GULF STATES UTILITIES COMPANY

RIVER BEND STATION    POST OFFICE BOX 220    ST. FRANCISVILLE, LOUISIANA 70775
AREA CODE 504    635-6094    346-8651

February 13 , 1992
RBG- 36502
File Nos. G9.5, G9.25.1.3

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Gentlemen:

River Bend Station - Unit 1
Docket No. 50-458

Please find enclosed an Informational Report concerning cracks discovered in welds in the hydraulic control unit piping at River Bend Station - Unit 1. This report is submitted to inform the NRC of these conditions and document GSU's investigation and corrective actions.

Sincerely,

W.H. Odell
Manager - Oversight
River Bend Nuclear Group

LAE/PDG/JRH/GAB/DCH/PAM/kvm

cc: U.S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011

NRC Resident Inspector
P.O. Box 1051
St. Francisville, LA 70775

INPO Records Center
1100 Circle Parkway
Atlanta, GA 30339-3064

Mr. C.R. Oberg
Public Utility Commission of Texas
7800 Shoal Creek Blvd., Suite 400 North
Austin, TX 78757



IE22 1/1

## INTRODUCTION

On February 28, 1991 hydraulic control unit No.36-21 was found leaking. After closer examination of the HCU, it was noted that the water was spraying out from a circumferential crack in a short, horizontal segment of charging water piping between the accumulator pipe coupling and the charging water check valve, near the toe of the weld (see Figure 1, weld #1). This was documented on condition report (CR) 91-0074. The plant was not operating at the time of discovery.

The hydraulic control units (HCUs) are part of the control rod drive hydraulic system. They are used to regulate the pressure and flow of water to and from the control rod drives (CRDs). There are 145 HCUs at River Bend, one for each CRD. During normal plant operation, the HCUs direct and control cooling water and drive water to the control rods. During a reactor scram, the HCUs provide the water needed for rapid insertion of the control rods into the reactor core via scram water accumulators mounted on the HCU skids.

## INVESTIGATION

The leaking pipe was replaced and liquid penetrant test (PT) examinations were performed on the remainder of the HCUs (144 units) at the location of the leak (weld #1, Figure #1). Sixteen additional linear indications were discovered and reworked; none were leaking (See Table #1).

A metallurgical evaluation was performed on the cracked pipe nipple. The study concluded that the failure mechanism was most likely due to low cycle fatigue at the toe of the weld. General Electric issued Rapid Information Communication Services Information Letter (RICSIL) No.056 to document the problem.

The following action plan was developed for the determination of the root cause:

- Review and evaluation of existing design bases, procedures and other pertinent physical data for errors, omissions or anomalies that could be responsible for or contribute to the problem.
- Assessment of the data available from the plant through testing to support the investigation.
- Collection and analysis of the data to establish a potential root cause.
- Confirmation of the root cause through field testing.
- Design and implementation of corrective actions.

Reviews of the existing piping stress analyses and application of design basis transients required for River Bend Station do not demonstrate the existence of a low cycle fatigue problem. However, using observed piping displacements as input to the computer model, failure at the joint in question could be predicted. Furthermore, since the subject piping operates only after a reactor scram or Technical Specification (TS) rod insertion time test, it was hypothesized that the forcing function responsible for the pipe cracking developed during reactor scrams or TS time test events instead of during normal operation of the plant. It was later determined that there was no significant risk introduced from single rod scrams.

Review of the RBS operating and maintenance procedures has been completed; no obvious anomalies were found that would account for or contribute to the observed condition.

A reactor scram history has been developed to help establish the relationship between pipe cracking and positions of control rods and to provide an empirical baseline for the types and numbers of scram cycles related to the failures. Currently, the pattern of crack incidence appears to be completely random, occurring on both the east and west sides of the reactor and at several different charging water header and branch line locations. Correlations along other common lines are presently being evaluated. Also, experiences from other BWR/6 plants are being reviewed for applicability to the RBS problem. One other BWR/6 plant (KKL in Switzerland) was found to have experienced a similar problem. Their experiences are being reviewed for applicability to River Bend Station.

Tests to collect piping and structural vibration data were conducted during the reactor shutdown scram and the mid-cycle 4 (MDCY4) outage that followed. Through analysis of this data it has been determined that the cracking is due to piping vibrations caused by a hydraulic transient phenomenon of unknown source in the system. It has also been determined that the vibrations emanate from the charging water header down into the vicinity of the cracking, rather than up from the scram water accumulator. The investigations are continuing.

Based on the above and on the results of a fracture mechanics analysis performed by General Electric, an operability evaluation was prepared. Details of this evaluation are presented in the next section.

**OPERABILITY EVALUATION**

GSU has determined that the plant is operable based on the following:

1. PT examinations of the welds at location #1 have been and will continue to be performed following every full core plant scram from power for 100% of the HCUs. All indications documented during these inspections shall be reworked/replaced prior to restart of the plant from each scram.

