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October 9, 2002

U.S. Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, DC 20555-0001

Subject: Duke Energy Corporation (DEC)
McGuire Nuclear Station Units 1 and 2
Docket Numbers 50-369 and 50-370
Technical Specifications Amendment Request for Additional Information (RAI); TS 3.7.15 - Spent Fuel Assembly Storage, and TS 4.3 - Fuel Storage (TAC NOS. MB5014 and MB5015)

Reference: (1) DEC letter to NRC dated August 1, 2000, (2) DEC letter to NRC dated April 18, 2002, and (3) NRC letter to Mr. H.B. Barron of DEC dated September 19, 2002

This letter provides additional information that was requested by the NRC staff in the referenced letter dated September 19, 2002. The NRC staff's questions and DEC's responses are stated below.

Question No. 1

Provide the Boron Concentration in the Refueling Water Storage Tank.

Response

McGuire TS 3.5.4 requires the Refueling Water Storage Tank (RWST) to be within the limits specified in the Core Operating Limits Report (COLR). The current COLRs for McGuire (Unit 1 Cycle 16 and Unit 2 Cycle 15) require a minimum 2675 ppm boron in the RWST, as well as in the Spent Fuel Pool.

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Question No. 2

On page 7 of Attachment 6, submitted on April 18, 2002, the third assumption states that most calculations are done in two dimensions (2-D). Provide a basis for why 2-D calculations are still being performed.

Response

The main criticality calculations that Duke Energy performed in support of the McGuire and Oconee boron credit LARs (Oconee SER dated 4/22/02) were carried out using a radial (2-D) model of the fuel assemblies in the spent fuel pool storage racks. This modeling method was used mainly because the 2-D model was much easier to set up and much faster to execute than a full 3-D model. Typically, in criticality analyses, detailed refinements to a computational model - such as going from a 2-D to a 3-D representation of unirradiated fuel - are employed when it is desired to reduce excess conservatism associated with the more simplistic "bounding" model.

For criticality evaluations of irradiated fuel, the axial "end effect" phenomenon has been described and assessed as a potential non-conservatism in 2-D models (see, for example, ORNL/TM-1999/246). However, there is a large degree of variability in the axial burnup profiles of actual irradiated fuel assemblies, depending on their reactor core locations, power histories, and presence or absence of burnable poisons. In lieu of determining worst-case axial burnup profiles and then performing all criticality calculations with explicit, computationally expensive 3-D models, it is much more efficient to develop a set of bounding axial biases/uncertainties as a function of fuel enrichment and burnup. Then, all the main criticality calculations can be performed in two dimensions, and the tabulated axial biases/uncertainties can be included as reactivity penalties. This is certainly a conservative approach, but given the relatively small amount of reactivity worth associated with the 2-D to 3-D axial burnup bias, it is evident that there is no real advantage to employing an explicit 3-D model for all criticality calculations.

Note that the burnup credit approach employed by Duke in support of this LAR - generating burnup vs. enrichment reactivity-equivalent curves with a series of 2-D calculations, and then applying a conservative 3-D axial "end effect" reactivity bias, if any - has also been used in other recent boron credit LARs, such as those submitted for Indian Point 2 (9-20-01 LAR), San Onofre (2-22-02 LAR), and Beaver Valley (3-28-01 LAR; 2-11-02 SER).

Question No. 3.

Reactivity equivalencing is discussed in Attachment 6 on page 11, in the first paragraph of section 3.1.1 and again in Attachment 6 on page 13 in the first paragraph of section 3.1.2. Provide a basis for using reactivity equivalencing.

Response

Reactivity equivalencing is a standard technique for taking reactivity credit for burnup as a function of fuel initial enrichment. The requirements for using reactivity equivalencing are summarized in the August 1998 NRC memorandum from L. Kopp to T. Collins - "Guidance on the Regulatory Requirements for Criticality Analysis of Fuel Storage at Light-Water Reactor Power Plants." This memorandum also states that reactivity credit may be taken "for neutron absorbers that are an integral part of a fuel assembly" (such as the IFBA material credited in Attachment 6, page 13 of the current submittal).

