



UNITED STATES
 NUCLEAR REGULATORY COMMISSION
 REGION II
 101 MARIETTA STREET, N.W.
 ATLANTA, GEORGIA 30303

Report No.: 50-416/84-17

Licensee: Mississippi Power and Light Company
 Jackson, MS 39205

Docket No.: 50-416

License No.: NPF-13

Facility Name: Grand Gulf 1

Inspection Date: May 2 - 4, 1984

Inspection at Grand Gulf site near Port Gibson, Mississippi

Inspectors:

N. Economos 5/24/84
 Date Signed

W. P. Ang 5-24-84
 Date Signed

H. L. Whitener 5-24-84
 Date Signed

Approved by:

J. J. Blake 5/30/84
 Date Signed
 J. J. Blake, Section Chief
 Engineering Branch
 Division of Reactor Safety

SUMMARY

Scope and Purpose of Inspection: This work effort was a special announced inspection conducted by RII Reactor Safety Division Staff for the following purposes:

1. To establish a factual recounting of significant events surrounding the Grand Gulf Residual Heat Removal loop "B" steam condensing mode pipe system cracking.
2. To evaluate the licensee's performance with respect to the pipe and support plate failures; engineering evaluation(s), and corrective actions taken to preclude recurrence of these events.

This work effort involved 53 inspector-hours on site. The inspection focused in the areas of pipe stress analysis, pipe thermal expansion calculations, hanger/support inspection for damage; review of weld fabrication and NDE records and observation of repair activities.

Summary of Findings: The licensee's preliminary findings indicate the cracks in the 3" diam. line resulted from material fatigue caused by pipe vibration that resulted from a combination of low flow conditions, and valve sequencing procedures necessitated by limiting operating licensing conditions. The contribution of water hammer to the pipe failure does not appear to be as significant as believed earlier. At the close of this inspection the licensee had not yet determined the operating conditions which caused certain RHR pipe support plates to fail.

Results: No violations or deviations were identified.

REPORT DETAILS

1. Licensee Employees Contacted

*J. E. Cross, Nuclear Plant Manager
*R. Rogers, Assistant Plant Manager Operations
*C. R. Hutchinson, Assistant Plant Manager Maintenance
*F. Walsh, Maintenance Superintendent
*J. R. Elms, Technical Assistant to Plant Manager
J. Malone, ISI Coordinator
R. A. Courtney, NDE Level III Examiner
R. Dubey, Piping Analysis Supervisor
K. Baker, Maintenance Field Engineer, Welding
G. Vining, Maintenance Field Engineer, Supervisor
D. Cupsted, Pipe and Hanger Technical Support

Other licensee employees contacted included construction craftsmen, technicians and office personnel.

Other Organization

Bechtel

*C. F. O'Neil, Resident Engineering
*D. E. Stewart, Resident Engineering
*R. L. Gordon, Pipe and Hanger Design Supervisor

*Attended exit interview

2. Exit Interview

The inspection scope and findings were summarized on May 4, 1984, with those persons indicated in paragraph 1 above. The licensee acknowledged the findings and took no exceptions. The findings were:

- Inspector Followup Item 50-416/84-17-01, Incomplete Pipe Support/Restraint Calculation Documentation - paragraph 6.
- Inspector Followup Item 50-416/84-17-02, Inspection of Loose Hanger Bolts and/or Nuts - paragraph 4.a.

3. Licensee Action on Previous Enforcement Matters

This subject was not addressed in the inspection.

4. Crack in Residual Heat Removal System Piping (92706)

On May 1, 1984, the licensee reported that during a tour/inspection of residual heat removal (RHR) system piping, employees observed leakage from a three-inch carbon steel line which runs from the "B" loop RHR heat exchangers' outlet to the reactor core isolation cooling (RCIC) system pump.

The line was designed to be used in the steam condensing mode of RHR system. Preliminary investigation by the licensee disclosed that two cracks had been identified, the first was located near the attachment weld joining the 3" diam. weld-o-let to the 18" diam. RHR outlet line, and the second was in the first 90° elbow of this 3" diam. line located approximately two feet from the aforementioned attachment weld. Water hammer was thought to be the cause of failure as the hangers on the 3" diam. line were distorted and because no leaks were observed during earlier tours of this system that day. See morning report of May 1, 1984 and preliminary notification PNO-II-84-31 dated May 1, 1984, attachments A and B respectively.