2. As described below, PT examinations were conducted on the next three welds upstream of weld #1 prior to restart from the MDCY4 outage (see Figure 1). Note that these welds were determined to be susceptible to cracking from review of available pipe stress analyses. All (100%) of the weld #2 and #3 locations were inspected and a selected sample of the weld #4 locations were inspected (only when an indication was found in either of the corresponding weld #2 or #3 locations) . All indications were reworked accordingly and no indications were found in any of the inspected welds at location #4. Table 2 summarizes the results of these inspections.

3. The forcing function responsible for the cracking has been determined to occur during full core scrams from power and not during normal operation of the plant. Also, there is no significant risk introduced from single rod scrams, which are required for Tech Spec control rod scram time testing (with valve V113 closed

and no flow in the charging water riser to the accumulators) or from mode switch scrams after plant shutdown. This is supported by the vibration test data and by the results of the General Electric fracture mechanics analysis.

4. The fracture mechanics analysis performed by General Electric demonstrates that at least 4 additional full core scrams from power can be tolerated without the development of a through wall crack even when a crack of 0.5" long x 0.0825" deep is assumed to exist (pipe wall thickness is 0.147"). Since the HCUs are subject to general visual inspections on a daily basis by Operations personnel, it is likely that leaks would be discovered and isolated before the pipe had the opportunity to break. Therefore, pipe break can be eliminated as a potential consequence. This conclusion is further strengthened by GSU's commitment to rework/replace all welds with known indications prior to restart of the plant from future scrams.

5. Based on the leak rate of a crack computed in the General Electric fracture mechanics analysis, leakage from a through wall crack in a charging water pipe does not present an operability concern.

6. The recommendations of GE RICSIL #056, PT inspection of welds and general inspection of clamps, have been reviewed and implemented, as applicable to River Bend Station.

7. In accordance with RICSIL #056, this is not a safety issue. During normal plant operation, automatic and manual scram capability is maintained even without accumulator pressure due to reactor pressure. The most severe impact in the case of using reactor pressure would be slower control rod scram insertion time (to 2.5 - 3.0 seconds). The safety significance of this has been reviewed and is acceptable on the basis of the total rod density inserted from all rods into the reactor core as a function of time.

8. A 10CFR50.59 evaluation was performed. Based on the conclusion in item 7 above no unreviewed safety question has been identified.

