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10CFR50.55a

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

South Texas Project
Units 1 & 2
Docket Nos. STN 50-498 & STN 50-499
Request for Relief from ASME Boiler and Pressure Vessel
Code, Section XI Requirements, Relief Request RR-ENG-10

In accordance with the provisions of 10 CFR 50.55a(g), HL&P requests relief from IWA 5250 of Section XI of the ASME Boiler and Pressure Vessel Code (ASME XI) in order to defer permanent repair of flaws in the Essential Cooling Water (ECW) piping system. The flaws were detected during service. HL&P intends to perform a code repair of the flaws as soon as practical, but not later than the next scheduled outage of 30 days or more for each unit.

HL&P has evaluated the ECW flaws and determined that the operability and functionality of the system have been maintained and that deferring repair of the flaws will not affect the health and safety of the public.

HL&P has evaluated the condition of the ECW piping in accordance with the guidance of Generic Letter 90-05. Deviations from that guidance are identified and justified. That evaluation is attached and HL&P believes it provides an adequate basis for the requested relief.

If you have any questions, please contact Mr. A. W. Harrison at 512-972-7298 or me at 512-972-7138.

S. L. Rosen
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Vice President,
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AWH/lf

Attachment: Request for Relief from ASME Boiler & Pressure Vessel Code, Section XI Requirements Relief Request RR-ENG-10

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L4/NRC/

REQUEST FOR RELIEF FROM ASME BOILER AND
PRESSURE VESSEL CODE, SECTION XI REQUIREMENTS
RELIEF REQUEST NO. RR-ENG-10

Reference Code: ASME Boiler and Pressure Vessel Code, Section XI, 1983 Edition through Summer 1983 Addenda

A. Introduction

A1 Components For Which Exemption is Requested:

(a) Name and Identification Number: Class 3, moderate energy piping in the Essential Cooling Water (ECW) system:

(b) Function: See Section 9.2.1.2 of the STPEGS UFSAR

(c) Class: ASME Code Class 3

(d) Number of Components: Weld Numbers as follows:

EW 1302, FW0032, 30" Weld in Unit-1, ECW Intake Structure (Train C).
EW 1102, FW0032, 30" Weld in Unit-1, Train A Supply Line to MAB.
EW 1205, FW0043, 30" Weld in Unit-1, Train B Component Cooling Water (CCW) Heat Exchanger Outlet.
EW 2208, FS3452 6" Weld in Unit-2, Train A Essential Chiller inlet.
EW 2209, 6" Casting adjacent to Weld FS3451, Unit 2 Train A Essential Chiller outlet.

A2 Code Requirement For Which Relief is Requested:

Repair or replacement, in accordance with IWA-5250, of ECW system piping welds and casting containing through-wall flaws.

A3 Basis for Relief Request:

This relief request is submitted in accordance with NRC Generic Letter 90-05, "Guidance for Performing Temporary non-Code Repair of ASME Code Class 1, 2, and 3 Piping". The following information and justification is provided in accordance with the guidelines of Part B and C of Enclosure 1 to GL 90-05.

B. Scope, Limitations and Specific Considerations

B1 Scope

The scope consists of welds listed above in piping with through-wall leaks in the Essential Cooling Water System at the South Texas Project. The material of the piping is ASME SB 169, alloy 614 and the weld filler metal SFA 5.7 CuAl-A2.

The scope includes a 6" cast weld neck flange made of aluminum bronze Grade CA 952, which is seeping through-wall by dealloying adjacent to the weld, with no cracking. The problem of dealloying of castings has been described in previous submittals to the NRC (Reference 3), and was the subject of a presentation in Washington, DC. This flange will be replaced by April 16, 1992 and is being visually monitored in the interim. There is no measurable leakage at this time. The remainder of this relief request does not address the technical issues relative to this flange since it was previously presented in Reference 3. The following parts of the relief request address the flaws in welds described in Paragraph A1(d) above.

The materials properties used for flaw evaluation in welds were derived from fracture mechanics based crack-opening displacement (COD) tests summarized in Attachment 1.