Upon arrival, the inspectors were briefed on the pipe failure by personnel involved with pipe analysis, technical support, and maintenance. Also, the inspectors reviewed applicable ISOs and P&ID drawings and performed a plant tour with emphasis on the areas of RHR loops "A" and "B" in the vicinity of the cracked pipe. In addition, the inspectors requested and the licensee provided a copy of the planned corrective actions taken to repair the pipe, declare "B" loop operable, and verify the integrity of related ECCS systems. See attachment C to this report.

a. Plant Tour and Inspection of Affected Components

At the outlet of RHR heat exchanger No. B002B, the inspectors noted that the affected 3" pipe section and the weld-o-let attachment had been removed. The new weld-o-let had been welded to the 18" outlet line and preparations were underway to weld a 6" cap on the new weld-o-let, thereby isolating the 3" condensate line from service. At this time the inspectors witnessed the ultrasonic examination of weld FW-60 on RHR Loop A line 18"-GBB-21. This examination was performed on welds in high stress locations i.e., structural discontinuities, near the cracked line to determine whether the apparent vibration had compromised weld integrity. In addition, the inspectors observed the three pipe restraints that sustained some anchor plate damage as a result of this event. These were on the suction side of RHR pumps A and B. The restraints were identified as follows:

Residual Heat Removal

<u>Restraint No.</u>	<u>Location</u>	<u>Comment</u>
Q1E12G012R14 Loop "A"	Upstream from Valve F006A-A, line 18"-GBB-31, El.~ 119'	Base plate pulled off wall approxi- mately ¼"

Q1E12G012R05 Loop "B"	Downstream from Valve F006B-B, line 18"-GBB-32, El.~ 119'	Paint cracking at HILTI bolt connection and plate and wall interface. Slight base plate movement.
Q1E12G012R06 Loop "B"	Upstream from Valve F006B-B, line 18"-GBB-32, El.~ 133'	Base plate pulled off wall approxi- mately 3/4"

On May 4, 1984, the inspectors performed an inspection of restraint/hangers selected at random in loops "B" and "C" to check hangers/restraints and their anchor plates for possible damage. These components were identified as follows:

	<u>Restraint No.</u>	<u>Comment</u>
Loop "B"	Q1E12G010R04	One fastening nut not flush on plate and the bolt appears bent.
	Q1E12G010R05	Anchor plate not making contact with wall on left side.
	Q1E12G010R06	One half of nut on upper left hand side of anchor plate making contact.
	Q1E12G010R07	No visual evidence of damage.
	Q1E12G014R02	No visual evidence of damage.
	Q1E12G014R04	No visual evidence of damage.
	Q1E12G014R05	No visual evidence of damage.
	Q1E12G014R09	No visual evidence of damage.
	Q1E12G019R05	No visual evidence of damage.
	Q1E12G014C04	Pipe clamp lock nut found loose.
	Q1E12G014C01	No visual evidence of damage.
	Q1E12G010H04	U-Bolt clamp with nuts loose on both sides.

Loop "C"	Q1E12G007R04	No visual evidence of damage.
	Q1E12G007R05	No visual evidence of damage.
	Q1E12G007R06	Three of four nuts on clamp found loose.
	Q1E12G007H05	No visual evidence of damage.
	Q1E12G008R01	One of five nuts on anchor plate not making full contact.
	Q1E12G008R02	One of five nuts on anchor plate not making full contact.
	Q1E12G008H01	No visual evidence of damage.

