APPENDIX

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

NRC Inspection Report: 50-498/91-07
50-499/91-07

Operating Licenses: NPF-76
NPF-80

Dockets: 50-498
50-499

Licensee: Houston Lighting & Power Company (HL&P)
P.O. Box 1700
Houston, Texas 77251

Facility Name: South Texas Project (STP)

Inspection At: STP, Matagorda County, Texas

Inspection Conducted: February 25 through March 1, 1991

Inspectors: W. C. Seidle for
H. F. Bundy, Reactor Inspector, Test Programs Section, Division of Reactor Safety
Date: 3/12/91

W. C. Seidle for
D. A. Powers, Senior Reactor Inspector, Test Programs Section, Division of Reactor Safety
Date: 3/12/91

Approved: W. C. Seidle
W. C. Seidle, Chief, Test Programs Section
Division of Reactor Safety
Date: 3/12/91

Inspection Summary

Inspection Conducted February 25 through March 1, 1991 (Report 50-498/91-07; 50-499/91-07)

Areas Inspected: Routine, announced inspection of the licensee's programmed enhancements in response to Generic Letter 88-17 [loss of decay heat removal (DHR)].

Unit 1 Results: No inspection was performed for Unit 1.

Unit 2 Results: The licensee's programmed enhancements satisfied the intent of Generic Letter 88-17. The indications and alarms for core exit temperature, reactor coolant system (RCS) level, and residual heat removal (RHR) system performance were diverse and redundant. The licensee's quantification of level indication anomalies associated with the wide range magnetic float type level gauge will be tracked as Open Item 498;499/9107-01; (paragraph 2.2). The procedures and administrative controls were generally comprehensive and functional. However, licensee actions are required to resolve the following apparent procedural weaknesses:

- Failure to initiate timely closure of containment following loss of RHR in Procedure 04-RH-0001 (reference: paragraph 2.2, Open Item 498;499/9107-02)

- Inadequate precautions in Procedure OPOP04-RH-0001 to preclude a water hammer event upon starting a low-head safety injection (LHSI) pump following loss of RHR (reference: paragraph 2.2, Open Item 498;499/9107-04)

Because of the three-train design for most fluid systems and other unique design considerations, the equipment available to prevent and, if necessary, respond to loss of DHR was exceptional. The analyses supported the operating procedures. However, the ramifications of not identifying calculations which do not support the current plant operating procedures will require further study by the inspectors (reference: paragraph 2.2, Inspector Followup Item 498;499/9107-03). As suggested in Generic Letter 88-17, a Technical Specification (TS) change request to delete the automatic closure interlock for the RHR inlet valves had been submitted. Appropriate provisions were made in the administrative procedures to avoid RCS perturbations during mid-loop operations. However, the licensee was reminded that it should assure that all involved personnel receive appropriate training. No violations or deviations were identified.

## DETAILS

### 1. PERSONS CONTACTED

HL&P

*S. L. Rosen, Vice President, Nuclear Engineering
*R. W. Chewning, Vice President, Nuclear Support
*M. R. Wisenburg, Plant Manager
*D. J. Denver, Manager, Plant Engineering Department (PED)
*A. C. McIntyre, Manager, Design Engineering
*D. McCallan, Manager, Plant Operations Support
*M. K. Chakravorty, Director Nuclear Safety Review Board
D. M. Chamberlain, Group Supervisor, Qualification Engineering
*R. Estes, Senior Consulting Engineer, PED
J. R. Coulter, Senior Consulting Engineer, PED
J. B. Cook, Consulting Engineering Specialist
C. T. Bowman, Operations Support Supervisor
*S. Head, Supervisory Licensing Engineer
*A. K. Khosla, Senior Engineer, Licensing
*M. A. Coughlin, Senior Quality Engineer
*F. J. Comeaux, Independent Safety Engineering Group
G. C. Sandlin, Staff Engineer, Licensing
B. T. Norris, Operations Specialist

NRC

J. I. Tapia, Senior Resident Inspector
*R. Evans, Resident Inspector

The inspectors also interviewed other licensee employees during the inspection.

