Omaha Public Power District
444 South 16th Street Mall
Omaha NE 68102-2247

September 3, 1996
LIC-96-0130

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Station P1-137
Washington, D.C. 20555

References: 1. Docket No. 50-285
2. Letter from OPPD (W. G. Gates) to NRC (Document Control Desk) dated July 15, 1996 (LIC-96-099).
3. Letter from NRC (L. R. Wharton) to OPPD (T. L. Patterson) dated August 8, 1996.

Subject: Response to Request for Additional Information (RAI) on ZIRLO™ Cladding (TAC No. M96089)

On August 8, 1996, the Omaha Public Power District (OPPD) received the NRC's request for additional information (RAI) related to the Fort Calhoun Station (FCS) Application for Amendment submitted in Reference 2, to allow the use of either zircaloy or ZIRLO™ cladding. Attached please find OPPD's response to this RAI.

If you should have any questions, please contact me.

Sincerely,

T. L. Patterson
Division Manager
Nuclear Operations

TLP/brh

Attachment

c: Winston & Strawn
L. J. Callan, NRC Regional Administrator, Region IV
L. R. Wharton, NRC Project Manager
W. C. Walker, NRC Senior Resident Inspector

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OMAHA PUBLIC POWER DISTRICT
FORT CALHOUN STATION UNIT NO. 1

Response to RAI: ZIRLO™ Cladding

NRC Question:

Please provide justification that the loss of coolant analysis (LOCA) methodology and system analysis used to support plant operation with ZIRLO fuel is the same as the LOCA methodology and system analysis previously approved for use at Fort Calhoun, Unit 1. In this justification, show that the only changes are in the hot channel calculation and that the system calculation is identical to the previously approved system calculation, and not affected by changes in the hot channel calculation.

The approved LOCA methodology was reviewed by the staff and issued by letter dated March 26, 1992 (TAC No. M81831). In that safety evaluation, the staff identified a code stability issue with the large break model, which limited the methodology application.

OPPD Response:

The evaluation of the Fort Calhoun Station (FCS) Unit 1 large break LOCA transient for ZIRLO™ cladding was a reanalysis of the rod heat up portion of the limiting transient case only. The calculation of the system thermal-hydraulic transient behavior was not affected by the hot channel rod-heat up calculation in the ZIRLO™ cladding reanalysis. The system thermal-hydraulic data from the analysis of record limiting transient was used as a boundary condition input to the hot channel rod heat up calculation. Because the system thermal-hydraulic transient calculation did not change, the issue identified by the NRC staff regarding limited application of the large break model did not affect the results of the large break LOCA analysis for the ZIRLO™ clad fuel design. The following is a discussion of the reanalysis and comparison to the 1991 analysis of record. This comparison is also summarized in Tables 1 and 2.

Large Break LOCA

The first step of determining the impact of the ZIRLO™ cladding on FCS Unit 1 was to reanalyze (using LOCBART only) the base Zircaloy-4 cladding case to determine the plant-specific impact of the LOCBART changes that have been generically reported in the 1992, 1993, and 1994 10 CFR 50.46 reporting letters. Additional changes made in 1996 to correct errors in the cladding creep model that will be reported in the 1996 annual reporting letter were also included. The effect of the above-cited LOCBART coding changes, when analyzed on a plant-specific basis, resulted in a 60°F benefit.

Previously this benefit was not quantified on a plant-specific basis nor explicitly credited in the reported Peak Cladding Temperature (PCT) for FCS. The sources of this benefit include the 1992 *BART spacer grid heat transfer error correction*, the 1993 *large break LOCA fuel rod model errors* and *revised burst strain limit model*, the 1994 *pellet power radial flux depression error*, and the 1996 *cladding creep model error corrections*.

