GULF STATES UTILITIES COMPANY

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AREA CODE 504 635-6094 346-8651

July 29, 1991
RBG- 35,397
File Nos. G9.5, G9.42

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

Gentlemen:

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

Gulf States Utilities Company (GSU) identified a circumferential indication in the buttered area on the safe-end side of the N4A-2 feedwater nozzle to safe-end weld during examination of this weld during the second refueling outage at River Bend Station. Subsequent examinations of this weld were performed at a mid-cycle outage during the third fuel cycle and during the third refueling outage. The results of these inspections were provided to the staff in letters dated May 15, 1989 and supplemented on May 19, 1989, March 21, 1990, and November 19, 1990. In GSU's submittal dated November 19, 1990, GSU predicted acceptable continued operation through cycle 4 but agreed, given the most conservative bounding calculations, to limit continued operation of River Bend Station to 7000 hours during the fourth fuel cycle, at which time a mid-cycle examination would be performed. The staff responded in its Safety Evaluation of Indication in the Inlet Feedwater Nozzle (N4A-2) to Safe-End Weld, from C. M. Abbate to J. C. Deddens, dated February 22, 1991, and reiterated that a mid-cycle examination would be performed after approximately 7000 hours of operation.

However, further investigation into the assumptions of this analysis confirmed that the predicted crack growth rate was overly conservative, and that the upper bound crack growth rate for the conditions to which this feedwater nozzle is exposed are actually much lower. This lower predicted crack growth rate provides justification for operation of the unit for 12000 hours since the size of the indication would still be predicted to be less than the ASME Code allowable value.

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Performance of a midcycle examination within reasonable time constraints does not permit practicable decontamination of the nozzle, resulting in worker doses that are an order of magnitude greater than those experienced during refueling outages. GSU estimates the exposures, based on past midcycle examination worker doses to limited qualified NDE examiner pool personnel, to be 3-4 man-Rem. In light of the arguments contained herein, such exposure cannot be considered to comply with the ALARA concept.

Therefore, GSU is requesting NRC permission to operate River Bend Station an additional 5000 hours until the fourth refueling outage without reperforming an examination of the N4A-2 feedwater nozzle to safe-end weld, and that the staff amend its safety evaluation reflecting the information contained in the attached GE report.

HISTORY

During the second refueling outage at River Bend Station, an augmented inspection identified an indication in the N4A-2 feedwater inlet nozzle to safe-end weld. A circumferential indication, as shown in Figure 1-1 of Enclosure 1, was identified on the safe-end weld in the buttered area. The indication was detected and sized by manual examination to be approximately six and one-eighth inches long (17.6 percent pipe circumference), with a maximum depth of approximately 0.2 inches (18 percent through-wall) and an average depth of 0.16 inches. A crack growth evaluation was performed assuming that the observed indication was due to an active IGSCC crack. The predicted crack size at the end of the next fuel cycle was determined assuming upper-bound and realistic crack growth rates, and then compared to the ASME Code allowable flaw size. This analysis confirmed that required ASME Code margins would be maintained and continued operation of the plant was justified.

Additionally, manual and automatic (P-scan) ultrasonic examinations were conducted on the N4A-2 nozzle during the cycle 3 mid-cycle outage (MCY-3). The results of these inspections revealed no increase in depth of the indication, and the length of the indication had increased 0.5 inches to a total length of six and five-eighths inches.

Furthermore, manual and P-scan examinations were performed during the third refueling outage (RF-3) which revealed that the indication had grown to a maximum length of 7.7 inches (20.4 percent pipe circumference) and to a maximum depth of 0.33 inches (30 percent through-wall) as shown on Figure 1-2 of Enclosure 1. A comparison of the dimensional characteristics of the indication at each of the inspections is provided in Table 1-1 of Enclosure 1. Another crack growth evaluation, as well as a fracture mechanics analysis, was performed to determine acceptability for the next fuel cycle. Using the actual measured crack growth rate from MCY-3 to RF-3 (2.9 E-5 in/hr), the analysis confirmed that predicted crack size at the end of the next fuel cycle is within the ASME Code allowable value and that operation of the plant could continue until the end of the cycle.