*Denotes those attending the exit meeting on March 1, 1991.

### 2. PROGRAMMED ENHANCEMENTS IN RESPONSE TO GENERIC LETTER 88-17 - LOSS OF DECAY HEAT REMOVAL (TI 2515/103)

#### 2.1 Generic Letter 88-17 Recommendations and Inspection Scope

Generic Letter (GL) 88-17 provided recommended licensee actions to prevent and, if necessary, to respond to loss of decay heat removal (DHR) during operations with the reactor coolant system (RCS) partially drained.

Recommendations were made by GL 88-17 in two categories:

- Expeditious actions, which were to be implemented prior to operating in a reduced inventory condition, and

- Programmed enhancements, which were to be developed in parallel with the expeditious actions and were to replace, supplement, or add to the expeditious actions.

The NRC's review of the licensee's expeditious actions was documented in NRC Inspection Report 50-498;499/89-14. The status of the licensee's programmed enhancements was also discussed. Review of the licensee's programmed enhancements for Unit 1 was documented in NRC Inspection Report 50-498;499/90-17. The purpose of this inspection was to followup on NRC Inspection Report 50-498;499/90-17; comments and concerns and ascertain completion of programmed enhancements for Unit 2. For the purpose of future reference, the programmed enhancement recommendations are briefly paraphrased below (to avoid confusion, the numbers are identical to similar items contained in GL 88-17):

Programmed Enhancements

(1) Instrumentation

Provide reliable indication of parameters that describe the state of the RCS and the performance of systems normally used to cool the RCS for both normal and accident conditions. At a minimum, provide the following in the control room:

- Two independent RCS level inoications;
- At least two independent temperature measurements representative of the core exit whenever the reactor vessel (RV) head is located on top of the RV;
- The capability of continuously monitoring DHR syster performance whenever a DHR system is being used for cooling the RCS; and
- Visible and audible indications of abnormal conditions in temperature, level, and DHR performance.

(2) Procedures

Develop and implement procedures that cover reduced inventory operation, and that provide an adequate basis of entry into a reduced inventory condition. These include:

- Procedures that cover normal operation of the NSSS, the containment, and supporting systems under conditions for which cooling would normally be provided by DHR systems;
- Procedures that cover emergency, abnormal, off-normal, or the equivalent operation of the NSSS, the containment, and supporting systems if an off-normal condition occurs while operating under conditions for which cooling would normally be provided by DHR systems; and

- Administrative controls that support and supplement the procedures in items (a), (b), and all other actions identified in this communication, as appropriate.

(3) Equipment

- Provide equipment of high reliability for cooling the RCS and avoiding loss of RCS cooling;

- Maintain equipment available to mitigate loss of DHR or loss of RCS inventory should they occur including at least one high-pressure injection pump and one other system, each sufficient to keep the core covered; and

- Provide adequate equipment for personnel communications involving activities related to the RCS or systems necessary to maintain the RCS in a stable and controlled condition.

(4) Analyses

Conduct analyses to supplement existing information and develop a basis for procedures, instrumentation installation and response, and equipment/NSSS interactions and response.

(5) Technical Specifications (TS)

Technical Specifications that restrict or limit the safety benefit of the actions identified in this letter should be identified, and appropriate changes should be submitted.

(6) RCS Perturbations

Reexamine item (5) of expeditious actions and refine operations as necessary to reasonably minimize the likelihood of loss of DHR.

2.2 Licensee's Actions in Response to GL 88-17 Programmed Enhancement Recommendations - Unit 2

The licensee's actions relative to Unit 1 were discussed in NRC Inspection Report 50-498;499/90-17. Inspector observations contained in that report generally apply to Unit 2 and will not be discussed in detail herein. Rather, the following discussion will focus on followup to issues previously identified, procedural and other documentation changes implemented by the licensee, and new issues identified by the inspectors. The Attachment is a tabulation of related documents reviewed by the inspectors. When a document number is cited below, it will be the number assigned in the Attachment. In addition to reviewing the listed documents and interviewing appropriate personnel, the inspectors walked down installed control room and switch gear room instrumentation. The installed instrumentation and equipment were as described in Document 1 and satisfied the intent of GL 88-17. The level instruments had the required independence and a high degree of redundancy.