The inspectors communicated the above findings to the licensee who agreed to look further into these areas in terms of evaluation and remedial actions to be taken. Following this inspection, the licensee discussed by telephone their inspection/evaluation results with the regional staff and stated that except for the loose nuts all other conditions heretofore identified were within specification requirements. The licensee's representative agreed to institute an inspection program that would look for loose fastening nuts on supports, clamps, hangers, etc., and take appropriate action when such conditions were found. This was identified as an inspector followup item IFI 84-17-02 Inspection of Loose Hanger Bolts and/or Nuts.

b. Inspection of Cracked Pipe Suction

As stated earlier in this report, the failed pipe section exhibited two cracks. The first was located near the attachment weld joining the 3" diam. weld-o-let to the 18" diam. RHR outlet line No. 18"-GBB-81 and the second was in the 90° elbow of the 3" diam. line, No. 3"-GBB-90 just upstream from valve F065B or about two feet from the 18" diam. RHR outlet line. A close visual examination disclosed that the crack at the weld-o-let was located at the toe of the weld on the OD surface and propagated through to the ID surface of the 18" diam. pipe in a location which was approximately 1mm away from the edge of the weld-o-let penetration. The path of the crack on both sides of the joint appeared to be circumferential and singular e.g., without branching. The second crack which was located on the inside/short radius of the 3" diam. elbow followed a path that was transverse to the axis of this line with a slight positive slope from about 5 to 8 o'clock, see figures 1 and 2. The crack was located outside of the pipe to elbow weld heat affected zone (HAZ). The elbow appeared to be bent approximately 1° and 2° off the y axis of the pipe. At the time of this inspection, the licensee had not performed a failure analysis, therefore it was impossible to determine at this point the cause of failure. However, taking into account the fact that (1) this line experienced extended periods of

vibration, believed to be associated with low flow conditions, and that (2) unlike loop "A" this line did not have a vertical support at or near the elbow to resist this type of motion would suggest the failure resulted from material fatigue assisted by forces generated from a water hammer. The inspectors requested and the licensee has agreed to provide the staff with a copy of the failure analysis report for review.

c. Records, Review and Evaluation

The inspectors reviewed quality records of the failed pipe sections and weld-o-let, and the newly installed replacement materials. Applicable welding procedures, welder performance qualifications, filler metal receiving reports, and material certifications were reviewed to verify applicable code compliance.

In addition, the inspectors reviewed radiographs and UT data of welds examined as part of the corrective action plan taken to assure that the integrity of welds in high stress areas, near the failed pipe components, had not been violated. These welds were as follows:

Loop "A" - RHR Heat Exchanger B002A Outlet

<u>Weld</u>	<u>Line</u>	
W-1	20"-GBB-20	Elbow to Nozzle
W-55	18"-GBB-20	Pipe to Valve, F003A-A
W-56	18"-GBB-20	Pipe to Valve, F003A-A
W-60	18"-GBB-21	Pipe to Tee

Loop "B" - RHR Heat Exchanger B002B Outlet

W-1	20"-GBB-81	Elbow to Nozzle
W-2	18"-GBB-81	Pipe to Valve, F003B-B
W-3	18"-GBB-81	Pipe to Valve, F003B-B
W-20	18"-GBB-75	Pipe to Tee

The NDE examination procedures used to perform these examinations were written to comply with ASME Code, Section V (74S75)

No violations or deviations were identified.

5. Thermal Expansion

As part of the NRC review of plant conditions which may possibly have contributed to the pipe cracking on the RHR steam condensing mode return line (loop B) and loosening of wall plates, one on loop A and two on loop B, on RHR pump suction lines, the inspectors reviewed the available thermal expansion test results and baseline vibration data for the RHR system.

In general, the available expansion data related to the movement of RHR piping inside the drywell without shutdown cooling in operation. Under these conditions essentially no movement occurred in piping of the RHR shutdown cooling loops in the auxiliary building.

Discussion with licensee representatives indicated that due to minimal decay heat loads the shutdown cooling mode of RHR has not been heated to expected maximum temperature and stabilized for recording system expansion data at rated conditions. The system has been used briefly for plant cooldown on three occasions: after the hot-operation non-nuclear heatup, after the initial nuclear heatup, and for plant shutdown resulting from the current pipe cracking and loosened support plate problems. Data were obtained after the non-nuclear heatup at 15 locations to provide information on the shutdown cooling system behavior although not a maximum rated condition. Licensee representatives stated that all expansion data on the system were within the acceptance criteria with exception of three points.