Since these errors were discovered after the 1991 analysis of record, an assessment of their impact was conducted. The 1992 *BART spacer grid heat transfer error correction*, which consistently demonstrated significantly better grid wetting and lower clad temperatures, was conservatively assessed an estimated penalty of 0°F. The 1993 evaluation model changes included the *large break LOCA fuel rod model errors* (which were estimated to have negligible impact) and the *revised burst strain limit model* (which was estimated to range from negligible to a moderate, unquantified benefit) both of which were conservatively assessed an estimated penalty of 0°F. In the 1994 evaluation model changes, the *pellet power radial flux depression error* was assessed an estimated penalty of 0°F. The *cladding creep model error corrections* in the 1996 evaluation model have shown benefits ranging from 0°F to 10°F, and are currently expected to be conservatively assessed an estimated 0°F penalty in the 1996 annual 10 CFR 50.46 reporting letter. Therefore, the combined effects of these model changes were conservatively assessed as a 0°F penalty to the 1991 analysis of record.

The next step in the reanalysis was to change the LOCBART input to reflect the ZIRLO™ cladding proposed for use. Several other changes to the new fuel design judged to have small impacts on PCT, such as small changes in the grid design features, were also included in this reanalysis. The small reductions in grid surface area were conservatively modeled in LOCBART, as they reduce the surface area available for grid rewet and evaporative cooling effects. The individual effects of the grid changes, expected to be a small penalty, were not modeled separately from the ZIRLO™ cladding since none of the Zircaloy-4 clad fuel contains the revised grids, while all the ZIRLO™ clad fuel will have the revised grids.

The combined effect of the revised grid design and ZIRLO™ cladding resulted in a LOCBART calculated PCT of 2009°F, which is below the currently reported PCT of 2041°F, but 28°F above the Zircaloy-4 clad fuel PCT with the original grid design (as reanalyzed using LOCBART only to quantify the effect of LOCBART model changes).

The reanalysis also included a sensitivity study to assess the effects of 100 psig backfill pressure IFBA fuel on calculated PCT (compared to the non-IFBA 275 psig backfill pressure fuel, and the IFBA 200 psig backfill pressure fuel). The worst case 100 psig backfill pressure IFBA fuel with ZIRLO cladding was found to have a LOCBART PCT of 2003°F, which shows that for the 100 psig backfill pressure IFBA fuel design with ZIRLO™ cladding, the non-IFBA fuel (with a 275 psig backfill pressure) is more limiting with respect to PCT. With the currently reported 2041°F PCT remaining bounding for the new ZIRLO™ clad fuel design, 32°F of plant-specific LOCBART code change margin is available to be credited and has been conservatively neglected.

Table 1 shows the results of the ZIRLO™ cladding analysis for the large break LOCA analysis and the corresponding current large break LOCA licensing PCT with respect to the analysis of record.

Small Break LOCA

A reanalysis of the limiting small break LOCA rod heat up transient was performed using the SBLOCTA code and attaching the previously generated system thermal-hydraulic data. In this case, the thermal-hydraulic data attached were not the data generated in the original analysis, but rather the corrected data generated in the plant-specific reanalysis. This addresses the NOTRUMP Bessel function error reported in the 1992 10 CFR 50.46 reporting letter. Note that this Bessel function error correction was an evaluation model change that generically required reanalysis of the thermal-hydraulic transient for all plants analyzed with the NOTRUMP model containing the error. Only the Bessel function error was corrected in the NOTRUMP model change. The NOTRUMP system thermal-hydraulic transient was not reanalyzed for the ZIRLO™ clad fuel evaluation.

The effects of SBLOCTA model changes described in the 1993, 1994, and 1995 10 CFR 50.46 annual reports on the FCS analysis have only been previously quantified on a plant-specific basis for the SBLOCTA axial nodalization issue. A reanalysis of the Zircaloy-4 clad fuel using the current version of SBLOCTA shows that the conservatively assessed +10°F penalty is actually +8°F on a plant-specific basis for FCS. When the SBLOCTA input was modified for the ZIRLO clad fuel design, a 3°F benefit over the Zircaloy-4 clad fuel design was observed. As a result, the currently reported PCT of 1440°F remains conservative for the Zircaloy-4 clad fuel by 2°F and for the ZIRLO™ clad fuel design by 5°F.