B2 Limitations

The weld flaws originate on the inner diameter of the pipe and were detected during plant operation. The intent is to permit the cracks to leak, subject to an evaluation of structural integrity and consequences of leakage, or to perform temporary patch repairs as described in Attachment 2. Credit is not taken for the patches for structural integrity purposes. A Code repair will be performed as soon as possible, but not later than the next scheduled outage exceeding 30 days.

B3 Specific Considerations

System interactions, ie. consequences of flooding and spray on equipment have been evaluated (See Attachment 3).

The structural integrity of welds with cracks have been evaluated for all design loading conditions, including dead weight, pressure, thermal expansion and seismic loads. A summary is provided in Attachment 4.

The methodology used in structural integrity analysis consists of an analysis by linear elastic fracture mechanics and by limit load analysis. The safety margin is evaluated by whichever is the more conservative analysis.

The structural integrity is monitored by the following methods:

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

Any significant changes found during this monitoring will be followed by a reevaluation of structural integrity.

The temporary non-Code repair consists of one of the following options:

(1) Leave the weld joint as is, subject to monitoring as described above, and subject to meeting the criteria for consequences and for structural integrity as described above.

(2) Identical to option -1, except that a strap with rubber patch as shown in Attachment 2 may be used as an augmentation to stop the leakage, if deemed desirable for housekeeping reasons. Credit is not taken for such a patch for structural integrity. Daily monitoring will be conducted to assure that the patch is effective in limiting leakage, and the patch will be removed at the time of every monthly walkdown to visually monitor the crack size.

(3) A welded patch, as shown in Attachment-2 which is used to stop leakage, with no credit for its addition to structural integrity. Monitoring of cracked weld will continue at the repair location outside the patch in the monthly walkdowns.

C. Evaluation

C1 Flaw Detection

The flaws were detected during service. It is intended to perform a Code repair on them as soon as practical, but not later than the next scheduled outage exceeding 30 days. It may not be 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:

- o Potential for fit-up problems during repair, which may extend the schedule beyond the LCO time;
- o 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 time necessary to perform the repair and to complete hydrostatic testing in accordance with the Code, Section XI. It is HL&P's intent to file a separate relief request for hydrostatic testing of repairs in this system, which may provide more flexibility in conducting repairs.

It is HL&P's preference to perform the Code repairs under controlled conditions during a scheduled outage of longer duration, provided the structural integrity is assured in the interim.

C2 Root Cause Determin tion ar Flaw Characterization

The root cause of the flaws has been studied in two laboratory failure analyses which have been provided to the NRC (Ref. 1, 2). These indicate that the crack propagation occurred by a process of dealloying in the weld in a narrow zone along the crack front. These cracks initiated under the backing ring from preexisting weld flaws at the root. The backing ring configuration and preexisting flaws appear to promote the severe envi ent conducive to dealloying of the weld metal along the crack fror t not in the bulk of the weld metal). Flaws observed have been li ed to welds with backing rings.

The flaws are being measured by ultrasonic testing. While this method does not determine flaw depth or the nature of a flaw, it appears to be reasonably accurate in estimating the length of a known crack. It has thus proven to be useful in monitoring cracks that have been detected by through-wall leakage. There are limitations in the application of any NDE technique to the detection of small defects at the root due to the backing ring configuration.

For structural integrity purposes, the estimated sub-surface flaw size is assumed to be through wall.

C3 Flaw Evaluation

Flaw evaluation is performed as described in Attachment 4. Each flaw is evaluated by two alternate methods, linear elastic fracture mechanics and limit load method.

The fracture mechanics method prescribed in Generic Letter 90-05 is used for the flaw in the 6" pipe (EW 2208-FS3452) since it fits the limits of the Generic Letter. However, the limit load analysis in accordance with Reference 3 is found to be more conservative in this case and is tabulated as the limiting case.

For 30" welds, where the r/t values are far in excess of the limits in Generic Letter 90-05, the methodology of Sanders (Ref. 6) as reported in Tada (Ref. 7) is used in lieu of the formulation in Generic Letter 90-05. These methods are well accepted in the industry.

