UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

HIGH PRESSURE INJECTION SYSTEM BACKFLOW EVENT AT

ARKANSAS NUCLEAR ONE, UNIT NO. 1

ARKANSAS POWER AND LIGHT COMPANY

DOCKET NO. 50-313

1.0 INTRODUCTION

A turbine trip occurred on Arkansas Nuclear One, Unit No. 1 (ANO-1) on January 20, 1989, initiated by a generator lockout due to a broken pole piece in the turbine generator exciter. The subsequent reactor trip and certain feedwater control system and electrical distribution system problems required the operators to manually initiate high pressure injection (HPI) flow to the reactor coolant system (RCS). It was later discovered that the check valve in the B HPI injection line (MU-34B) had failed to reseat after HPI flow was terminated. Also, because the reactor coolant pump in the C reactor coolant system (RCS) loop had tripped when its 6.9 kV power supply bus failed to fast-transfer to the startup transformer on loss of the main generator, a differential pressure between the B and C RCS loops was created. The combination of the failed check valve in the B HPI header and the differential pressure between the RCS loops, caused 545°F reactor coolant to circulate from the B loop to the C loop through the low temperature HPI piping. In response to the event, the licensee performed an assessment of the potential damage to the affected HPI piping. This assessment included both analytical and physical inspection of piping and supports. As a result certain plant modifications were made to the HPI system.

2.0 EVALUATION

All the HPI piping exposed to elevated temperature including the cross-connect pipes were analyzed with an assumed temperature of 545°F. Based on the results of the licensee's analysis, seven fittings for which the calculated stresses exceeded ASME Code allowables were identified and were replaced by the licensee. An additional weld near a valve was also replaced as a construction convenience.

The licensee also performed detailed visual inspections and non-destructive examinations of the affected HPI system piping and pipe supports. These inspections consisted of three parts:

- Piping was inspected for general degradation caused by thermal movement of pipe into interferences, walls, shield wall penetrations, etc. The pipe was inspected for obvious deformations, damage and scratch marks which could have resulted from excessive deflection caused by thermal expansion.

- A sample of welds on pipe runs were examined by liquid dye penetrants. Each of the HPI lines inside containment and both cross-connect loops were tested. Two to three welds on each line were examined.

- High stress areas or components (fittings) in the BC Loop identified by the stress analysis were examined by both dye penetrants and volumetric examinations to the extent possible. In a few locations, due to weld geometry (socket weld or fillets), volumetric examination was not achievable.

The criteria for acceptance was the existence of no damage, deformations, cracks, or other piping degradation. A visual examination of the supports that experienced the elevated temperature condition was also performed with the same acceptance criteria. The staff found the examinations described above to be acceptable and considered them to be a confirmatory action since the piping system was not in a degraded condition.

In order to ensure that the backflow condition does not recur, the licensee took several actions including plant modifications, check valve leak testing, and procedure changes for the upstream motor operated isolation/control valves (MOVs).

The licensee installed one additional check valve inside containment for each HPI injection line. The new and existing check valves will be full flow tested during cold shutdown and will be individually leak rate tested during each refueling outage at a pressure corresponding to the maximum pressure differential which occurs during unbalanced reactor coolant pump (RCP) operation. The maximum permissible leak rate will be less than the flow which bounds the thermal design analysis for the HPI lines.

In addition, the licensee installed local temperature instrumentation on each HPI line outside of containment as well as a temperature tape which will provide positive and permanent indication of a temperature transient in the piping. Each local temperature instrumentation and the temperature tape will be monitored and the reading logged once per shift by operations personnel. The operation logs will be reviewed by the Shift Supervisor. Any readings considered off-normal will be evaluated and appropriate corrective actions will be taken.

Furthermore, the quarterly testing procedure for the upstream MOV's has been modified to detect any significant backleakage through the check valves. This modified procedure provides for venting of piping upstream of the MOV followed by opening of the MOV. The procedure will direct the operator performing the test to record the "as-found" pressure on the system, the pressure on the system at the start of a one minute observation period and the system pressure at the end of the observation period. If the pressure change during the one minute observation is greater than or equal to 200 psig, the procedure requires the operator to initiate a condition report which is an internal procedure for tracking and resolving abnormal conditions. Once a condition report is initiated, an engineering evaluation will be required for root cause determination and the identification of corrective actions. The pressure rise acceptance criterion of 200 psig during the one minute observation period would correspond to a leak rate less than the flow which bounds the thermal design analysis for the HPI lines.

3.0 CONCLUSION

Based on the piping replacements that were completed, the satisfactory results of the licensee's inspection, and the additional actions taken including plant modifications and testing program upgrade as described above, we have determined that the licensee's actions in response to the January 20, 1989 HPI backflow event are adequate and acceptable.

Dated: August 11, 1989

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