Omaha Public Power District
1623 Harney Omaha, Nebraska 68102-2247
402/536-4000

January 23, 1986
LIC-86-024

Mr. Ashok C. Thadani, Project Director
PWR Project Directorate #8
Division of PWR Licensing - B
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Reference: Federal Register, Vol. 50, No. 141, Tuesday, July 23, 1985

Dear Mr. Thadani:

Fort Calhoun Specific Weld Chemistry Data
Reporting Requirements of 10CFR 50.61

In accordance with the above reference, Omaha Public Power District, (OPPD) is required to submit to the Nuclear Regulatory Commission the projected values of RT_{PTS} (at the inner vessel surface) for the Fort Calhoun Station Unit No. 1 reactor vessel beltline materials, giving values from the time of submittal to the expiration date of the operating license. This letter documents recently obtained beltline weld chemistry data which impacts Fort Calhoun's position with regard to the pressurized thermal shock (PTS) issue in addition to addressing the above mentioned reporting requirements of 10CFR 50.61.

In an effort to better address the PTS issue, a search of Combustion Engineering's, (CE's) weld records was performed in 1984 to determine beltline weld chemistries for the Fort Calhoun Station reactor vessel. Weld chemical composition analyses were obtained for all weld wire heats used in the beltline region except weld wire heat 51989, which was used in the middle shell longitudinal seam welds. This heat was traced to the torus longitudinal seam welds on the Fort Calhoun reactor vessel head. It was determined that weld chip samples could be removed from these welds for analysis. A conference call involving OPPD, CE, and NRC personnel was held on 7/30/85 to review plans for sampling this material during the 1985 refueling outage. As a result of this conversation and others between CE and NRC personnel, several items of NRC concern were introduced and preliminarily resolved. These NRC concerns are addressed in the following paragraphs.

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cc: AD - D. CRUTCHFIELD (Ltr only)
EB (W. JOHNSTON)
RSB (THOMAS)
EICSB (PARR)
FOB (W. REGAN)

The first concern was how the location of the weld seams could be accurately distinguished from the surrounding base metal. This was accomplished by polishing the areas to be sampled and then etching them with a nitric acid solution to reveal the weld outline. After the chip samples were removed, the sample areas were blended and inspected by magnetic particle testing. Photographs were taken of the prepared surfaces after etching, after chip removal and after blending at all locations to document that only weld material was removed.

The second concern was the ability to distinguish between uncharted weld repairs and cosmetic welds. CE has determined that the possibility of an uncharted weld repair was small and that cosmetic welds were not performed on the OD weld surface, rather the submerged arc weld was ground smooth to the surface. To further minimize this concern, duplicate samples were obtained for each weld from different locations.

The results of optical emission chemical analyses performed on the chip samples, including a check analysis by x-ray fluorescence for copper and nickel content, are shown in Table 1. The report for all elements determined in the optical emission analysis is attached as Table 2. The optical emission values are an average of two analyses. The x-ray fluorescence values represent a single analysis. The chemical analysis results for wire heat 51989 are consistent with the values expected for a weld made with a Mil B-4 wire and a Linde Type 124 flux, as is indicated for these welds by the weld information records. Likewise, the results of the chemical analyses for wire heat 13253 are consistent with a Mil B-4 Modified wire and Linde Type 1092 flux. The D.C. Cook and Salem 2 surveillance welds were also made with heat 13253 and a Linde Type 1092 flux. The nickel content of the Salem 2 (0.71 w/o) and D.C. Cook (0.74 w/o) surveillance welds are almost identical to the Fort Calhoun (0.73 w/o) value, indicating that 13253 was the wire heat used, and further indicating that weld metal was sampled, since the base metal normally contains less than 0.60 w/o nickel. The copper contents between these welds vary significantly (D.C. Cook - 0.27 w/o, Salem 2 - 0.23 w/o, Fort Calhoun - 0.14 w/o). This can be attributed to the variation in copper coating on the coils of the wire making a heat of weld wire. This wide variation in copper has been observed on several other heats of wire for which multiple analyses are available. A portion of the samples from each weld seam was metallographically examined using a Nital solution to reveal the microstructural characteristics. In all cases, the examination showed the fine-grained ferritic structure of weld metal.