However, some problems were found. These are summarized here and described in detail later in the report. Level indication anomalies of 4 to 6 inches had been observed by the licensee for the wide-range magnetic float-type level gauge with certain RHR pump configurations. The licensee's resolution of this issue will be tracked as an open item (498;499/9107-01) (paragraph 2.2.1.1). The revised operating procedures and administrative controls (Documents 2, 3, and 4) supported the licensee's plans for mid-loop operations and prevention of and recovery from loss of DHR. However, clarity issues were identified by the inspectors for licensee consideration. these are discussed in paragraph 2.2.2. Licensee actions to resolve the following procedural concerns will also be tracked:

- Demonstration by the licensee that actions specified in Procedure OPO04-RH-0001 to initiate containment closure following loss of RHR are timely (paragraph 2.2.2, Open Item 498;499/9107-02)

- Revision of Procedure OPOPO4-RH-0001 to require initiation of component cooling water flow prior to low-head safety injection (LHSI) pump start following loss of RHR (paragraph 2.2.4, Open Item 498;499/9107-04)

Because of the three-train design for most fluid systems and other unique design considerations, the equipment available to prevent and, if necessary, respond to a loss of DHR was above average. Analyses existed to support operational requirements. However, the ramifications of not identifying calculations which do not support the current plant operating procedures required further study by the inspectors (paragraph 2.2.4, Inspector Followup Item 498;499/9107-03).

The TS change request to delete the automatic closure interlock (ACI) for the RHR inlet valves had been submitted. Reasonable requirements were included in the procedures to avoid RCS perturbations. However, the inspectors concluded that training requirements for all personnel planning to participate in reduced inventory operation should be specified in the procedures.

Details of the inspectors' concerns and other comments on the licensee's actions in response to the programmed enhancement recommendations are documented below. No violations or deviations were identified.

2.2.1 Instrumentation

2.2.1.1 Level Instrumentation

The RCS level instruments were as described in NRC Inspection Report 50-498;499/90-17. They were considered diverse and were redundant. However, the inspector noted that an issue involving level indication anomalies of 4 to 6 inches for the wide range magnetic float- type level gauge with RHR pump discharge lined up to the "A" crossover leg had not been resolved. Testing in accordance with Document 5 had been partially completed on October 30, 1990. However, the licensee acknowledged that the testing must be completed in order for it to quantify these anomalies and incorporate appropriate precautions into procedures and training. Completion of these actions by the licensee will be tracked as Open Item 498;499/9107-01.

Other RCS level instruments appeared to be fully functional.

2.2.1.2 Temperature Monitoring

The temperature monitoring capability was as described in NRC Inspection Report 50-498/90-17; 50-499/90-17 and fully functional. It was diverse and responsive to GL 88-17.

2.2.1.3 DHR Performance Monitoring

The DHR performance monitoring instrumentation was as described in NRC Inspection Report 50-498;499/90-17 and fully functional. This capability was provided primarily by the emergency response facility data acquisition and display system (ERFDADS). Screen RH-11 provided instantaneous readings and 30 minute trends for RCS level and core exit temperature. Screen RH-12 provided instantaneous readings and 30 minute trends for RHR flow and RHR pump motor current. Screens RH-01, -21, -22, and -23 provided comprehensive displays of overall RHR system performance including a number of 1-hour trends. In addition, Screens RC-05, -12, and -21 provided useful information on RCS status for reduced inventory operation. These displays represented state-of-the-art, DHR performance monitoring and appeared user friendly.