The critical stress intensity factors are derived from fracture mechanics based crack opening displacement tests tabulated in Attachment 1. Table 1 in Attachment 4 shows the safety margin for each flaw by whichever method is more conservative.

A limitation in flaw size of 3 inches or 15% of the pipe circumference, whichever is smaller, as prescribed in Generic Letter 90-05, is not imposed. The safety margins are evaluated as adequate, particularly considering that the material is highly ductile and the use of linear elastic fracture mechanics is very conservative.

C4 <u>Augmented Inspection</u>

It is not considered practical to perform augmented NDE inspections of the volumetric type described in Generic Letter 90-05 because the presence of backing rings in the affected weld joints limits the capability for volumetric examination. Through-wall leaks have been detected only in backing ring welds, which constitute an estimated one third of the population. Also, the majority of the welds are buried and inaccessible to any kind of non-destructive examination.

Also, as indicated in C5, below, HL&P is developing a strategic plan for monitoring and mitigating the potential degradation of ECW weld joints. This plan will accomplish the underlying purpose of the GL 90-05 requirement for augmented inspection; i.e., to address the potential generic nature of the condition.

The below ground welds will be monitored on at least a monthly basis by a walkdown of the ground condition above the pipe layout in the yard. Cracks large enough to approach the crack size for failure will most likely be noticeable through soil changes which can be detected by geotechnical walkdowns. Where such a change is observed, it is possible to excavate and monitor the location visually.

Walkdowns of the ground surface above the buried ECW pipes have been conducted on a periodic basis since November 8, 1991. No surface indications, either dampness or seepage, have been observed. The experience with other buried pipes at this site has been that significant leaks will eventually result in water seepage or springs at the ground surface. The absence of anomalous moisture conditions at the ground surface above the ECW pipes supports the opinion that there are no major leaks in buried ECW piping.

A previous evaluation of the structural integrity of underground ECW piping had estimated the worst case bending stress in the underground butt welds as 17.3 ksi. At this stress level the estimated crack size for plastic collapse is over 40% of the circumference. It is expected that any failure by cracking will be evidenced by indication of leakage at ground level well before approaching such a large size (for example, a crack 5-1/2 inches long at the surface in Unit 2 leaked about 2.5 gpm).

Visual walkdowns of accessible portions of the system have been performed monthly and have been found to be effective in detecting through-wall cracks when they are small and seeping.

In the hypothetical case that multiple sub-surface flaws that have not reached the surface are postulated, the structural integrity model described in Reference 3, Figure 2.2 applies (excluding the horizontal line representing the strength of 100% dealloyed metal). It can be seen from this that subsurface flaws of considerable depth are required to cause plastic collapse, even if they are assumed to be distributed around the entire circumference.

C5 A strategic plan is under development for monitoring and mitigating the potential degradation of ECW weld joints. The plan includes repairing the welds in the short term. Long term plans will address the service life of the ECW system and include such considerations as welding, materials, metallurgy, corrosion, as well as system chemistry.

HL&P will keep the NRC apprised of progress through the Region IV Office.

Attachments:

1. Crack opening displacement test data for aluminum bronze welds.
2. Sketches of temporary repairs.
3. System interaction analysis.
4. Flaw evaluation for four aluminum bronze welds.

References:

