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

April 12, 1993

Docket Nos. 50-498
and 50-499

Mr. Donald P. Hall
Group Vice-President, Nuclear
Houston Lighting & Power Company
P. O. Box 1700
Houston, Texas 77251

Dear Mr. Hall:

SUBJECT: RELIEF REQUEST FOR REPAIR OF ESSENTIAL COOLING WATER PIPING, SOUTH TEXAS PROJECT, UNITS 1 AND 2 (TAC NOS. M82646 AND M82647)

By letter dated January 17, 1992 (ST-HL-AE-3984), Houston Lighting & Power Company (HL&P), in accordance with the provisions of 10 CFR 50.55a(g), requested relief from IWA 5250 of Section XI of the ASME Boiler and Pressure Vessel Code in order to defer permanent repair of flaws in the essential cooling water piping system. The flaws were detected during service. Additional information was provided in HL&P letters dated April 30, 1992, June 22, 1992, August 21, 1992, and August 27, 1992. HL&P stated that Code repairs would be performed as soon as practical, but not later than the next scheduled outage of 30 days or more for each unit. Until permanent repairs can be made, three temporary repairs were proposed: (1) leave the component or weld joint as-is, subject to monitoring per the guidelines of Generic Letter (GL) 90-05, "Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2, and 3 Piping;" (2) same as first option, except apply a rubber patch and hose clamp as needed for housekeeping reasons; and (3) a welded patch used to stop leakage, with no credit taken for its addition to structural integrity. Monitoring would continue at the repair location outside the patch.

We have reviewed the request and conclude that Code repair requirements, as defined in GL 90-05 are impractical. We conclude that for the flaws described, the pipe still retains substantial margins of safety with respect to design loads and therefore has adequate structural integrity. Furthermore, HL&P committed to the periodic and augmented inspection guidance in GL 90-05.

With respect to the leak mitigation measures, we find that two of the proposed approaches are consistent with GL 90-05 and are acceptable. However, option (3), the use of non-Code weld repairs, is unacceptable.

DFOI 1/1

Therefore, we have determined that the relief request may be granted, subject to the exception noted above, pursuant to 10 CFR 50.55a(g)(6)(i) and provided that the augmented and periodic inspections of Generic Letter 90-05 are performed. This relief is granted until the next scheduled outage of 30 days or more for each unit. At that time, Code repairs must be performed. Granting of such relief is authorized by law, will not endanger life or property, or the common defense and security, and is otherwise in the public interest.

Our detailed findings are included in the enclosed Safety Evaluation.

Sincerely,

Original Signed By

Suzanne C. Black, Director
Project Directorate IV-2
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Office of Nuclear Reactor Regulation

Enclosure:
Safety Evaluation

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO NON-CODE REPAIR OF ASME CODE PIPING

HOUSTON LIGHTING & POWER COMPANY

CITY PUBLIC SERVICE BOARD OF SAN ANTONIO

CENTRAL POWER AND LIGHT COMPANY

CITY OF AUSTIN, TEXAS

DOCKET NOS. 50-498 AND 50-499

SOUTH TEXAS PROJECT, UNITS 1 AND 2

1.0 INTRODUCTION

By letter dated January 17, 1992, and supplemented on April 30, 1992, Houston Lighting & Power (HL&P), the licensee, requested relief from the repair requirements of Section XI of the ASME Code. This request was for the purpose of making temporary non-Code repairs to welds and cast fittings which are part of the essential cooling water (ECW) systems for the South Texas Project Units 1 and 2. The ECW systems are moderate energy ASME Code class 3 piping that convey essential cooling water to various safety related equipment. The pipe and weld materials are aluminum bronze. Affected components include six-inch cast flanges, thermowell welds in 30" pipe, one-six inch butt weld, and three each 30-inch butt welds. The subject flaws were detected during service when seepage or a small leak was observed on the affected component.

Some of these failures (leaks) and similar previous ones have been metallurgically examined for root cause. In the case of the six-inch cast flanges, degradation was by dealloying of the cast aluminum bronze. Dealloying of cast aluminum bronze fittings was previously reported to the NRC in a letter dated November 1, 1988. The root cause of cast fitting dealloying was concluded to be improper heat treatment during manufacturing. Most of the small diameter cast fittings susceptible to dealloying have been replaced.