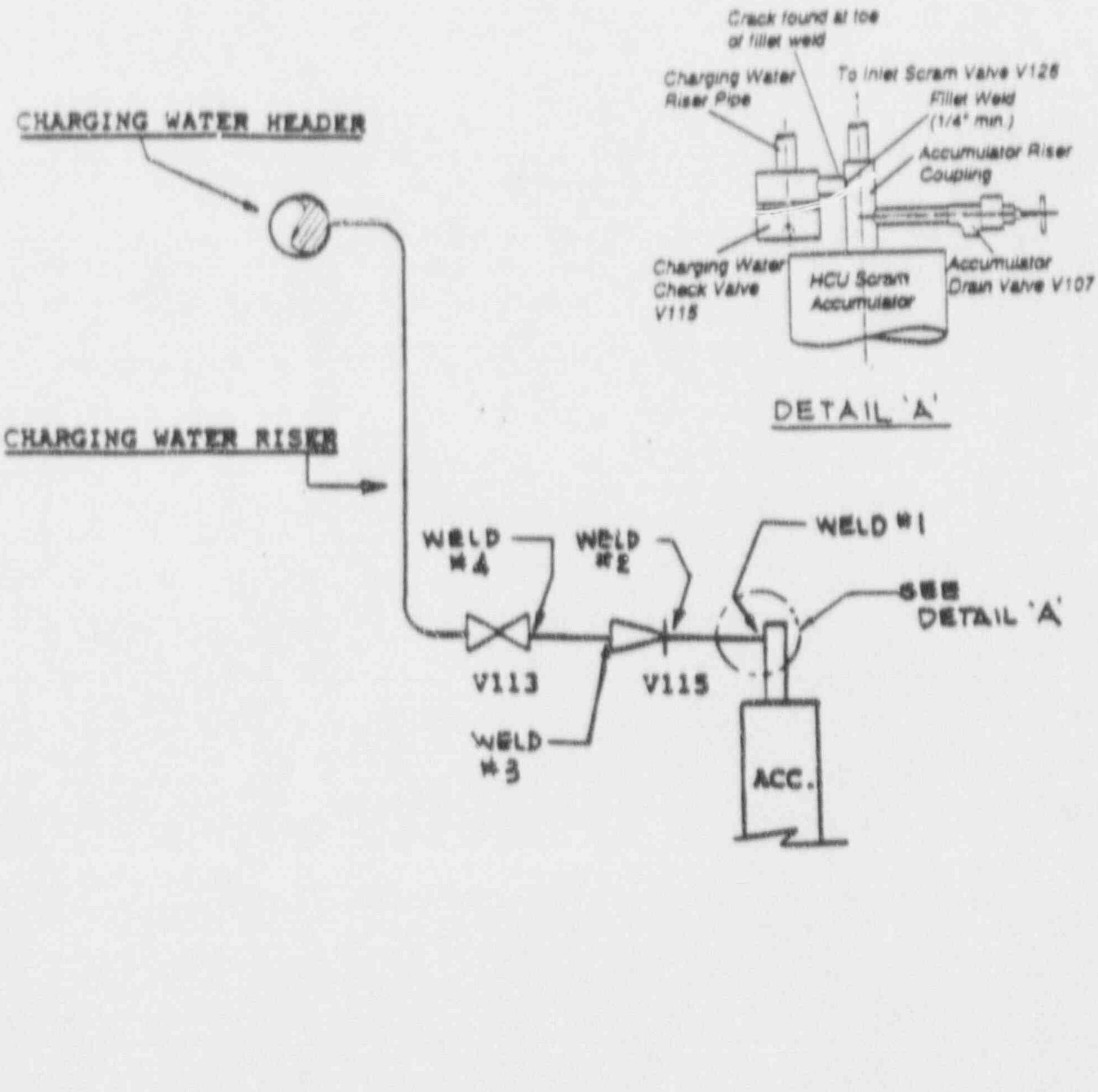
## CONCLUSIONS

Cracking of the HCUs at RBS is determined to be caused from low cycle fatigue due to a fluid transient of unknown origin which occurs during full core reactor scrams from power. Cracking typically occurs in the first two or three welds on the charging water line off the accumulators on the HCU skid. This is not a safety issue because automatic or manual scram can be achieved during normal operation without accumulator pressure by using reactor pressure. Moreover, during startup, the ability to scram is assured by the commitment at RBS to rework or replace all known indications in charging water pipe welds prior to plant startups.

The investigation to determine the source of the responsible fluid transient and to conceptualize corrective actions is currently in progress. Due to the complexity of the problem and lack of significant precedence in the industry, a firm date for resolution of the problem has not yet been established.

# FIGURE 1

## Typical HCU Charging Water Piping Arrangement




PT EXAMINATION SEQUENCE and CRITERIA

a. 100% examination of weld #1.

b. 100% examination of welds #2 and #3.

c. Where weld #2 or #3 revealed an indication, then weld #4 was inspected.

# TABLE 1

## Weld #1 Indication Summary from February '91

| *CRD NO.* | *REPAIR* |
|---|---|
| 12-21 | New support riser installed |
| 12-25 | Buff, grind, no weld |
| 12-29 | Buff, grind, weld |
| 12-37 | New support riser installed |
| 20-09 | Weld found satisfactory, no rework |
| 20-21 | Buff, grind, weld |
| 20-37 | Buff, grind, weld |
| 24-17 | Buff, grind, weld |
| 28-05 | New support riser installed |
| 28-13 | New support riser installed |
| 28-25 | Buff, grind, weld |
| 28-45 | New support riser installed |
| 32-21 | New support riser installed |
| 36-21* | New support riser installed |
| 44-17 | New support riser installed |
| 48-17 | New support riser installed |
| 52-21 | New support riser installed |

* through wall crack

## TABLE 2

### Indication Summary for Weld#s 2, 3, 4 Following MDCY4

| | WELD | | | |
|---|---|---|---|---|
| *CRD NO.* | *#2* | *#3* | *#4* | *REPAIR* |
| 04-41 | X | | | File, buff, no base metal removed |
| 12-29 | X | X | | Weld repair #3, file, buff #2 |
| 12-37 | X | | | File, buff, no base metal removed |
| 20-29 | X | X | | File, buff, no base metal removed |
| 24-17 | X | X | | File, buff, no base metal removed |
| 24-41 | X | | | File, buff, no base metal removed |
| 28-45 | X | | | File, buff, no base metal removed |
| 32-53 | X | | | File, buff, no base metal removed |
| 36-25 | X | | | File, buff, no base metal removed |
| 36-45 | | X | | File, buff, no base metal removed |
| 36-49 | | X | | File, buff, no base metal removed |
| 36-53 | | X | | File, buff, no base metal removed |
| 40-45 | X | | | File, buff, no base metal removed |

X denotes linear indication reported

NOTES:

1. In accordance with the disposition of CR 91-0409, only the indications found on HCUs 12-29 and 28-45 were stress related. For the purposes of the current investigations, all are considered to have been stress related.

2. No indications were found on any of the #4 location welds.