However, using the upper bounding crack growth rate (5 E-5 in/hr) results in a predicted crack size greater than the ASME Code allowable flaw size. Therefore, GSU agreed to perform a mid-cycle inspection to provide additional assurance of safety margin.

DISCUSSION

Further investigation into the assumptions of the crack growth analysis performed during RF-3 has revealed that many of the assumptions used to justify operation until the mid-cycle outage for the fourth fuel cycle (MCY-4) are overly conservative. GSU has reexamined all factors and has had GE perform an additional evaluation (Enclosure 1) to determine the amount of conservatism in their previous analysis of the indication at River Bend. The GE analysis identified several factors, including the determination of whether crevice conditions exist in the annulus, conductivity and crud buildup, that can affect the predicted growth of an indication. The results of flow visualization tests confirm that crevice conditions do not exist in the feedwater thermal sleeve annulus. The effects of crud were studied by GE and found to have no effect on crack growth rate. The average reactor water conductivity at River Bend for the current fuel cycle has averaged 0.17 μS/cm, which is below the administrative limit of 0.2 μS/cm.

GE data on Alloy-182, using actively loaded compact tension specimens at an average conductivity of 0.47 μS/cm, showed crack growth rates ranging from 2 E(-5) in/hr to 4.2 E(-5) in/hr. The upper bound limit of 5 E(-5) in/hr used in previous analyses was found to be unreasonable in relation to field data for BWR conditions. Three methodologies were used to determine expected crack growth rates in the thermal sleeve annulus: actual ultrasonic examination, the GE IGSCC model, and the GE crack advance verification systems.

All of these methods corroborate a bounding crack growth rate of approximately 3 E(-5) in/hr and, for fracture mechanics purposes, a value of 2.9 E(-5) in/hr was used.

In order to demonstrate that the failure mode of Alloy-182 is ductile and that the toughness is better than that used in the ASME Code for SAW stainless steel weld metal, Charpy tests on Alloy-182 weld specimens were conducted and the results were compared with the stainless steel flux weld results. Table 4-1 of Enclosure 1 shows the results of Charpy energy and lateral expansion values for Alloy-182 and stainless steel specimens. It is seen that the Alloy-182 test results are better, especially on the basis of lateral expansion values, when compared to the stainless steel SAW welds.

GE performed a fracture mechanics analysis to calculate structural margins based on the stress state at the subject weld and the projected crack growth of the indication. The methodology used is consistent with Paragraph IWB-3640 and Appendix C of Section XI of the ASME Code. The stresses were calculated from the forces and moments supplied by GSU based on the stress report for the subject piping system. Table 5-1 of Enclosure 1 shows the calculated values of nominal membrane and bending stresses for various loads. Figure 5.3 of Enclosure 1 is the flaw assessment diagram used in the flaw assessment. From this figure, it is seen that the subject butt weld can tolerate a through-wall circumferential crack 25 percent of the circumference long and still maintain ASME Code required structural margins. Based on the bounding crack growth rate of 2.9 E(-5) in/hr and a hot operating time of approximately 12000 hours, the crack is predicted to grow an additional 0.348 inches deep to a total depth of 0.678 inches or 60 percent through-wall. Since continued plant operation with a potentially leaking through-wall flaw is not acceptable, IWB-3640 procedures set a limit on the end-of-period projected flaw depth at 75 percent for austenitic base metal and non-flux welds, and 60 percent for the flux welds. The projected crack depth at the end of the current cycle is such that ASME Code required structural margins are maintained.