Leakage through the butt welds has been previously studied and the causes understood. Leakage was the result of initial weld flaws which cracked through-wall during service. The analyses indicated that the crack propagation occurred by a process of dealloying in the weld metal in a narrow zone along the crack front. These cracks grew from preexisting weld flaws. The flaws were in the filler metal and emanated at the root, under the backing ring. Origin of the flaws has been attributed to lack of fusion and/or hot cracking of the root pass. The presence of backing rings along with the preexisting flaws appear to promote the severe environment conducive to dealloying of the weld metal along the crack front (but not in the bulk of

the weld metal). The observed weld flaws have been limited to welds with backing rings. The pipe base material is unaffected.

Three different temporary repairs were proposed by the licensee, depending upon individual flaw circumstances:

1. Leave the component or weld joint as-is, subject to monitoring per the guidelines of Generic Letter (GL) 90-05, "Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2, and 3 Piping."

2. Same as option #1, except apply a rubber patch and hose clamp as needed for housekeeping reasons.

3. Apply a welded patch to the pipe O.D. (in the case of the larger weld flaws). No credit for structural reinforcement would be taken. Monitoring would continue at the areas outside the patch.

Code repairs would be performed at the next available opportunity, but no later than the next scheduled outage of 30 days or more for each unit.

Relief was requested because it was not practical to perform Code repairs with assurance of completion within the time period permitted by the limiting condition for operation (LCO), due to a number of factors including:

- Potential for fit-up problems during repair, particularly in the case of the 30-inch thin wall pipe, which may extend the schedule beyond the LCO time;

- Potential need for access to the inside surface, which may require disassembly and removal of equipment such as valves, pumps or strainers.

- Difficulties of isolation of sections due to leakage of butterfly valves which extends the time necessary to perform the repair and to complete hydrostatic testing in accordance with Section XI of the Code.

The actions outlined have incorporated the framework of GL 90-05 but deviate from the specifics of the flaw analysis method in the generic letter. Because of this, the staff requested additional information regarding the analytical methods and the underlying assumptions. The licensees' responses were dated June 22, August 21, and August 27, 1992.

2.0 DISCUSSION

The central issue of this relief request concerned the mechanical properties of the degraded material and its consequent impact upon the structural stability of the degraded components. This issue was evaluated separately for the cast components versus welds.

In 1988, the licensee notified the staff of its findings regarding the dealloying of cast aluminum bronze pipe fittings. The small bore socket weld fittings of the ECW system were the first to show the evidence of dealloying. Failures were attributed to inadequate heat treating at manufacture in conjunction with the crevice effect at the socket weld joint. A typical leaking fitting had one region of through-wall dealloying along with an evenly distributed dealloyed layer over the rest of the fitting interior. This uniform layer was found to have penetrated up to 55 percent of the wall. The net effect was similar to a uniform loss of wall thickness with a pinhole leak.

In the case of the 6-inch cast weld neck flange failures, improper heat treatment was also the root cause of the leaks. However, the initiation mechanism appeared to be different. One flange leaked at the site of an original construction defect. The defect was a part through-wall crack in the weld which subsequently propagated by dealloying during service. Slight leakage through other flanges was attributed to through-wall dealloying. It was believed the dealloying was delayed due to the lack of the deep crevice inherent in the smaller socket weld fittings. Some of the 6-inch flanges were installed with backing rings. Apparently the slight crevice of the backing ring along with the undesirable microstructure inherited from inadequate fabrication heat treatment rendered the flanges susceptible to dealloying, but at a slower rate than was experienced with the socket weld fittings.

Strength of the dealloyed fittings was evaluated by performing hydrostatic proof tests (burst tests to failure) on fittings removed from service. Varying amounts (up to 55 percent) of dealloying existed in these samples. The tested components did not fail under proof test, but eventually the leak rate exceeded the hydrostatic test pump capacity. The lowest pressure measured at this point, for the most dealloyed fitting, was 50 times design pressure (operating pressure 40 psig, design pressure 120 psig, test pressure 5900 psig).

Tensile tests of dealloyed cast material were also conducted. Test results showed that the ultimate tensile strength of dealloyed material was 30 ksi (versus a Code minimum of 65 or 75 ksi, depending upon the alloy grade). Due to the low stresses of the ECW system, this degraded tensile strength was considered adequate, by licensee analysis, for the calculated system loads.

The licensee concluded that based upon the test results, leaking cast fittings retained substantial service margins, even if completely dealloyed. Additionally, the licensee concluded the failure mode would be by an increased leakage rate, not a large scale break.