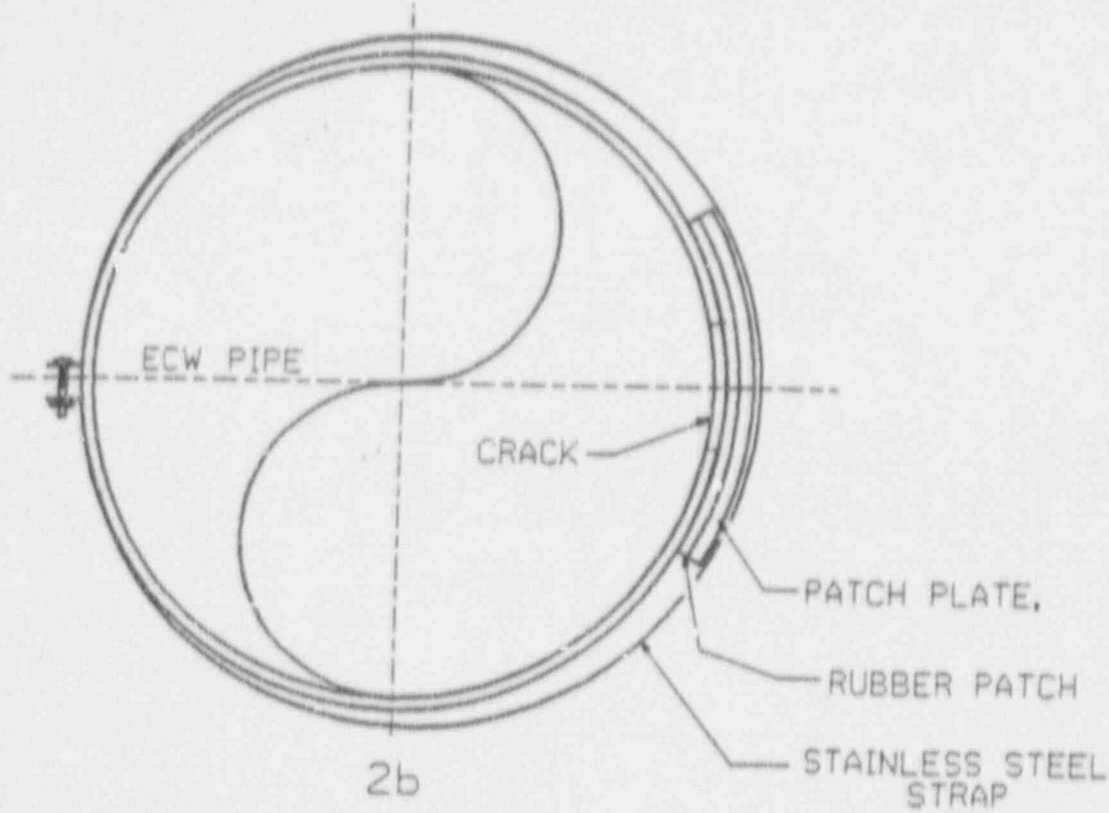
1. HL&P Materials Technology Report MT-3512A, December 17, 1991.
2. HL&P Material Technology Report MT-3512B, January 8, 1992.
3. Letter to NRC ST-HL-AE-2748, dated November 1, 1988, with attached Bechtel National/Aptech report 8804-06FA Rev. 3.
4. Aptech Engineering Services Report AEG 8303381 (Rev.1), July, 1983.
5. Sanders, J. L., Jr., "Circumferential Through Crack in a Cylindrical Shell Under Combined Bending and Tension", Journal of Applied Mechanics, Vol. 50, p. 221 (March 1983)
6. Tada, H. J., et al, "The Analysis of Cracks Handbook", Del Research Corporation (1985)