Table 2 shows the results of the ZIRLO™ cladding analysis for the small break LOCA analysis and the corresponding current small break LOCA licensing PCT.

TABLE 1
Large Break LOCA Analysis Table

		Zircaloy-4 Analysis of Record 1991	Zircaloy-4 ZIRLO™ Analysis New Base Line Case 1996	ZIRLO™ ZIRLO™ Analysis 275 psig non-IFBA 1996	ZIRLO™ ZIRLO™ Analysis 100 psig IFBA 1996
Analysis PCT		**2066**	1981	2009	2003
Permanent Assessments (Structural Heat Modeling)		**-25**			
Unquantified LOCBART Issues:					
1992 BART spacer grid errors	0 (conservative assessment)		modeled	modeled	modeled
1993 fuel rod model errors	0 (conservative assessment)		modeled	modeled	modeled
1993 revised burst strain model	0 (conservative assessment)		modeled	modeled	modeled
1994 pellet radial flux error	0 (not modeled)		modeled	modeled	modeled
1996 clad creep model error	0 (conservative assessment)		modeled	modeled	modeled
Net PCT		**2041**	1981	2009	2003
PCT to be reported		2041	2041	2041	2041
Uncredited available margin			(60)	(32)	(38)

The currently reported PCT of 2041 remains bounding for ZIRLO™ clad IFBA (100 psig) and non-IFBA (275 psig) fuel.

TABLE 2
Small Break LOCA Analysis Table

	Zircaloy-4 Analysis of Record 1991	Zircaloy-4 Bessel Function Analysis 1992	Zircaloy-4 LOCTA Axial Nodalization 1994	Zircaloy-4 ZIRLO™ New Base Line Case 1996	ZIRLO™ ZIRLO™ Analysis Case 1996
Analysis PCT	**1444**	**1336**[2]	**1411**[3]	**1419**[4]	**1416**[4]
Permanent Assessments	-14	**0**	**-1**	**+19**	**+19**
1992 NT Bessel Function Error	-108[2]	modeled	modeled	modeled	modeled
1993 NT SI in the Broken Loop	+150	n/a[1]	+150	+150	+150
1993 NT Improved Condensation	-150	n/a[1]	-150	-150	-150
1993 NT Drift Flux Errors	-13	n/a[1]	-13	-13	-13
1994 NT Boiling Heat Trnsfr Error	-6	n/a[1]	-6	-6	-6
1994 NT Steam Line Isol. Logic	+18	n/a[1]	+18	+18	+18
1994 LOCTA Axial Nodalization	+75[3]	n/a[1]	modeled	modeled	modeled
1995 NT Specific Enthalpy	+20	n/a[1]	n/a[1]	+20	+20
1996 Current Assessments	**+10**	n/a[1]	n/a[1]	modeled[4]	modeled[4]
1996 LOCTA fuel rod initialization	+10	n/a[1]	n/a[1]	modeled[4]	modeled[4]
Net PCT	**1440**	**1336**[1]	**1410**[1]	**1438**[4]	**1435**[4]
PCT to be reported	1440			1440	1440
Uncredited Available PCT margin				2	5

The currently reported PCT of 1440 remains bounding with respect to ZIRLO™ clad fuel.

1. n/a signifies that at the time of these analyses, the issues had not been applied to the calculated PCT assessments.
2. The NOTRUMP Bessel function reanalysis was a direct reanalysis of the original case. The sensitivity of 108 degrees comes from the difference between 1444 and 1336 degrees.
3. The SBLOCTA axial nodalization reanalysis was a direct reanalysis of the Bessel function case. The sensitivity of 75 degrees was the difference between 1336 and 1411 degrees.
4. The ZIRLO™ reanalysis cases (Zircaloy-4 and ZIRLO™) were direct reanalyses of the SBLOCTA axial nodalization case. The sensitivity of 8 degrees for the LOCTA fuel rod initialization issue (conservatively assessed a 10 degree penalty) comes from the difference between 1411 and 1419 degrees.