2.2.1.4 Visible and Audible Indications of Abnormal Conditions

Most of the parameters monitored by ERFDADS as discussed above had alarm setpoints. In addition, there were a number of annunciators related to reduced inventory operations on the main annunciator panel. A low RCS level alarm at 6 inches above mid-loop was actuated by by either narrow range RCS level instrument. The fifth highest reading core exit thermocouple actuated a control room annunciator at 160° F. Other annunciators were provided to draw attention to RHR train malfunctions, including RHR pump low current. Overall, there were excellent indications of abnormal conditions, which might occur at reduced inventory.

2.2.2 Procedures

The inspectors reviewed the revised procedures which supported reduced inventory and mid-loop operations (Documents 2, 3, and 4). They reflected the programmed enhancements committed to in Document 1. With certain exceptions discussed in this report, they were comprehensive and provided an excellent base for reduced inventory and mid-loop operations. However, as discussed in NRC Inspection Report 50-498;499/90-17 and paragraph 2.2.1.1 above, the wide-range level indication anomalies were not addressed. Also, as discussed in paragraph 2.4 below, Procedure OPOP04-RH-0001 (Document 2) did not include adequate precautions to preclude RHR heat exchanger water hammer when starting a LHSI pump following loss of DHR. Other concerns and observations involving procedures were as follows.

Procedure OPOP04-RH-0001, Step 5.14 involved using a steam generator (SG) as a heat sink. There was no discussion of lineup of the RCS or secondary systems to support this use. A licensee representative stated that this step will be enhanced to provide proper systems lineup. He also stated that in making this enhancement, use of the SG in the reflux cooling mode will be considered. The inspector recommended that these considerations be incorporated into the operator training program.

Procedure OPOP04-RH-0001, Step 5.15 called for containment evacuation and closure. This step occurred after DHR had been lost and recovery failed. Because the licensee's analysis allowed a maximum time lapse of 15 minutes from loss of DHR to closure of containment, the inspector questioned whether this step was timely. Licensee representatives stated that other considerations in the procedures would initiate timely containment closure. However, if an action is included in an abnormal operating procedure, it must be timely. This action will be tracked as Open Item 498/9107-02; 499/9107-02 pending licensee demonstration that Procedure OPOP04-RH-0001 will effect timely containment closure in the event of loss of DHR capability.

2.2.3 Equipment

As discussed in NRC Inspection Report 50-498;499/90-17, the equipment available to provide normal core cooling during reduced inventory operations and RCS inventory makeup was diverse and redundant. The three-train design for most fluid systems, together with the fact that the LHSI pumps were not required for normal RHR operation, contributed to the high degree of diversity and redundancy for DHR.

2.2.4 Analysis

The licensee has performed calculations that were considered design basis documents necessary to support non-power operation in accordance with the programmed enhancements of GL 88-17, "Loss of Decay Heat." By reviewing the calculations that are referenced in this report, the inspector verified that procedural and administrative control requirements were adequately supported by such calculational analyses. With the exception of the issue discussed below, the licensee's data input assumptions and calculational methods were found to be reasonable.

During this inspection on Unit 2 and during the May 1990 inspection on Unit 1 (NRC Inspection Report 50-498;499/90-17), the licensee furnished Calculation MC-6143, "RHR HX Water Hammer," for inspector review. The documented objective of MC-6143 was to find the magnitude of the water hammer resulting from the collapse of a void created by a slump of an RHR heat exchanger. The licensee had, by another calculation, estimated that, with an RHR system fluid temperature of 140° F, a 7.5 cubic foot void would develop on loss of RHR pump head.

The licensee's water hammer analysis resulted in the determination that the loading on the RHR piping and heat exchanger tubes as a result of the collapse of the void was acceptable. The inspector agreed with the method of the calculation, but observed that the calculation did not reference or provide loading acceptance criteria. The calculation was also premised on an RHR system flow rate of only 100 gallons per minute. The inspector, consequently, questioned the licensee on how RHR system flow would be restarted at the specified low flow rate. The licensee's representative stated that MC-6143 had been abandoned in lieu of another approach, because such RHR system throttling had been found impracticable. The other approach involves collapsing the void prior to restart of the RHR pump by ensuring a two minute minimum operation time of the component cooling water (CCW) system. The licensee has not performed a calculation to verify this approach but has assumed, based on engineering judgment, that such minimum CCW operation will suffice to sub-cool the RHR heat exchanger.

