Entergy

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1CAN020008

U. S. Nuclear Regulatory Commission
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Subject: Arkansas Nuclear One - Unit 1
Docket No. 50-313
License No. DPR-51
Supplemental Information Regarding Hot Leg Nozzle RC-1071/1072

Gentlemen:

In letter dated February 24, 2000 (1CAN020006), Entergy Operations requested an alternative repair in accordance with 10CFR50.55a(a)(3)(i) and (ii) for a reactor coolant system hot leg nozzle associated with root valves RC-1071/1072 for Arkansas Nuclear One, Unit 1 (ANO-1). A conference call was conducted between the NRC, Entergy Operations and Framatome Technologies on February 24, 2000, to discuss comments by the NRC Staff regarding our repair approach and the supporting analysis. An additional submittal was provided to the NRC on February 25, 2000 (1CAN020007), to respond to the NRC request for additional information. Upon confirmation of the information provided, the NRC Staff granted verbal acceptance of the alternate ASME Code repair requested by Entergy Operations on February 25, 2000.

During a parallel effort to justify a thicker weld pad buildup, it was learned that although the evaluations of primary stresses in the new weld pad and new fillet weld overlay had conservatively taken no credit for any of the existing weld material, the flaw evaluations contained one non-conservative assumption. Specifically, based on field information, which showed all flaws to be either in the J-groove weld or very near the base of the fillet weld where it joins the J-groove weld, the flaw evaluations had assumed that the fillet weld did not contain flaws. The flaw indications are shown on the enclosed dye penetrant test (PT) results for this nozzle prior to weld repair activities (Enclosure 1). This assumption, although possibly realistic, was not bounding and could not be proven since the fillet weld geometry does not lend itself to UT inspection. Therefore, a new evaluation was undertaken that conservatively assumed significant flaws might also exist in the old fillet weld.

An additional analysis was performed on February 26 and 27, 2000, which evaluated cracking of the existing fillet weld. Cracks were conservatively assumed to exist anywhere on the fillet weld to ensure that adequate structural weld material was applied to the repair process. The analysis

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that was performed was the same as that process previously considered for the initial flaw evaluation considered by the NRC staff. The results of the additional flaw analysis resulted in the weld pad and the new fillet weld dimensions increasing. A diagram of the dimensions for the new weld is shown on Figure C-1, which is enclosed in the flaw evaluation details of Appendix C to Framatome Report 32-5007242-02 (Enclosure 2). There have been no indications that cracks exist in the nozzle itself. The inside diameters of two nozzles removed from other locations have been inspected with no indications identified.

The weld pad design proposed in our February 24 and February 25, 2000 submittals increased from 0.62 inch to 0.75 inch and the fillet weld increased from 0.5 inch weld with a 2:1 taper to an approximate 0.88 inch weld with a 1.5:1 taper. The weld pad buildup, and the increased weld height (along the nozzle axis) will serve to stiffen the nozzle. This taper is considered acceptable based on the same EPRI report (EPRI Report TR-107455) that provides a quantitative estimate of the improvement with a 2 to 1 taper and notes that any increases in the length of the axial leg improve vibration resistance. The EPRI study did not quantify the amount of improvement for increases over 1 to 1, other than to note that they exist, and to suggest further quantification of the amount as one of the areas for potential further study. Entergy did not credit either the initial 2:1 taper or the revised 1.5:1 taper in the quantitative vibrational analysis. Prior to weld pad buildup, the assembly exhibited a first bending mode at 25.5 hertz and a torsional mode was also experienced at 21.7 hertz. After welding was completed, the first bending mode had increased to 31.9 hertz and the torsional mode increased to 22.5 hertz. This moves the frequency further away from the motor running speed vibrations present at approximately 20 hertz, and will reduce the vibrational stresses accordingly.

Two pictures of the new nozzle configuration are being provided for information. These pictures show a reducer which transitions the 1 inch valve to the 3/4 inch nozzle as they approach the valves as shown on our Figure 7-1 of our February 25, 2000 submittal. The wall thickness of the nozzle has not been reduced and retains its Code requirements for minimum wall thickness. The weld repair was performed using Framatome welding procedures and welders certified under their program for this welding application. Since a minimum of a 200 degree F preheat temperature was maintained during initial weld pad installation, a temper bead process was not required.

Please contact me if you require any additional information.