These three points near the heat exchangers were out of range due to a temperature distribution being different than that assumed for determining the expected movement. Specifically, the heat exchangers were bypassed and remained cold.

In the above review of the RHR system behavior during plant heatup and cooldown the inspector did not identify any condition which would be expected to result in damage to the support plates on the RHR pump suction lines. The licensee also reached this conclusion and directed investigation toward possibly water hammer or piping vibration effects.

Baseline vibration data on various operating modes of the RHR system were obtained at or near full flow conditions for piping and near the inlet and discharge nozzles of the RHR pumps for pump start/stop. These data show minimal vibrations which are well within the acceptance criteria. The licensee stated that the data for pump start and stop were taken only at points near the pump inlet and outlet nozzles. System alignment for the pump start and stop tests was not recorded on the data sheets. The licensee initiated additional vibration measurements of the RHR system as a result of the current pipe cracking and support plate problems and has informed the NRC that there appears to be a vibration problem not initially identified. Further investigation and evaluation is in progress related to the potential for system vibration as a result of the low flow mode of shutdown cooling operation and/or pump start and stop contribution to the system damage.

No violations or deviations were identified.

6. Design Activities Regarding Pipe Support Repair

The licensee reported leakage from the "B" Loop RHR heat exchanger's outlet piping. During subsequent inspection of the RHR system, the licensee further identified potential damage to three pipe supports/restraints.

The staff reviewed available data to verify the adequacy of the original design and the design adequacy of the repairs to the damaged pipe supports. The computer print-out for the piping stress analysis was not available on-site. The licensee's A/E, Bechtel, telecopied to the site stress reports and pipe support/restraint load summary sheets for the following stress problems:

- Calculation Number 69A - included the "B" Loop piping that leaked
- Calculation Number 46 - included the damaged pipe support
- Calculation Number 69C - included the "A" Loop piping comparable with the damaged "B" Loop piping

The stress reports showed piping stresses within the allowable. No violation of original design requirements was identified.

The potentially damaged pipe supports identified by the licensee were:

- Q1E12G010R06 Two top concrete expansion anchors of one baseplate were pulled out approximately $\frac{1}{2}$ "
- Q1E12G010R05 $\frac{1}{32}$ " gap between baseplate and concrete surface. No visible damage to concrete.
- Q1E12G012R14 Two top concrete expansion anchors of one baseplate pulled out approximately $\frac{1}{4}$ ". No visible damage to concrete surface.

The above noted pipe supports/restraints calculations for the existing designs were reviewed. No technical discrepancies were noted. However, documentation of the source of forces and moments on the baseplates for Q1E12G010R05 were not adequately identified and required clarification. The licensee and its A/E agreed to clarify the documentation. Pending clarification, this was identified as Inspector Followup Item 84-17-01, Incomplete Pipe Support/Restraint Calculation Documentation. No violations or deviations of applicable design requirements were identified in the existing support/restraint calculations.

The corrective action for the damaged conditions on the above noted pipe supports were as follows:

- Q1E12G010R06 Replace and Relocate baseplate and concrete expansion anchors. Use 3/4" diameter concrete expansion anchors in lieu of 5/8" diameter.
- Q1E12G010R05 & Q1E12G012R14 Drypack grout behind baseplate (Q1E12G012R14 only) and re-torque to installation torque.

Applicable calculations and repair action were reviewed and discussed with the licensee. No technical discrepancies were noted. However, the calculations for the modification of support/restraint Q1E12G010R06 did not completely document the source for the load on the repaired baseplate. The licensee and the A/E agreed to clarify the calculation. Pending clarification of the calculation, this was identified as a second item for Inspector Followup Item 84-17-02. No violations or deviations of applicable design requirements were identified.

The licensee and its A/E were continuing to investigate the cause of the damage to the pipe supports. The licensee and the A/E acknowledged that pipe supports/restraints were subject to loads that have not been accounted for. The licensee and the A/E were continuing to determine the cause of failure in an effort to either eliminate it, or redesign the piping system for the experienced condition.

No violations or deviations were identified.