The licensee's representative informed the inspector that a calculation that is found to be in error is voided upon the issuance of a revised procedure; however, a calculation that is no longer used as a design basis document, such as MC-6143, is not controlled in any particular manner. The inspector believes that this latter practice created the following vulnerability. Without annotating a caution on a faulted calculation (because it employs an unrealistic data assumption), a potential exists that at a later time the licensee might rely on the calculation as a basis for another analysis. Pending further review of the controls that the licensee places on design basis documents, this issue is considered an inspector followup item (50-498;499/9107-03).

In following up on the licensee's application of the use of the CCW system to collapse an RHR heat exchanger void, the inspector reviewed Procedure OPOP04-RH-0001. The inspector found that the procedure ensures operator verification of CCW flow for at least two minutes prior to restarting an RHR pump. However, the inspector noted that preceding this procedural step the operator is directed to start a LHSI pump, and that the necessary precaution is not given prior to starting the LHSI pump. The precaution prior to LHSI pump start is necessary in that the LHSI system injects at a rate of up to 1900 gallons per minute into the reactor coolant system via the RHR heat exchanger. The inspector believes that adding the precaution is important to protect the safety grade equipment. Specifically, the inspector's extrapolation of the licensee's calculation shows that the loading on the RHR heat exchanger tube bundle upon starting a LHSI pump with a 7.5 cubic foot void would result in about a 10 ton shock. During a conference call on March 4, 1991, the licensee's representative stated that Procedure OPOP04-RH-0001 would be revised by the end of the week to include the precaution prior to start of a LHSI pump. Because inclusion of appropriate precautions in the operating procedures should preclude a water hammer event from occurring, the licensee did not plan further study of this event. It should be noted that the inspector did not independently verify the adequacy of running the CCW system for 2 minutes to assure void collapse. Pending review of the revised procedure, this issue is considered an open item (50-498;499/9107-04).

2.2.5 TS Changes

The inspector reviewed HL&P letter ST-HL-AE-3485, which proposed an amendment to the Unit 1 and 2 TS. The amendment was proposed in response to GL 88-17. The proposal described the deletion of the automatic closure interlock (ACI) on the RHR suction valves.

As discussed in the proposal, the licensee concluded that during RHR operation, the ACI provides a potential for inadvertent RHR isolation valve closure. The licensee found that if ACI actuation occurs, the RHR pressure relief valves are not available to assist in relieving RCS overpressure transients and the low-pressure letdown lines are isolated. The licensee made the proposed amendment in agreement with the recommendation of the Westinghouse Owners' Group in WCAP-11736, "Residual Heat Removal System Autoclosure Interlock Deletion Report." The Owners' Group found that the results of the RHR unavailability analysis for an interfacing systems loss-of-coolant accident is improved with the removal of the ACI. Specifically for STP, the probabilistic risk analysis showed that deleting the ACI decreased the likelihood of loss of RHR during a seven week mission time by a factor of greater than 40. The licensee's proposal noted unique features in the STP design as compared to the base system analyzed in WASH-1400. The features are namely (1) the STP RHR system is completely contained within the containment building, (2) there are three separate STP RHR trains, and (3) STP operations uses LHSI pumps and not RHR pumps for safety injection.

The inspector noted that the proposal had been properly processed through the STP Nuclear Safety Review Board and submitted to NRC pursuant to 10 CFR 50.90. The inspector understood that the licensee is currently working with the NRC Office of Nuclear Reactor Regulation to set an implementation date for the amendment. Based upon the schedule for the implementation of modifications, the licensee anticipates that the TS changes will go into effect in late 1991 for Unit 1 and mid-1992 for Unit 2.

2.2.6 Reactor Coolant Systems Perturbations

In Procedure OPGP03-ZO-0035, the licensee set forth the procedural controls to minimize RCS perturbations during reduced inventory operations. The procedure defined activities that could lead to RCS perturbations. It also assigned various personnel responsibilities for ensuring safe operations. The procedure provided various precautions for entry into and subsequent operation in a condition of reduced inventory. The procedure appeared to minimize RCS perturbations.