Very truly yours,

Jimmy D. Vandergrift
Director, Nuclear Safety Assurance

JDV/sab
Attachments

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Picture 1 of Repaired Nozzle RC-1071/1072

Picture 2 of Repaired Nozzle RC-1071/1072

Enclosure 1

RC-1071/1072 Dye Penetrant Test of J-Weld to Fillet Weld Prior to Weld Repair

ANO NDE	LIQUID PENETRANT EXAMINATION	○ ISI ○ PSI ○ MAINTENANCE ◉ INFO ○ WQT	NDE REPORT NO 100PT020 ◉ UNIT #1 ○ UNIT #2

OUTAGE	JOB ORDER NO	OTHER TRACE DOCUMENTS	DATE
1P002	MAI 22814	CR-ANO-1-2000-0097	2/19/00

SYSTEM	LINE NO	ISO/DWG NO	COMPONENT DESCRIPTION
RCS	CCA-1-36"	M1E-040-0	RC-1072 LEVEL TAP ASSEMBLY

CODE SECTION	EDITION	CODE SUBSECTION	EXAM CATEGORY	PROCEDURE/REV
INFO ONLY	N/A	N/A		1415.002 / 10

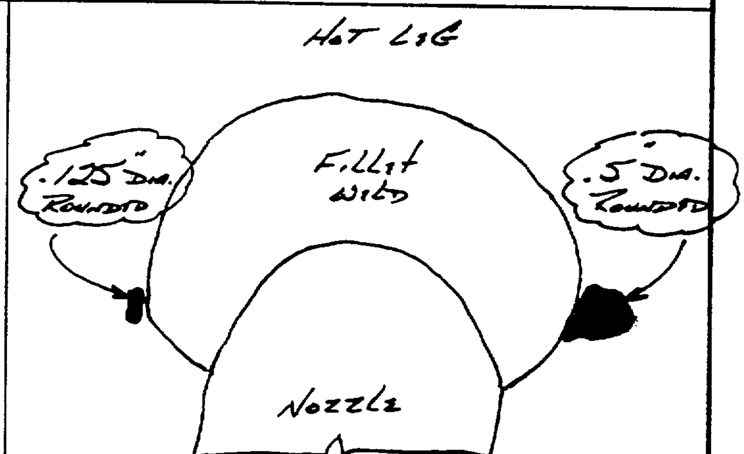
MATERIAL TYPE	SURFACE CONDITION	ZERO REFERENCE
○ CS ○ SS ◉ INCONNEL	AS WELDED	N/A

TECHNIQUE	METHOD	UV METER
◉ SOLVENT REMOVABLE ○ WATER WASHABLE	◉ VISIBLE ○ FLOURESCENT	MODEL NO N/A S/N: N/A

TEMP EXAM SURFACE	TEMP MATERIALS	THERMOMETER
110°F	90°F	S/N 78644 EXP DATE 1/13/01

PENETRANT			CLEANER		DEVELOPER		
BRAND#	BATCH#	TIME	BRAND#	BATCH#	BRAND#	BATCH#	TIME
SKL-SP	93D12K	10 min	SKC-S	98L08K	SKD-S2	96J09K	10 min

PART IDENTIFICATION	RESULTS	IND. CODE	REMARKS
NOZZLE TO HOT LEG WELD	N/A	Rounded	SEE COMMENTS AND ATTACHED PICTURE.



COMMENTS:

AN INFO PT EXAMINATION WAS PERFORMED TO DETERMINE THE POINT OF RCS LEAKAGE.

EXAMINED BY / LEVEL	ASSISTED BY / LEVEL	REVIEWED BY
DALE STRINGER / II	PAT WEAVER / II	[signature]
DATE 2/19/00	DATE 2/19/00	DATE 2/25/00

ANII REVIEW ______________ DATE ________

ENCLOSURE ADDED ◉ YES ○ NO

Enclosure 2

Appendix C to
Framatome Report 32-5007242-02

Appendix C

Flaw Evaluation for Weld Pad

C-1 Introduction

The addition of a weld pad on the outside (OD) surface of the elbow requires that a flaw evaluation be performed for an assumed area of degraded Alloy 82/182 weld material to demonstrate that a postulated flaw, which is now considered to be embedded, does not propagate to an unacceptable depth into the Alloy 52/152 pad material during 10 heatup/cooldown cycles. The Alloy 52/152 weld overlay material has crack growth characteristics equal to or better than the reference fatigue crack growth curve in Appendix C to ASME Code Section XI [2]. This weld alloy has been confirmed to be resistant to time dependent crack growth phenomena. The Section XI, Appendix C fatigue crack growth rates will be increased by a factor of two to account for the effects of a water environment.