Attachments:

- A. Morning Report dtd May 1, 1984
- B. PNO-II-84-31 dtd May 1, 1984
- C. "B" RHR Action Plan

ATTACHMENT A

MOVING REPORT - REGION II
DATE: MAY 12, 1984

LICENSEE/FACILITY

NOTIFICATION/SUBJECT

DESCRIPTION OF ITEM OR EVENT

GRAND GULF 1
DN: 53-410

NO DUTY OFFICER, 4/30

REPORTABLE OCCURRENCE: AT 5:40 P.M., ON 4/30, WITH UNIT 1 IN STEAM CONDENSING MODE, LEAKAGE FROM THE H LOOP RHR HEAT EXCHANGER'S OUTLET/RIC PUMP SUCTION PIPING WAS OBSERVED. STEAM CONDENSING TO THE H LOOP RHR HEAT EXCHANGER WAS IMMEDIATELY STOPPED AND THE LEAK WAS STOPPED. CRACKS WERE FOUND IN THE ELBOW PIPE CONNECTION WHICH IS LOCATED BETWEEN THE H LOOP RHR HEAT EXCHANGER OUTLET AND VALVE F0058. THE LINE IS A 3" CARBON STEEL LINE. WATER HAMMER IS THOUGHT TO BE THE CAUSE AS THE HANGERS ON THE 3" LINE ARE DISTORTED AND A DEFINITE TIME FRAME FOR THE EVENT IS KNOWN. THE CAUSE OF THE CRACKING IS UNDER FURTHER INVESTIGATION AND REPAIRS WILL BE MADE. LOSS OF THE H LOOP HEAT EXCHANGERS FOR USE BY CONTAINMENT SPRAY PLACES THE PLANT IN A 72 HOUR TECHNICAL SPECIFICATION ACTION STATEMENT. BEST ESTIMATES ARE THAT REPAIRS CAN BE MADE IN THIS TIME. THE PLANT CONTINUED TO OPERATE AT 58 POWER. NRC REGION II INSPECTORS ARE ON SITE. A WRITTEN REPORT IS DUE BY 6/1/84. PNO ISSUED.

HATCH 1 & 2
DN: 53-501
53-500

NO DUTY OFFICER, 4/27

ON 4/27 AT 2:50 P.M. THE PLANT EXPERIENCED A TEMPORARY LOSS OF THE FIRE SUPPRESSION SYSTEM WHEN PART OF THE FIRE MAIN RUPTURED. THE LICENSEE WAS IN THE PROCESS OF INSTALLING FUSES INTO THE FIRE SYSTEM CONTROL PANEL WHICH HAD BLOWN DUE TO AN ELECTRICAL STORM, WHEN ALL THREE FIRE PUMPS STARTED. THE PRESSURE SURGE RUPTURED PART OF THE 14" FIRE MAIN. THE LICENSEE STOPPED THE FLOW AND HAS SINCE ISOLATED THE FAILED SECTION TO RESTORE THE SUPPRESSION SYSTEM TO OPERATION. DURING THE EVENT THE FIRE SUPPRESSION SUPPLY TANKS WERE LOWERED TO 195,000 GALLONS EACH (15 LITER 170,000 GALLONS). ROUTINE FOLLOWUP.

NUCLEAR FUEL
SERVICES, INC.
ERWIN, TN
DN: 58-943

ONSITE INSPECTOR/POWER
FACILITY

AT APPROXIMATELY 10:15 A.M. ON 4/30/84, THE LICENSEE EXPERIENCED A TEMPORARY LOSS OF COMMERCIAL ELECTRICAL POWER. THE POWER WAS OFF FOR THREE MINUTES. NON-ESSENTIAL EMPLOYEES EVACUATED THE PROCESS AREAS IN ACCORDANCE WITH PROCEDURES. EMERGENCY ELECTRICAL POWER SYSTEMS FUNCTIONED AS DESIGNED. AIR SAMPLES WERE COLLECTED AND SHEL CONCENTRATIONS OF AIRBORNE URANIUM DETERMINED PRIOR TO EMPLOYEES RETURNING TO THE PROCESS AREA. THERE HAS BEEN NO MEDIA INTEREST. THE LICENSEE DOES NOT PLAN TO MAKE A NEWS RELEASE. REGION II WILL FOLLOWUP DURING THE NEXT ROUTINE INSPECTION.