2.1 Characterization of Weld Cracks

Leaks in the 30 inch diameter girth welds have been characterized as to root cause, flaw size and structural stability. As outlined in the introduction, the root cause is dealloying within preexisting cracks in the weld metal. The cracks have been sized using ultrasonic testing (UT). Structural stability of

the cracks has been evaluated. AS part of the structural evaluation, the filler metal fracture toughness has been determined from laboratory tests (crack opening displacement) on the same type of material. Crack monitoring is accomplished by periodic estimation of leak rate and with UT.

The licensee is applying UT to monitor cracks that have been detected by through-wall leakage. This technique is judged by the licensee to be reasonably accurate in estimating crack length. However, the licensee has found that there are uncertainties in determining flaw depth. This is due to the weld root geometry and the presence of backing rings. Additionally, the ability to detect small defects at the root is questionable due to the backing ring configuration.

For structural integrity evaluation purposes, sub-surface flaws were assumed to be through-wall over their entire length. This assumption avoided complications in estimating the mechanical properties of possible dealloyed material at the crack front and difficulties in estimating crack depth. Thus no credit was taken or assumed for the strength or size of any remaining ligaments of material at the crack fronts.

The crack ends were assumed to be bounded by unaffected material. Thus far, this assumption appears to be valid. Experience has shown that overall crack lengths have not changed, although the leak rates (and presumably the through-wall lengths) have increased very slowly in some cases.

It was further postulated that a shallow 360° flaw existed at each 30-inch girth weld joint. A flaw of this type was conservatively assumed to exist because of the inspection difficulties in detecting small flaws near the backing ring. The sensitivity of the joint to this kind of flaw was small. According to licensee analysis, 360° circumferential cracks would have to be 80 percent through-wall to become unstable under design loads.

Each flaw was evaluated for structural stability by two means: fracture mechanics and limit load analysis. The safety margin was evaluated by whichever was the more conservative analysis.

2.2 Evaluation

The fracture mechanics method prescribed in GL 90-05 was used for the flaw evaluation in the 6" pipe since it is in accordance with the GL. However, a load limit analysis was found to be more conservative and was considered as the limiting case. For an estimated crack length of 1" in the 6" flange weld, the load limit analysis gave a failure margin of 31.7 times the design stresses.

For the 30" welds, the fracture mechanics method of GL 90-05 was not applicable. Instead, an alternative industry accepted method was employed. The staff found the choice and application of the alternate method (by J. L. Sanders, Journal of Applied Mechanics, vol 50, p. 221, March 1983) to be acceptable. For each 30" diameter weld analyzed, the fracture mechanics analysis gave a more conservative result than a load limit analysis. For an

assumed 10.375" long through-wall crack (the worst case) at the worst assumed loading, the failure margin was 1.8 times the assumed stress (this one case was repaired in April 1992). Cracks in the 4" to 6" range, which included all the other such flaws, had failure margins of 3.5 and higher. The assumed loadings used in these analyses included all appropriate design loadings with the crack placed in the positive bending moment regardless of the actual relative locations.

Flaws were monitored by the following methods:

- Daily monitoring for qualitative assessment of leakage (quantitative for measurable leaks).
- Daily visual monitoring of surface crack and leakage.
- Ultrasonic estimation of sub-surface crack size at least once every three (3) months.
- Walkdown of the system at least monthly.

Any significant changes found during this monitoring were planned to be followed by a reevaluation of structural integrity. No significant changes were noted during the monitoring. This lent greater credibility to the licensee's assertions that dealloying was proceeding at a slow rate and that crack propagation was not expected under normal loads.

Of the three temporary repairs proposed, two of them followed the staff guidance of GL 90-05. Those were: leave the pipe as-is, subject to the monitoring provisions of the GL; and, apply a non-structural patch consisting of a rubber patch and a hose clamp, if deemed necessary for housekeeping reasons, with monitoring as in the first option. In this case, the staff observes that due to the somewhat unique nature of the degrading mechanism, the second option may be less desirable than the leave-as-is option. In the staff's opinion, some water flow through the crevice may beneficial. Leakage flow could reduce the severity of the water chemistry in the crevice by way of a rinsing action and thus reduce or stop the dealloying process. It is up to the licensee to judge this comment against potentially greater needs for leak mitigation.

Because the service water system is constructed of aluminum bronze instead of the more commonly employed lined steel pipe, the licensee's third temporary repair proposal (a welded patch) appeared to be more compelling than usual. However, the staff position does not allow such an approach. This is because the non-reversible nature of a welded patch means that subsequent monitoring of the original flaw is not feasible. Additionally, there is concern for creating worse conditions than existed before the welding was attempted. In this specific case, a larger crevice area would be created under the patch, and the crack tips would not be accessible for monitoring.