C-2 Embedded Flaw Model

An embedded flaw is postulated to be present between the elbow and the weld pad. This flaw can be considered to be a compound flaw formed by the 5/8" deep J-groove flaw, analyzed for the carbon steel elbow material (Table 1), and the triangular shaped area inside the PT clear profile shown in Figure C-1 [1,12]. The PT clear line, which is outside the original fillet weld, is truncated by the line along the top of the weld pad at 3/4" above the elbow surface. The total depth of the postulated flaw is the sum of the 5/8" deep J-groove and the 3/4" high triangular void, or $1^3/_8$". The specified thickness of the weld ligament in the region is 0.56", and since the design thickness of the pad is 1/2", there is a 0.060" allowance for crack growth. Although there is about 3" of elbow base metal below the flaw, only 0.56" will be credited to create a symmetric center cracked panel (CCP) model.

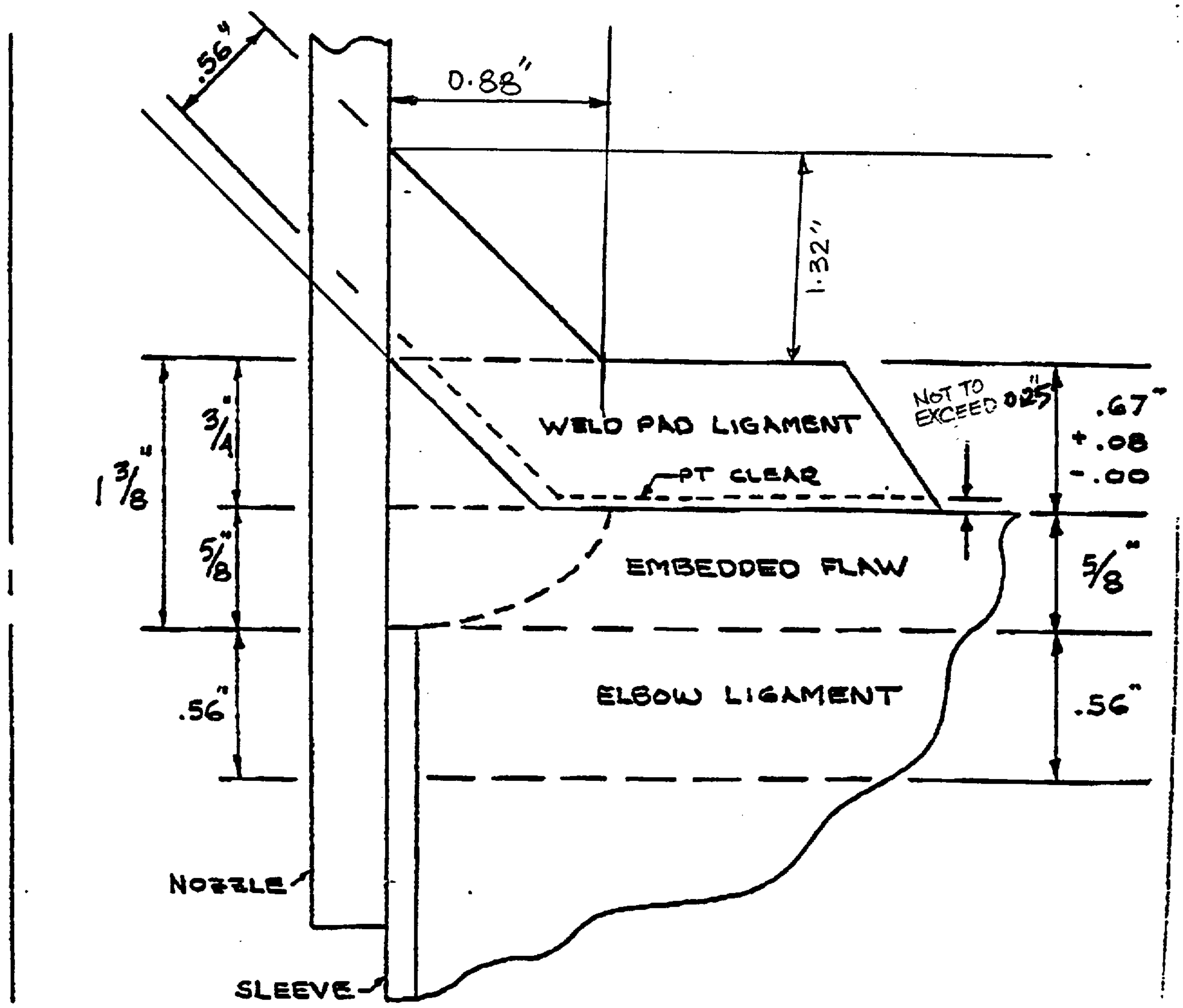


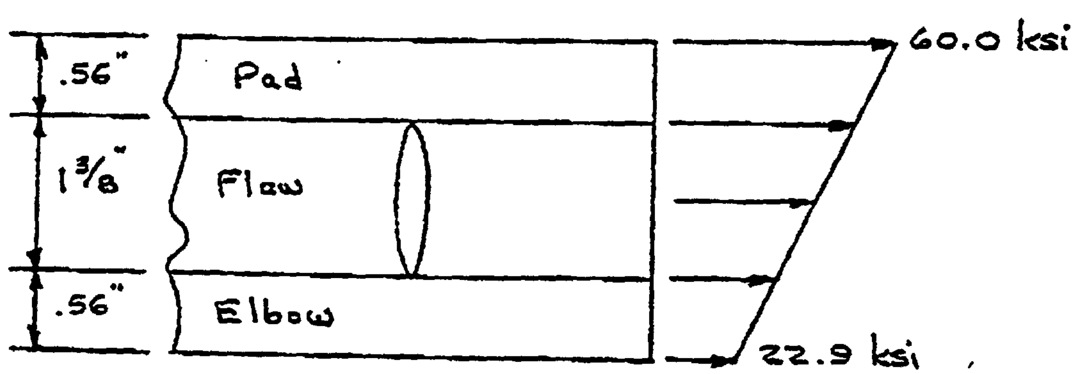
Figure C-1. Embedded Flaw Model for Weld Pad

C-3 Applied Stresses

Since a detailed description of the stresses is not currently available for the weld pad and the elbow in the vicinity of the existing partial penetration weld, these stresses will be estimated in a conservative manner. From the elbow analysis, the maximum hoop stress is 20.6 ksi. This stress is applied to the CCP surface that is opposite the weld pad. At the intersection of the elbow and weld pad, there would be additional stresses due to structural discontinuities and the residual effects of welding. Operating stresses are assumed to be below 30 ksi, which is some 10 ksi above the stress used in the elbow analysis. From ASME Code Case N-474, the yield strength of the Alloy 52/152 nickel-chromium-iron material is taken as 27.7 ksi at 550 °F. This value is used to approximate the residual weld stresses. The stress applied to the CCP surface at the weld pad is then 27.7 ksi plus 30 ksi, or 57.7 ksi. An additional stress of 2.25 ksi is applied over the width of the CCP model to simulate the effect of pressure applied to the crack face.

