooling at that time were identified as simultaneous draining of the RCS from two points and erroneous level indication due to insufficient nitrogen pressure in the pressurizer (the tygon tubing had collapsed). Procedures were revised at that time.

#### Details

The resident inspectors conducted a series of interviews, reviewed logs, procedures, and other data related to the above incident to gain a complete understanding of what occurred, why, and what actions were taken by licensee management. The inspectors also reviewed the licensee's investigative results as reported to senior management.

Additionally, Generic Letter 87-12, dated July 19, 1987, cited numerous cases where shutdown cooling had been lost on other plants, and it directed that all affected licensees take appropriate steps to preclude future occurrences. On September 21, 1987, LP&L responded to the generic letter by describing the equipment and controls used to ensure maintenance of reactor water level control and shutdown cooling at Waterford-3. Among these, significant to the May 12, 1988, incident, was assurance that the tygon tubing length of the Refueling Level Indication System (RLIS) would be maintained to a minimum. LP&L also committed to change the RCS draindown procedure to visually inspect, prior to each drain down, RLIS hose and tubing for anomalies which could affect the accuracy of level indication. The response also committed to install a permanent Refueling Water Level Indication System (RWLIS) by the end of the second refueling outage. This system would not have the problems attendant to the soft, temporary hoses used in the existing RLIS. The RWLIS would have a wide range of +12 to +48 feet mean sea level (MSL) and a narrow range of +12 to +15 feet MSL indication in the control room with an annunciator.

By May 7, 1988, the new RWLIS was installed and flushed but not connected to the RCS. With the refueling canal flooded (and no need for the RLIS) at about +30 feet MSL, the RLIS point of connection to the RCS at drain valve RC-105 was disconnected so that the RWLIS could be permanently connected to the RCS. RC-105 was tagged shut in accordance with the licensee's clearance procedure. The RWLIS was then installed at RC-105. The new system has a connection point to accommodate the RLIS hose, should it be desirable to use the RLIS as a backup. This connection is several

feet away from RC-105, thus when the RLIS was reconnected, between 20 and 30 feet of excess length of RLIS hose remained. Although the licensee's response to GL 87-12 assured minimum length, the excess hose was not removed nor did any of the licensee's procedures require it. This is the first part of an apparent Deviation from the licensee's response to GL 87-12 which stated that RLIS tubing length is maintained to a minimum (382/8816-01).

About four hours after RC-105 was tagged shut, the clearance was released. The Shift Supervisor was informed that the RWLIS fluid boundaries were intact and the RLIS was reconnected. A Nuclear Auxiliary Operator (NAO) walked down the new system but did not recognize the excess hose on the RLIS as a condition with the potential of causing erroneous level indication. The clearance was removed and RC-105 was reopened. At this time, there was no procedure in the control room which addressed the new RWLIS system operating requirements. The shift supervisor apparently did not recognize that the RLIS was now connected through a system that could be full of air and not aligned for operation. Technical Specification 6.8.1.a requires written procedures to be established, implemented, and maintained covering refueling equipment operation, and draining and filling of the reactor vessel, as recommended in Appendix A of Regulatory Guide 1.33, Revision 2, February 1978. Placing the new RWLIS in service in combination with the RLIS without a controlling procedure is therefore an apparent violation of NRC regulations. This carries significance in light of previous problems with RCS level control (LER 86-015) and the theme of the licensee's response to GL 87-12 which assured the NRC of careful and controlled handling of the RCS level indicating systems (382/8816-02).

It was not until May 9, 1988, that the procedure controlling RWLIS and its interface with the RLIS hoses appeared in the control room. The setup and operation of the RCS level indicating systems were implemented by Revision 6 to Operating Procedure OP-1-003, "Reactor Coolant System Drain Down." Attachment 8.4 of the new revision requires a backfill of the tubing in the RWLIS to ensure air is removed from the system prior to placing the RWLIS in service and appears to be a prerequisite to placing the RLIS in service. As a side issue, the new revision was approved by the Plant Manager on May 7, 1988, and thus could probably have been made available to the control room if it had been pursued. On the morning of May 8, 1988, the engineer responsible for the station modification which installed the new RWLIS inspected the completed work. He noticed the excess RLIS tubing hanging down to the -11 feet MSL level in the containment. He moved it to a grating at -4 feet MSL in a large loop to accommodate the excess tubing. He apparently did not recognize the potential of such a condition to cause erroneous level indications, because no action was initiated to shorten the hose to minimum length.