Performance of Code repairs would require isolation of the various leaks, executing the repairs, and performance of a post-repair hydrostatic test. However, isolation of any of the various leak locations cannot be accomplished without removal of an entire train of the ECW system. This would render inoperable a substantial number of safety related components and cause entry into the LCO time restriction for the ECW system. Removal of such a number of components from service is not, in the staff's review, in the best interest of safety. In addition, a post repair hydrostatic test is likewise unfeasible without restoring to additional measures to isolate the system prior to performing the test. In this case a hydrostatic test is only feasible during a unit outage.

3.0 CONCLUSION

The staff has determined that Code repair requirements in this case are impractical. This is due to the inability to isolate the leaks for repair and hydrostatic test without removing a number of safety related components from service. Additionally, by means of the analyses and the results of the licensee's periodic monitoring, the staff finds the flawed piping to have adequate structural integrity. The basis for this finding is that the flawed pipe still retains substantial margins of safety with respect to design basis loads. This is demonstrated by the monitoring results which show the leakage rates (thus crack sizes) to be unchanged. Furthermore, the licensee has committed to the periodic and augmented inspection guidance provided in GL 90-05, which will reasonably assure structural integrity and protect the public health and safety.

With respect to the leak mitigation measures, the staff finds that two of the temporary measures proposed are consistent with approaches in GL 90-05 and appropriate in this case. However, the proposed non-structural weld repairs (Option 3) are not acceptable to the staff as they are proposed and thus are not permitted.

Pursuant to 10 CFR 50.55a(g)(6)(i) relief is granted to permit the two temporary measures that are consistent with GL 90-05, and to impose the augmented and periodic inspection guidance referenced above, until the next scheduled outage exceeding 30 days, but no longer than the next scheduled refueling outage. The temporary non-Code repairs must then be replaced with a Code repair. Accordingly, the relief is authorized by law and will not endanger life or property or the common defense and security and are otherwise in the public interest, given due consideration to the burden upon the licensee and the facility that could result if the Code requirements were imposed on the facility.

Principle Contributor: G. Hornseth

Dated: April 12, 1993

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

April 13, 1993

Docket No. 50-317

Mr. Robert E. Denton
Vice President - Nuclear Energy
Baltimore Gas & Electric Company
Calvert Cliffs Nuclear Power Plant
1650 Calvert Cliffs Parkway
Lusby, Maryland 20657-4702

Dear Mr. Denton:

SUBJECT: REACTOR VESSEL SURVEILLANCE CAPSULE REPORT - REQUEST FOR EXTENSION OF SUBMITTAL DATE, CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NO. 1 (TAC NO. M86014)

By letter dated March 22, 1993, Baltimore Gas and Electric Company (BG&E) requested an extension for the submittal of a summary technical report of the test results from a capsule of material retrieved from the Calvert Cliffs Nuclear Power Plant, Unit No. 1, reactor vessel during refueling outage number 10 on April 23, 1992. The summary technical report is required to be submitted within 1 year from the withdrawal date. BG&E requests that the due date of April 23, 1993, be extended to June 23, 1993, a period of 60 days. The Regulations, 10 CFR Part 50, Appendix H, Section III.A, allow for the granting of extensions for submitting the required reports. Consideration for extensions are based on reasonable and just causes, provided by the requesting licensee.

BG&E indicates that Asea Brown Boveri-Combustion Engineering (ABB-CE) and Babcock and Wilcox Company are under contract to perform the necessary capsule analysis and to generate the summary technical report. BG&E further indicates that it has made a significant effort to improve the capsule analysis methodology which has resulted in considerably more time required for its contractors to complete the analysis and generate the report than was originally anticipated.

BG&E has identified several improvements that have resulted from its efforts to improve the capsule analysis methodology. These improvements include:

1) The source distribution in the reactor fuel is derived from three dimensional diffusion theory depletion calculations. All ten cycles of Unit 1 history were redepleted via the ABB-CE ROCS/DIT/MC computer codes. Each cycle was distinctly modeled. In the previous capsule analyses, cycles were grouped by length and each group modeled separately;

2) Detailed time-dependent power distributions were integrated to yield average cycle characteristics. Previously, middle of cycle power distributions simulated the integrated results;