The total average remote tensile stress applied to the CCP model to evaluate the postulated embedded flaw between the weld pad and elbow is obtained as follows:

At weld pad surface:	60.0 ksi
At elbow surface:	22.9 ksi
Average stress:	41.5 ksi



C-4 Stress Intensity Factor Solution

The stress intensity factor solution for a center cracked panel with a through-wall flaw model is given by

$$K_I = \sigma\sqrt{\pi a}\left(\frac{2b}{\pi a}\tan\frac{\pi a}{2b}\right)^{1/2}, \qquad \text{[Ref. 6, Eqn. (2.23)]}$$

where $2a$ = width of crack
$2b$ = width of panel
σ = remote tensile stress,

For the case of the postulated embedded flaw,

$2a = 1.375$ in. $(0.625 + 0.750)$
$2b = 2.495$ in. $(2a + 2(0.56))$

$a = 0.6875$ in.
$b = 1.2475$ in. $(a/b = 0.55)$

$\sigma = 41.5$ ksi

$K_I = 71.1$ ksi$\sqrt{\text{in}}$

C-5 Fatigue Crack Growth

Heatup/cooldown stresses are conservatively assumed to cycle from zero to the maximum value computed above. From the Section XI reference fatigue crack growth curve for austenitic materials in air, Fig. C-3210-1 [2], and using a factor of two to account for a water environment, the crack growth rate is determined as follows:

$\Delta K_I = 71.1$ ksi$\sqrt{in}$

R = 0.9 (maximum effect of mean stress)

T = 550 °F (operating temperature)

In air: da/dN = 0.0021 in./cycle

Water environment factor = 2.0

In water: da/dN = 0.0042 in./cycle

During 10 heatup/cooldown cycles, flaw growth would be

$\Delta N = 10$ cycles

$\Delta a = da/dN \times \Delta N = 0.042$ in.

C-6 Conclusion

Using conservative analysis, it is predicted that the postulated embedded flaw would grow 0.042 inch over a fuel cycle. This amount of crack growth is within the 0.060 inch layer of sacrificial material included in the design of the weld pad.