Between the time the RWLIS and RLIS systems were placed in service on the night of May 7, until May 12, 1988, the refueling canal was flooded to at least +30 feet MSL. This means the level was about 10 feet above the reactor vessel head flange.

On the morning of May 12, 1988, shortly after midnight, the operators drained the refueling cavity to 19 feet 10 inches MSL in accordance with Refueling Procedure RF-6-001, "Refueling Reactor Vessel Head and Internal Installation" to accommodate installing the head. During this evolution, the RCS level could have been monitored by observation of the actual level in the refueling canal. The reactor vessel head was then installed.

At 3:09 a.m., the operators commenced an RCS draindown from 19 feet 10 inches MSL to 13 feet 6 inches MSL to facilitate work on the steam generators and reactor coolant pump seals. This was to be controlled by Operating Procedure OP-1-003, Revision 6. The operators apparently presumed the RWLIS and RLIS were in service and failed to verify among other things that all of the filling and venting procedures for the RWLIS were completed, as required by Section 6.4.1 of OP-1-003. Section 6.4.1 also leads to an inspection of the RLIS tubing; however, if previously done, the procedure does not specifically require another physical inspection of the tubing. LP&L's response to GL 87-12 committed to revise OP-1-003 to require a visual inspection of the RLIS hose prior to each draindown. There was some controversy between the inspectors and licensee personnel as to whether or not Section 6.4.1 of OP-1-003 specifically requires such an inspection prior to each draindown. The inspectors considered the commitment to be inadequately implemented. This is the second part of an apparent Deviation from the licensee's response to GL 87-12 which stated that the above revision would be made (382/8816-01).

Failure to comply with the initial requirement of Section 6.4.1 of OP-1-003 to verify filling and venting of the RWLIS and then proceeding with the draindown is the second part of the apparent violation to implement procedures covering draining and filling of the reactor vessel as required by Technical Specification 6.8.1.a (382/8816-02).

At 4:55 a.m., the operators secured RCS draining due to disagreement between the RWLIS, which was indicating 13.92 feet MSL and the RLIS was indicating 18 feet 2 inches MSL. The licensee stated that three individuals walked down the RLIS tubing and that they had even momentarily disconnected the tubing from the pressurizer to ensure there was no vacuum in the hose. No problems were identified with the RLIS as a result of those actions.

After contacting the engineer responsible for the RWLIS and determining that the RWLIS reference leg should be dry, the Shift Supervisor directed the RWLIS reference leg to be drained. The reference leg is the dry, low pressure side of the detector and should be vented to the pressurizer. The variable leg senses the head of water in the RCS. Upon opening the reference leg drain, RWLIS indicated 19.05 feet MSL while RLIS was indicating 17 feet 11 inches MSL. With the knowledge that the RWLIS had not been fully tested, the close agreement with the RLIS restored confidence in the RLIS level indication. At 5:14 a.m., RCS draining was resumed.

At about 6:00 a.m., an on-coming reactor operator noted a slight oscillation in shutdown cooling (LPSI-A) flow. By 6:13 a.m., LPSI-A appeared to start cavitating, so draining was again secured. An NAO was dispatched to the pump room to vent the pump. The NAO reported the presence of significant amounts of air in the pump. At 6:19 a.m., HPSI-A was started to raise RCS level, per Off-Normal Operating Procedure OP-901-046, "Loss of Shutdown Cooling." By 6:33, LPSI-B was placed in service and then LPSI-A was secured. No cavitation was experienced by LPSI-B, and shutdown cooling flow was apparently not interrupted. There was a slight increase in RCS temperature from 89° to 92° F. This could have been caused in combination by the flow perturbations during LPSI-A cavitation and by the fact that shutdown cooling flow had been reduced at about 3:50 a.m. At 6:38 a.m. with shutdown cooling flow stable, RCS level was at 17 feet 2 inches MSL by RLIS. The HPSI pump was secured at that time.

Over the next two hours, the RWLIS and RLIS systems were again inspected, and LPSI-A was recirculated and vented. No sources of air intrusion were found. The licensee stated that the operators were fully confident that RLIS was indicating the correct RCS level.