May 1, 1984

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE PNO-II-84-31

This preliminary notification constitutes EARLY notice of events of POSSIBLE safety or public interest significance. The information is as initially received without verification or evaluation, and is basically all that is known by the Region II staff on this date.

FACILITY: Mississippi Power and Light Co.
Grand Gulf Unit 1
Docket No. 50-416
Port Gibson, Mississippi

Licensee Emergency Classification:
 Notification of Unusual Event
 Alert
 Site Area Emergency
 General Emergency
 Not Applicable

SUBJECT: CRACK IN RESIDUAL HEAT REMOVAL SYSTEM PIPING

Licensee employees, making regular tours of residual heat removal (RHR) system piping areas at 5:40 p.m. yesterday, observed leakage from a three-inch line which runs from the "B" loop RHR heat exchangers' outlet to the reactor core isolation cooling (RCIC) system pump. This piping, which is used in the steam condensing mode of RHR, was isolated, and the leak was stopped. The unit was operating at three percent power at the time.

Preliminary investigation by the licensee disclosed cracks in the pipe elbow and weld-o-let located between the heat exchanger outlet and an isolation valve. The piping involved is a three-inch carbon steel line. Water hammer is thought to be the cause, as the hangers on the three-inch line are distorted and because no leaks were observed during earlier tours of the system that day. Mississippi Power and Light is still investigating the cause of the cracking and is planning to make repairs.

Because the "B" loop heat exchangers have been declared inoperable, and they cannot be used for containment spray, technical specifications require that the plant proceed toward cold shutdown if conditions are not rectified within 72 hours. A Region II metallurgist is on site. Both IE and NRR have been advised of the situation.

Grand Gulf Unit 1 attained recriticality on April 22 after having been shut down since November 1983 for maintenance, operator training recertification and correction of technical specification deficiencies. The unit is limited to five percent power by its operating license.

Media interest may occur in view of continuing coverage of Grand Gulf. The licensee does not plan a news release, but is prepared to respond to inquiries. Region II does not plan a news release.

The State of Mississippi has been informed.

The licensee informed the NRC headquarters duty officer of this event at 7:49 p.m. yesterday.

This information is current as of 3 p.m. today.

Contact: C. A. Julian, 242-5535

A. R. Herdt, 242-5585

~~8405040280~~ lp.

ATTACHMENT C

"B" RHR ACTION PLAN

1. Develop Operations Chronology/Chain of Events
2. Metallurgical Exam of Failed Pipe
3. To Declare "B" Loop Operable:
 - a. Repair Weld (Stub pipe repair and RT's)
 - b. Evaluate other welds and compare to baseline (UT's)
 - c. Walkdown pipe supports - Bechtel/79-14 review
 - d. Test selective snubbers - 2 snubbers off 18" line
 - e. Change Operations procedure to prevent water hammer events
 - f. Write Hydro Procedure and issue
 - g. Do Hydro and check for RHR heater integrity
 - h. Limitorque and conductivity elements repairs
 - i. Pump suction hanger - MNCR
4. RHR "A" Loop Evaluation
 - a. Walkdown pipe supports - Bechtel/79-14 review
 - b. UT-4 High Stress Weld - Evaluate Baseline
 - c. MT and M/T 18" stubweld
 - d. Pump suction hanger - MNCR
5. Other ECCS System Evaluation:
 - a. Walkdown HPCS
 - b. Walkdown LPCS
 - c. Walkdown RCIC
 - d. Walkdown RHRC



FIGURE 1

Three inch weld-o-let and 18" diam. RHR pipe weldment depicting circumferential crack at the toe of the weld.



FIGURE 2

Section of 3" diam. RHR pipe and weld-o-let removed because of leakage depicting cracking condition on the inside diameter of the 3" elbow and on the ID of the 18" RHR pipe surface near the weld-o-let penetration.