The adequacy of a smaller chip sample as opposed to a full boat sample was also a concern. This has been addressed by the fact that the Fort Calhoun closure head has a relatively small allowance for the removal of a sample and anything larger than the proposed chip sample might require a UT inspection and some degree of analysis. Meaningful results have been obtained since it was possible to do metallography and chemical analyses on the same chip specimens.

Using the results of the closure head weld sampling for heats 51989 and 13253, and other available records, copper and nickel contents have been determined for each weld deposit in the Fort Calhoun reactor vessel beltline. These copper and nickel contents are presented in Table 3. The chemistry established for wire heat 27204 resulted from a search in October 1985 of the CE Metallurgical and Materials Laboratory chemical analysis log books for weld deposit information and a review of data for the Diablo Canyon Unit #1 surveillance weld made with heat 27204. The lower shell longitudinal seam welds were each made using three heats of wire (27204, 12008, and 13253). It is not known whether only one or a combination of two of the wires were used to weld the ID of the seam. It was assumed for conservatism that the weld wire with the highest chemistry factor was used to weld the ID of the seam. Therefore, the copper and nickel content of wire heat 12008 was used in the PTS evaluation of these weld seams.

RT_{PTS} calculations have been performed, in accordance with 10CFR 50.61, to determine the RT_{PTS} for each weld and plate in the reactor vessel beltline at the projected end of license life and at 32 EFPY. The results are presented in Table 4. Fort Calhoun is currently licensed for operation through the year 2008. Assuming a capacity factor of 77% beyond Cycle 9 yields a projected end of license life at approximately 25 EFPY. Cycles 1-7 used a standard symmetric (i.e. out-in-in type fuel management) core loading pattern. A symmetric low radial leakage core loading pattern was utilized in Cycles 8 and 9. Although the Cycle 10 core was designed using an asymmetric loading pattern to further reduce fluence to the critical beltline welds, no credit has been taken in these calcilations for the additional flux reduction of Cycle 10 over Cycles 8 and 9 in the RT_{PTS} calculations. The limiting beltline material was found to be the lower shell longitudinal weld seam, 3-410 which currently has an RT_{PTS} of 182°F (calculated at the end of Cycle 9, 7.9 EFPY) and is projected to have an RT_{PTS} of 242°F at the end of license life (25 EFPY). Further calculations for this weld project an

RT_{PTS} of less than 265°F at 40 EFPY. Since all Fort Calhoun Station reactor vessel beltline materials fall below the PTS screening criteria of 270°F, no further analysis nor schedule for the implementation of a flux reduction program is required.

Sincerely,

R L Jaworski for

R. L. Andrews
Division Manager
Nuclear Production

RLA/MJM/me

Attachments

cc: LeBoeuf, Lamb, Leiby & MacRae
1333 New Hampshire Ave., N.W.
Washington, DC 20036

E. G. Tourigny, NRC Project Manager
P. H. Harrell, NRC Senior Resident Inspector

Table 1

Wire Type:	Mil B-4	Mil B-4	Mil B-4 Mod	Mil B-4 Mod
Heat No.:	51989	51989	13253	13253
Flux Type:	Linde 124	Linde 124	Linde 1092	Linde 1092
Flux Lot:	3687	3687	3791	3791
Weld Seam:	1-415C	1-415E	2-145/A (near 1-415C)	2-415/A (near 1-415E)
CE Lab No.:	D-41589	D-41591	D-41588	D-41590

	Optical Emission (X-Ray Flour.) W/O	Optical Emission (X-Ray Flour.) W/O	Optical Emission (X-Ray Flour.) W/O	Optical Emission (X-Ray Flour.) W/O
C	0.11	0.096	0.11	0.12
Mn	1.39	1.50	1.10	1.14
P	0.011	0.013	0.010	0.013
S	0.009	0.011	0.008	0.011
Si	0.30	0.36	0.17	0.18
Ni	0.20 (0.18)	0.13 (0.114)	0.72 (0.72)	0.74 (0.72)
Cr	0.08	0.08	0.04	0.04
Mo	0.47	0.52	0.43	0.44
Cu	0.16 (0.17)	0.18 (0.18)	0.14 (0.14)	0.14 (0.14)