At 8:56 a.m., LPSI-A was placed back in service for shutdown cooling. LPSI-B was not fully secured. It was left running in a recirculating mode in anticipation of more problems with LPSI-A, because the source of air intrusion was not yet resolved.

At 9:13 a.m., RCS draining was recommenced. At 9:32 a.m., the draindown was again secured because even though the RLIS had been considered correct, it was not decreasing whereas RWLIS was. Within two minutes, the NAO stationed at LPSI-A reported cavitation again. The operators shifted promptly to LPSI-B and again raised RCS level with HPSI-A for about four minutes. At this time, the engineer responsible for the RWLIS walked down the RWLIS and RLIS again and found that the excess RLIS hose he had previously placed on the grating at -4 feet MSL was now hanging over the grating and down to the -11 feet MSL level. When he pulled the hose up and started shaking it to see if any air was trapped, the RWLIS indicators in the control room became erratic, and bubbles showed up in the RLIS indicator. Level dropped from +17 feet MSL to just above +13 feet MSL. This was reported to the control room. The operators immediately started HPSI-A until the RLIS indicated 13 feet 8 inches MSL, which agreed with the RWLIS. No further problems occurred.

During the second draining which commenced at 9:13 p.m., the Operations Superintendent monitored operations in the control room due to the uncertainties revealed when LPSI-A first cavitated. This management attention was provided to help ensure shutdown cooling was maintained. Although licensee management claimed to have been sensitized to the significance of reactor vessel level problems in view of LER 86-015 and GL 87-12, implementation of corrective actions committed in both the LER and the response to GL 87-12 did not appear to be effective.

### Root Causes

The licensee attributed the loss of RCS level indication to a combination of causes. The NRC inspectors arrived at similar conclusions:

- a. Due to a programmatic breakdown in the process of turning over plant modifications to operations, the new RWLIS was not properly placed in operation thus effecting the attached RLIS. This left the operators with no reliable RCS level indication while draining.
- b. There was insufficient training of personnel expected to inspect and evaluate functionality of the RLIS. Consequently, obvious deficiencies were not identified and corrected prior to draining operations.
- c. Procedure OP-1-003, "Reactor Coolant System Drain Down" failed to clearly implement all of the commitments in the licensee's response to GL 87-12. This is a reflection on the review conducted by the Plant Operations Review Committee when the procedure was changed to incorporate those commitments, as well as the performance of those who initiated the change.

### Corrective Actions

The licensee is in the process of determining what corrective actions must be taken to prevent RCS level problems and/or loss of shutdown cooling in the future. The resident inspectors discussed tentative plans with licensee management and determined that the items listed below are under consideration. These actions would take place prior to the next draindown of the RCS. As of the end of this inspection period, the plant was in Mode 5, filled and vented, and pressurized to about 180 PSIA. No further draindowns were contemplated during this outage. Again, the items listed below are under consideration by the licensee and are not to be construed as a commitment at this time.

- a. Nuclear Operations Support Assessment (NOSA) will perform an assessment of the Station Modification Program overall work flow process. Particular attention will be focussed on modifications that could result in partial completion turnover to Operations.
- b. The Plant Operations Review Committee (PORC) will evaluate processing and distribution of procedure revisions/changes specifically for station modification implementation.
- c. This event will be incorporated into requalification training and initial training for licensed and non-licensed operators.
- d. This event will be reviewed with the engineers responsible for implementing station modifications or design changes.



- e. Training for engineering personnel will reemphasize the importance of operational impacts during the design and implementation of a station modification or design change.
- f. Procedure OP-1-003 will be revised to specifically address minimizing the length of tubing of the RLIS during installation and subsequent inspections.
- g. Procedure OP-1-003 will be revised to include RCS volumes for drain down from refueling. This should include intact steam generators and/or steam generators with nozzle dams installed.
- h. Operations Quality Assurance will perform an audit of SMP-138 to verify adequate installation to date.
- i. Nuclear Operations Engineering will review the post modification testing process.
- j. Modification Pre-implementation will be strengthened by placing additional emphasis on attendance and content of the meetings.
- k. The licensee will review the response to GL 87-12 to ensure that all commitments are implemented.

3. Exit Interview

The inspection scope and findings were summarized on May 23, 1988, with those persons indicated in paragraph 1 above. The licensee acknowledged the NRC inspectors' findings. The licensee did not identify as proprietary any of the material provided to or reviewed by the NRC inspectors during this inspection.