In order to determine the structural margins at the subject weld in the unlikely event that the indication should propagate through-wall during the current fuel cycle, a leak-before-break analysis has been performed. The leak-before-break assessment has been performed to estimate the inherent margin between the through-wall flaw length that can be detected by the leakage monitoring systems in place at River Bend Station and the flaw length or critical crack length that could lead to unstable crack extension. Calculations were performed to determine leak rate as a function of through-wall circumferential crack length and the results are shown in Figure 6-2 of Enclosure 1. Current Technical Specifications for River Bend Station limit the amount of unidentified drywell leakage to 5 gpm. However, new limits have been put into place in accordance with Regulatory Guide 1.45 and Generic Letter 88-01 since RF-3, which require initiation of shutdown actions and immediate drywell entry when unidentified leakage rate increases 2 gpm in any 24 hour period. Typical unidentified leakage rates at River Bend during the current cycle have been less than 1 gpm. Since this normal, or background, rate is so small, any changes in unidentified drywell leakage due to a potential through-wall crack would be readily identified. Using this information, the critical crack length was determined to be 15.2 inches. Also, the leakage crack length corresponding to a 5 gpm leak rate is approximately 4.6 inches. Therefore, the ratio of the 5 gpm crack length to the critical crack length is 3.3, which, being greater than a minimum value of 2.0 required in typical leak-before-break analyses, demonstrates that even in the unlikely event that the indication becomes a through-wall flaw, the resulting leakage will be detected well in advance of the crack length reaching the critical crack length, where failure of the weld could occur.

The evaluation of the indication in the River Bend Station N4A-2 feedwater nozzle to safe-end weld performed at RF-3 confirmed that continued operation for the current fuel cycle could be justified. However, to provide additional conservatism, GSU decided to justify continued operation for approximately 7000 hours using the most conservative value for crack growth rate. The discussion provides support for the elimination of the mid-cycle examination and continued plant operation until the fourth refueling outage, scheduled to begin in March 1992.

Operation of the plant until RF-4 would not increase the probability or consequences of a previously evaluated accident because the proposed change would allow the continued operation of River Bend for an additional 5000 hours in order to complete the current fuel cycle (approximately 12000 hours), and not perform an examination of the N4A-2 feedwater nozzle to safe-end weld indication during a mid-cycle outage. At the end of the current fuel cycle, assuming a nominal crack growth rate of 2.9 E(-5) inches per hour, the depth of the crack would have only penetrated 60 percent of the total thickness of the pipe wall in this location. Section XI of the ASME Code states that all structural safety margins are maintained for indications up to 60 percent through-wall, given the postulated length of this indication. Since all of the original design safety margins will still be maintained throughout the rest of the current fuel cycle, the probability or consequences of an accident previously evaluated in the safety analysis remain unchanged.

Operation of the plant until RF-4 would not create the possibility of a new or different kind of accident from any previously evaluated because no changes are being made to the design of River Bend Station (RBS). The consequences of an unlikely through-wall flaw is the same as any other drywell leakage concern. Technical specification limits on total unidentified drywell leakage (5 gpm) and unidentified leakage rate increase (2 gpm in 24 hours) are in place to determine any additional drywell leakage that could occur. Therefore, the possibility of a new or different kind of accident from any previously evaluated in the safety analysis is not created.

Continued operation of the plant until RF-4 would not involve a significant reduction in the margin of safety because plant operation assumes that the feedwater nozzle is designed to applicable ASME Code requirements. These requirements will still be maintained, and based on leak-before-break analysis, in the unlikely event that the indication becomes a through-wall flaw, the resulting leakage will be detected well in advance of the crack length reaching the critical crack length, where failure of the weld could occur. Therefore, there is no reduction in the margin of safety as a result of this change.

During the fourth refueling outage, this nozzle will be reexamined and then one of two repairs will be performed. The first, and most desirable to GSU, would be a permanent repair whereby this safe-end is completely removed and replaced with a new safe-end. This repair method will require the replacement of the existing thermal-sleeve as well. Final work on the design and procurement of this new thermal sleeve are proceeding. Should installation become impracticable or other conditions arise, GSU would utilize an improved weld overlay design developed by GSU personnel, as discussed with the staff in our meeting on July 23, 1991. This new design has been field tested and the results are being evaluated by the Electric Power Research Institute, which plans to issue the results of their evaluation in September 1991.

GSU requests a response by August 23, 1991, to facilitate completion of planning efforts to support this request.

Should you have any questions, please contact Mr. L. L. Dietrich of my staff at (504) 381-4866.

Sincerely,

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Manager - Oversight
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LAE/MFS/JRH/TMH/LLD/MSP

Attachment

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