RESULTS OF COD TESTS ON BROWN & ROOT FABRICATED WELD METAL SAMPLES

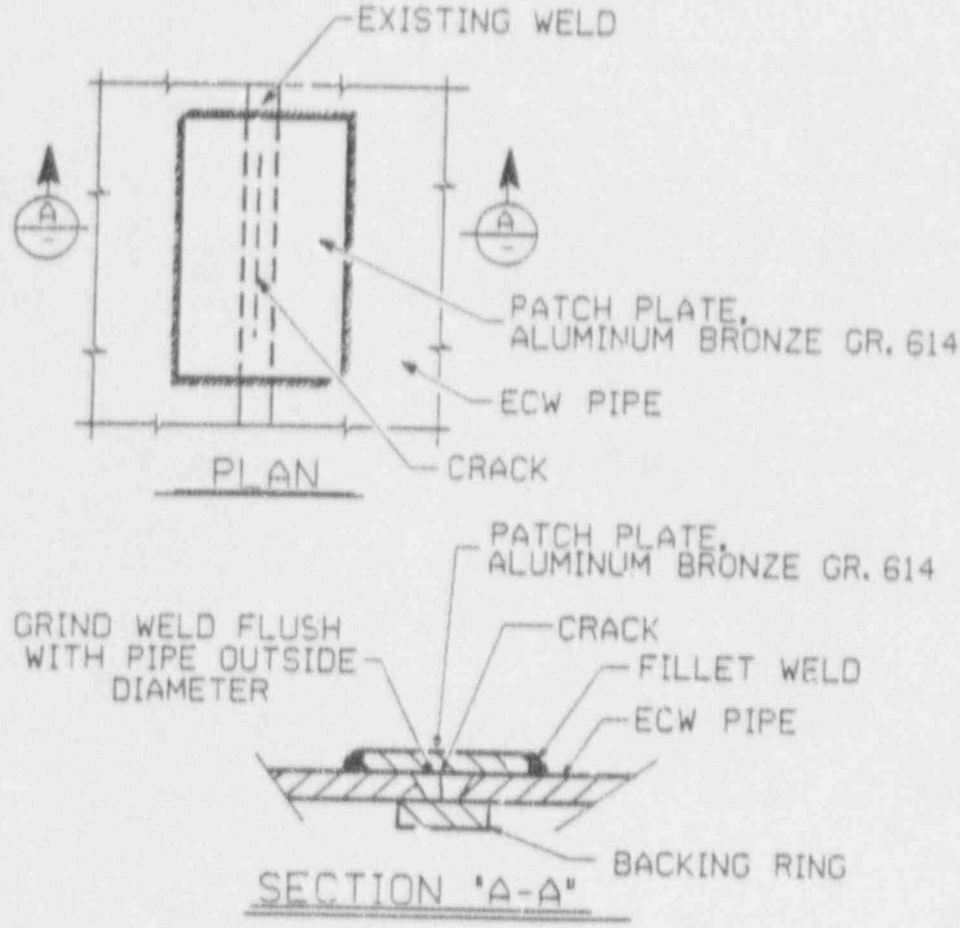
ID Code	Weld Location	Pipe Diameter	COD (Inches)
E1	Line 1305, Weld 0033 repair section	30"	*
E2	Line 1305, Weld 0033 repair section	30"	0.032
E3	Line 1305, Weld 0033 repair section	30"	0.030
F1	Line 1305, Weld 0033 non-repair section	30"	0.033
F2	Line 1305, Weld 0033 non-repair section	30"	0.033
F3	Line 1305, Weld 0033 non-repair section	30"	0.029
G1	Line 1207, Weld 0009	10"	0.014
G2	Line 1207, Weld 0009	10"	0.016
H1	Line 1207, Weld 0008	10"	0.022
H2	Line 1207, Weld 0008	10"	0.023
I1	Line 1305, Weld 0040	30"	0.027
I2	Line 1305, Weld 0040	30"	0.023
I3	Line 1305, Weld 0040	30"	0.025

*Test invalid--improper fatigue crack.

TEMPORARY REPAIRS TO STOP LEAKAGE



2b
RUBBER PATCH WITH CLAMP



2c
WELDED PATCH

ATTACHMENT 3

SYSTEM INTERACTION ANALYSIS

The consequences of flooding and water spray from the subject cracks have been evaluated and found acceptable as detailed below. The potential significance of a loss of flow to the system has also been considered and found acceptable.

The subject cracks are located in the following areas: CCW Heat Exchanger room of the MAB, ECW Sump room of the MAB, CCW Pump/Essential Chiller room of the MAB, and Essential Cooling Water Intake Structure (ECWIS) Pump Cubicle. Water leaking into the first three areas drain to the lowest elevation of the MAB. An upper limit of 8 gpm has been placed on the total of all ECW leaks in the MAB, which limits the internal flooding at the lowest level of the MAB to about 6 inches over a 7 day period, assuming loss of non safety related power. This allows ample time to restore power to the installed sump pumps or utilize portable pumps to prevent further flooding. A limit of 2.5 gpm has been placed on leakage from the crack in the ECW pump cubicle. This would allow approximately 4½ days of unattended operation of this train before the flood level in the cubicle approached the lowest level component which could affect the operation of the ECW system. In this case the acceptable flood level is above the threshold of the watertight door accessing the cubicle, so the flood can be limited by as simple an action as leaving the watertight door undogged to allow the cubicle to drain.