Aside from administrative procedural requirements, the inspector did not find evidence of the licensee's intentions to train on RCS perturbations. According to the administrative procedures, control room operators are trained on mid-loop operations; however, no requirement existed for training other critical personnel involved in controlling or performing work activities that could create RCS perturbations. These personnel included the mid-loop coordinator, the reactor containment building coordinator, the outage manager, and, perhaps, others such as maintenance supervisors. The inspector was informed that the first three types of personnel have received appropriate training, although such training is

not procedurally required. It was the inspector's understanding that the underlying intent for training discussed in GL 88-17 is that all critical personnel, not just reactor operators, be trained in mid-loop operations. The inspector made this observation for the licensee's consideration.

3. EXIT MEETING

The inspectors met with licensee representatives denoted in paragraph 1 on March 1, 1991, and summarized the scope and findings of this inspection. The findings were updated in telephone conferences with licensee representatives on March 4 and 5, 1991. Proprietary materials provided to the inspectors were returned to the HL&P senior licensing engineer at the conclusion of this inspection and none of their contents are reproduced in this report.

ATTACHMENT

DOCUMENTS REVIEWED

1. Letter ST-HL-AE-3097, HL&P to NRC, "Revised Response to NRC GL 88-17 - Loss of DHR," dated August 3, 1989

2. Procedure OPOP04-RH-0001, Revision 3, "Loss of RHR"

3. Procedure OPGP03-ZG-0035, Revision, "Reduced RCS Inventory Operations"

4. Procedure OPOP03-ZG-0009, Revision 3, "Mid-Loop Operation"

5. Procedure OPEP07-RH-0006, Revision 0, "Mid-Loop Level Indications with Varying Plant Configurations"

6. Memorandum, Damon F. McCauley, Jr., to R. Morales, "RHR Undercurrent Indication/Alarm, 890232/890065," dated March 5, 1990

7. Calculation MC-6143, Revision 0, "RHR HX Water Hammer," dated August 3, 1989

8. Letter ST-HL-AE-3485, HL&P to NRC, "Unit 1 and Unit 2 Technical Specification 4.5.6.2.b," dated June 12, 1990

9. Calculation MC-6140, Revision 0, "RHR Mid-Loop Operation - HX Void Volume," dated August 4, 1989

10. Calculation MC-6142, Revision 0, "RHR Train Heat Loads," dated August 4, 1989

11. Calculation MC-6137, Revision 0, "Nozzle Dam Failure," dated August 4, 1989

12. Calculation MC-6139, "RHR Mid-Loop Operation - Volume Change After Slump," dated August 4, 1989

13. Calculation MC-6144, "RHR Mid-Loop Operation - Throttling LHSI Pump Flow," dated August 31, 1989

14. Calculation MC-6138, "RHR Pump at Mid-Loop in the Event of LOOP or Loss of Instrument Air," dated August 3, 1989

15. Calculation MC-6136, "RCS Mid-Loop Venting," dated September 22, 1989

16. Engineering Change Notice No. 89-J-0099H, "Instrument Setpoint List," dated June 22, 1989

17. Engineering Change Notice No. 89-J-0100H, "Instrument Setpoint List," dated May 9, 1990

18. Modification Document Change Notice No. 89232-48, "Revise Calc. EC-5005," dated April 5, 1990

19. Modification Document Change Notice No. 89065-69, "Revise Calc. EC-5005," dated June 30, 1990

20. Calculation No. NE-TH-89-03-00, "Unit 1 Containment Pressure/Temperature," dated July 12, 1989

21. Modification Document Change Notice No. 87091, documents for Unit 1 the increase in weight of cables and combustible load due to gauge installation, dated May 26, 1989

22. Modification Document Change Notice No. 87092, documents for Unit 2 the increase in weight of cables and combustible load due to gauge installation, dated October 23, 1989