Duke Power
A Duke Energy Company

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March 16, 2004

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

Subject: Duke Energy Corporation
Catawba Nuclear Station Units 1 & 2, Docket Nos. 50-413, 50-414
Additional Information Regarding Mixed Oxide Fuel Lead Assemblies
Assembly Bow (TAC Nos. MB7863, MB7864)

By letter dated February 27, 2003 Duke Energy submitted an application to amend the licenses of McGuire and Catawba to allow the use of four mixed oxide fuel lead assemblies. The NRC staff discussed Assembly Bow treatment for MOX with Duke Energy and Framatome in a teleconference on February 3, 2004. Attachment 1 to this letter provides the formal reply to that discussion. Inquiries on this matter should be directed to Michael T. Cash at (704) 382-5826.

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attachments

A001

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MOX File 1607.2304
Catawba Document Control File 801.01– CN04DM
Catawba RGC Date File (J. M. Ferguson – CN01SA)

Oath and Affirmation

I affirm that I, WR Mc Collum, am the person who subscribed my name to the foregoing, and that all the matters and facts set forth herein are true and correct to the best of my knowledge.

WR Mc Collum

Subscribed and sworn to before me on this 16TH day of March 2004.

Notary Public

My Commission expires:

MICHAEL T. CASH
Notary Public
Lincoln County, North Carolina
Commission Expires January 22, 2008

Jan 22, 2008
Date

Attachment 1
Response to Request for Additional Information
Treatment of Assembly Bow

Introduction

On December 9, 2003 FANP filed an Interim Report with the Nuclear Regulatory Commission pursuant to 10 CFR Part 21.21 (a) (2) titled "Fuel Assembly Bow Analysis (Reference 1). In that report Framatome ANP (Framatome) identified an issue currently under review by Framatome regarding assumptions and methods associated with power peaking analysis under conditions of "assembly bow." In reference to the same matter, Virginia Electric and Power Company (Dominion) discussed treatment of this issue in a response to a Request for Additional Information dated January 22, 2004 (Reference 2). Framatome has communicated assembly bow penalty factors to Duke Energy, for addressing assembly bow for the MOX lead assemblies intended for use at Catawba Nuclear Station.

Fuel assembly bow causes an increase or decrease in the inter assembly water gap depending upon the direction of the bow. The change in water gap results in local neutron moderation changes that increase or decrease rod power, with the largest effect in fuel rods adjacent to the gap. The largest local power changes occur in corner fuel rods with the next greatest effect on fuel rods located on the outer row of the fuel assembly. For fuel rods where bow results in an increase in the amount of moderator adjacent to the fuel rods (i.e. an increase in the effective fuel rod pitch), the increase in neutron moderation increases local power. Conversely, for fuel rods where the bow results in a decrease in the amount of moderator adjacent to the fuel rods, the decrease in neutron moderation decreases local power.

Framatome assembly bow penalty factors have been calculated and supplied to Duke Energy on a fuel pin location specific basis. The bounding factors for the different fuel regions are shown in Figure 1. Duke Energy has reviewed information provided by Framatome as well as the Dominion submittal regarding this issue and has formulated a method of accommodating assembly bow penalties for MOX lead fuel assemblies. The method is outlined below and addresses the matter within the framework of existing Duke Energy methods for reload analysis.

Treatment of Assembly Bow Penalty (F_q^{AB}) in Loss of Coolant Accident (LOCA) and Center Line Fuel Melt (CFM) Analyses

Duke Energy's methods will accommodate either a single penalty factor for a fuel assembly, or will incorporate a pin location-specific penalty factor. The assembly bow peaking penalty factor, F_q^{AB} , is accounted for by statistically combining this factor, using square-root- sum-of-the-squares (SRSS), with the nuclear uncertainty factor, rod bow factor and any other factor, provided that the factors are independent.

A sample statistical combination is presented below as Equation 1.

$$F_Q^{SCUF+RB+AB} = 1 + BIAS + \sqrt{(F_Q)^2 + (PIN)^2 + (F_Q^E)^2 + (F_Q^{RB})^2 + (F_Q^{AB})^2} \qquad \text{(Eq. 1)}$$

Where,

Bias = bias in nuclear uncertainty
F_Q = assembly nodal uncertainty
PIN = pin uncertainty
F_Q^E = engineering hot channel factor
F_q^{RB} = rod bow penalty factor
F_q^{AB} = assembly bow penalty factor

Peaking factors calculated as part of reload design calculations would be augmented by the uncertainty factor calculated by Equation 1, and any other applicable factor that may affect peaking. The application of specific uncertainty factors in reload calculations is described in References 3 and 4.