All components which are important to safety and located in the CCW Heat Exchanger room or ECW Sump room are either qualified for a spray environment or would fail to the desired position if affected by spray. The CCW Pump/Essential Chiller room contains several components which are important to safety and are not qualified for a spray environment, however the cracks in these areas are not producing a spray. Any spray which could affect active components will be diverted or collected by temporary measures.

The specific rooms in which the subject cracks are located were all evaluated for internal flooding from moderate energy pipe cracks and other sources of internal flooding per the requirements of Branch Technical Positions ASB 3-1 and MEB 3-1. The limits on flooding rates described herein are a small fraction of the flooding rates analyzed in the moderate energy line break analysis.

The loss of water from the Essential Cooling Pond from the maximum leakage rate over a 30 day period represent a decrease of less than ½" of water in the ECP, which compares to a margin of more than 4 feet remaining in the ECP at the end of the design basis analysis.

The effect on ECW flow rate from the maximum leak rate is a small fraction of 1%.

Attachment 4

FLAW EVALUATION METHODS AND RESULTS FOR ALUMINIUM-BRONZE WELDS

INTRODUCTION

The four through-wall flaws have been evaluated for structural integrity by two alternates methods, linear elastic fracture mechanics (LEFM) and limit load. The critical bending stress (σ_b^c) for a LEFM basis is calculated from:

$$K_I = (\sigma_m F_m + \sigma_b F_b)(\pi a)^{1/2} = K_{IC}$$

$$\sigma_b^c = (K_{IC} / F_b(\pi a)^{1/2}) - \sigma_m(F_m / F_b)$$

where K_{IC} = 112 ksi $in^{1/2}$ (the lowest measured toughness for the weld metal; the average value is 119 ksi $in^{1/2}$), and where F_m and F_b are the membrane and bending surface correction factors derived from Sanders (5), as reported in Tada (6), for the 30-inch weld, and from NUREG/CR-4572 for the 6 inch weld.

The condition for limit load failure is calculated from the plastic collapse formulas in ASME Section XI Appendix H similar to the approach previously used with small bore pipe (3).

$$\sigma_b^c = 2/\pi \cdot \sigma_f (2 \sin \beta - \sin \theta)$$

$$\beta = \pi/2 (1 - \theta/\pi - \sigma_m/\sigma_f)$$

The results based on limit load analysis are also tabulated in Table 1 under the column "Bending Stress Limit Load".

It can be seen that the three 30-inch welds are controlled by the fracture properties of the weld material, whereas the 6-inch pipe is limit load controlled. All the weld joints tabulated have a substantial safety margin as summarized in Table 1 by which ever method is more conservative.

Table 1

SUMMARY OF FLAW EVALUATION RESULTS FOR FOUR ALUMINUM-BRONZE WELDS

Weld Numbers	Pipe Size (in)	Thickness (in)	Maximum Crack Length 2a (in)	Percent Circumference	Applied Membrane Stress σ_m (psi)	Applied Bending Stress σ_b (psi)	Critical Bending Stress σ_b^c (psi) Fracture	Critical Bending Stress σ_b^c (psi) Limit Load	Failure Margin (σ_b^c/σ_b)
EW1302-FW0032	30	0.25	5.50	5.58	3600	6721	26,406	50.677	3.93
EW1102-FW0032	30	0.25	4.375	4.68	3600	6247	22,153	51,966	3.55
EW1205-FW0043	30	0.25	10.375	11.1	3600	8296	14,960	44,948	1.80
EW2208-FS3452	6.625	0.375	1.0	5.09	1060	1650	83,544	52,343	31.7