Table 2

COMBUSTION ENGINEERING
METALLURGICAL & MATERIALS LABORATORY

DATE: 11-13-85
P.O. NO.
C-E JOB NO. 99759617
PROJECT NO. 960001

CHEMICAL ANALYSIS
REPORT

C-E Lab No.	D41588	D41589	D41590	D41591
Customer No.				
Description	Area 1 2-415-A	Area 1 1-415-C	Area 2 2-415-A	Area 2 1-415-E
C	.11	.11	.12	.096
Mn	1.10	1.39	1.14	1.50
P	.010	.011	.013	.013
S	.008	.009	.011	.011
Si	.17	.30	.18	.36
Ni	.72	.20	.74	.13
Cr	.04	.08	.04	.08
Mo	.43	.47	.44	.52
V	.003	.004	.003	.004
Cb	< .01	< .01	< .01	< .01
Ti	< .01	< .01	< .01	< .01
Co	.016	.012	.016	.011
Cu	.14	.16	.14	.18
Al	.002	.006	.002	.007
B	< .001	< .001	< .001	< .001
W	< .01	< .01	< .01	< .01
As	.010	.010	.013	.011
Sn	.005	.006	.006	.006
Zr	< .001	< .001	< .001	< .001
N	.009	.015	.009	.009
O				
Fe				

Reactor Vessel Closure Head
Omaha Public Power Dist.
Fort Calhoun Station

Reported by: H. Anthony Stephens

Combustion Engineering, Inc. 911 West Main Street Chattanooga, Tennessee 37402 (615) 265-4631 Telex 558429

Table 3

Chemical Content of Fort Calhoun Beltline Welds

Weld Seam	Material (Wire Heat/Flux Lot)	Chemical Content Cu	Ni	Comment/Source
2-410 A/C	51989/3687	0.17	0.17	Fort Calhoun closure head longitudinal weld sample.
3-410 A/C	27204/3774	0.22	1.02	Average of multiple weld deposit records including PG&E Diablo Canyon surveillance weld.
	13253/3774	0.21	0.73	Average of Salem #2 and Cook #1 surveillance welds, and Fort Calhoun closure head torus-to-dome girth seam weld samples.
	12008/3774	0.23	0.95	Average of multiple weld deposit records of tandem arc welds in which second weld wire heat copper content known.
9-410	20291/3833	0.21	0.74	Cooper Station surveillance weld.
8-410	13253/3774	0.21	0.73	(see 3-410)

Table 4

RT_{PTS} for Fort Calhoun Beltline Welds

Weld Seam	Cu W/O	Ni W/O	Chem.* Factor	RT_{PTS} 25 EFPY	RT_{PTS} 32 EFPY	RT_{PTS} 40 EFPY
2-410 (longitudinal)	0.17	0.17	80	110°F	116°F	123°F
3-410 (longitudinal)	0.23	0.95	175	235°F	250°F	264°F
8-410 (circumferential)	0.21	0.73	142	192°F	205°F	216°F
9-410 (Circumferential)	0.21	0.74	143	193°F	206°F	217°F

*Chemistry Factor = -10 + 470(Cu) + 350(Cu)(Ni)

10CFR 50.61 Equation:

$$RT_{PTS} = I + M + [-10 + 470(Cu) + 350(Cu)(Ni)]f^{0.270}$$

I = generic mean value of initial reference temperature = -56°F for welds made with Linde 1092 and 124 fluxes.

M = margin to cover uncertainties in initial RT_{NDT} = 59°F since generic value of I was used.

The PTS criteria applied to the vessel ID for longitudinal weld seams is RT_{PTS} = 270°F and for circumferential weld seams is RT_{PTS} = 300°F.