Treatment of Assembly Bow Penalty in Departure from Nucleate Boiling (DNB) Analyses

As stated earlier, the fuel assembly bow impact is accommodated by a pin peaking factor penalty distribution within the fuel assembly. The approach taken to evaluate the DNB effects of fuel assembly bow for the MOX lead assembly assessment is very conservative. It involves applying the peaking penalty for assembly bow in a deterministic manner rather than including it as a separate radial uncertainty for inclusion in the Statistical Design Limit (SDL). Since DNB calculations are done on a subchannel basis as per References 5 and 6, the heat input to each channel is strongly influenced by the four surrounding fuel rods. Therefore, the impact of the fuel assembly bow penalty for a particular subchannel will be dependent on location within the fuel assembly. For DNB analyses, the assembly bow peaking penalty will be accounted for by using the radial location dependence of the peaking penalty distribution. The pin-by-pin penalty will be overlaid with the MOX lead assembly peaking distribution in the DNB analyses such that the local effect of assembly bow is applied to the MOX lead assemblies on a pin by pin basis.

If desired, a more simplified and conservative approach of applying a single peaking penalty, equal to the maximum pin penalty of 7.65%, may be applied to the entire assembly for DNB analyses.

Enlarged Gap Affect

Fuel assembly bow also produces increased cooling for the peripheral fuel rods due to the enlarged water gap. A peaking factor credit that accounts for this effect can be developed and applied for LOCA and for DNB. This credit would be developed internally or supplied to Duke Energy by Framatome, and may be used if applicable, available, and needed. At this time Duke Energy does not intend to apply such a factor.

Summary

The scheduled date for completion of Framatome ANP's assessment of this issue is stated as December 17, 2004 in Reference 1. Duke will evaluate the continued application of this approach for MOX fuel cycle analyses. This approach may be revised when Framatome ANP has completed their assessment of this issue.

References

1. Framatome ANP Document NRC:03:083 "Interim Report of an Evaluation of a Deviation Pursuant to 10CFR 21.21 (a) (2)," December 9, 2003.

2. Response to Request for Additional Information Regarding Assembly Bow Concern, Virginia Electric and Power Company, Docket 50-338/339, January 22, 2004.

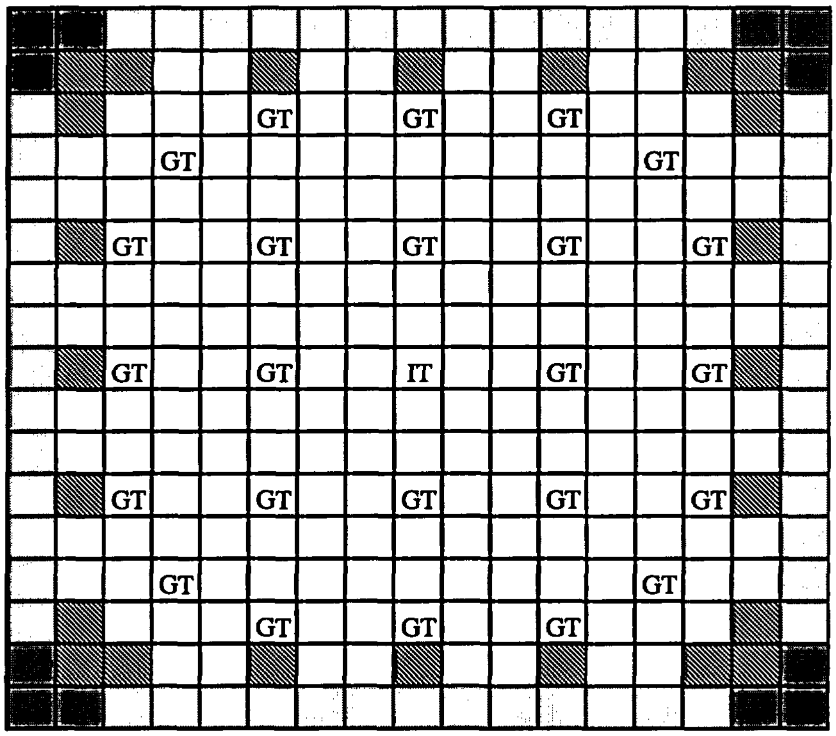
3. DPC-NE-2011PA, "Duke Power Company Nuclear Design Methodology for Core Operating Limits of Westinghouse Reactors," Rev. 1, October 1, 2002.

4. DPC-NF-2010A, "Duke Power Company McGuire Nuclear Station, Catawba Nuclear Station Nuclear Physics Methodology for Reload Design," Rev. 2, June 24, 2003.

5. DPC-NE-3000-PA, "Thermal-Hydraulic Transient Analysis Methodology," Rev. 2, December 2000.

6. DPC-NE-2004-PA, "McGuire & Catawba Nuclear Stations Core Thermal-Hydraulic Methodology Using VIPRE-01," Rev. 1, February 1997.

Figure 1. Assembly Bow Region Peaking Penalty Factors



= Pin Location #1 7.65 %

= Pin Location #2 6.38 %

= Pin Location #3 4.43 %

= Pin Location #4 3.06 %

Note: These are the factors that apply to the situation in which the MOX fuel assemblies are not adjacent to other MOX fuel assemblies. This situation is consistent with MOX fuel lead assembly core designs in which the lead assemblies will be located in separate quadrants for reasons of symmetry.