Duke's application of reactivity equivalencing for both burnup credit and IFBA credit is consistent with the methods outlined in WCAP-14416-NP-A, "Westinghouse Spent Fuel Rack Criticality Analysis Methodology", as well as the previous version of this McGuire boron credit submittal (8/1/00 LAR; 11/27/00 SER). The objective for employing reactivity equivalencing, whether for burnup credit or IFBA credit, is to allow efficient storage of higher initial fuel enrichments in the McGuire spent fuel pools.

Question No. 4

In Attachment 6, on page 16, the second paragraph mentions that biases were determined to account for axial variation in burnup when performing calculations in 2-D. How are these biases determined and why are they conservative?

Response

While performing the supporting analyses for the McGuire August 2000 submittal, Duke determined larger (more conservative) 2-D to 3-D axial burnup biases than Westinghouse reported in WCAP-14416-NP-A. Duke contacted Westinghouse about this discrepancy, and Westinghouse performed its own re-analysis of these biases. Westinghouse eventually concluded that the original sets of axial biases they had reported were in fact non-conservative in many instances. Westinghouse informed its customers of this non-conservatism via a Nuclear Safety Advisory Letter (NSAL-00-

015, dated November 2, 2000). Since Duke's own calculations for both Oconee and McGuire show more conservative axial biases than even the updated Westinghouse results, Duke has, appropriately, applied its own calculated biases in determining boron credit requirements to achieve a total 95/95 k_{eff} less than 0.95 for fuel storage at McGuire and Oconee. The remaining discrepancies between Duke and Westinghouse axial burnup biases are most likely attributable to differences in fuel irradiation histories and spent fuel pool storage rack designs, as well as the fact that Duke conservatively ignores the reactivity effects of axial leakage (~ 0.002 to 0.003 Δk) in determining its 2-D to 3-D axial burnup biases.

The axial biases computed for the McGuire SFPs were determined by first choosing a range of axial burnup profiles for individual fuel assemblies. These burnup profiles were taken from actual "core-follow" calculations that modeled recent McGuire reactor operating cycles. The axial burnup profiles were then used in a series of 3-D spent fuel pool rack reactivity computations using the SIMULATE nodal code. Each of the final "bounding" SIMULATE cases modeled an infinite array (in the radial direction) of an individual fuel assembly, using the representative axial burnup profile that tended to maximize the reactivity of the actual 3-D model, as compared with the reactivity of a uniform-axial burnup 3-D model at the average burnup of the fuel assembly. All of the SIMULATE 3-D calculations also included specific top and bottom axial reflectors, which were modeled as mixtures of water and fuel assembly nozzle / spent fuel pool rack support structure material.

A comparison of the table below with Table 6 from WCAP-14416-NP-A shows that, for fuel burnup greater than 20,000 MWD/MTU, the McGuire Region 2A biases calculated by Duke are significantly more positive than those determined by Westinghouse. The nodal mesh size used in the Duke 3-D calculations (3 inches axially) is half that used by Westinghouse in producing its Table 6 data, which indicates that Duke employed a more detailed model to calculate axial burnup biases. Westinghouse, in its January 17, 1996 response to Question 5 in a second round of NRC review questions concerning this WCAP, also re-determined axial biases with 3.6-inch axial nodes, and found slightly more negative biases as compared with those using 6-inch nodes.

McGuire Region 2A SFP Axial Burnup Biases

Fuel Assembly Burnup (MWD/MTU)	3.0 wt % Enrichment Bias (pcm)	4.0 wt % Enrichment Bias (pcm)	5.0 wt % Enrichment Bias (pcm)
0	0	0	0
10,000	-291	-427	-466
20,000	+578	+32	-286
30,000	+2057	+1268	+529
40,000	+3830	+3293	+2245
50,000	+4449	+4847	+3933

Question No. 5

In Attachment 6, on page 33 in Table 9, the values for Region 2A minimum burnup required for fuel with initial enrichments of 4.00, 4.50 and 4.75 weight percent U-235 are less than the values stated in Attachment 6, page 32, Table 9 of the August 1, 2000, submittal. Provide an explanation for these differences.

Response

Table 9 presents the Filler fuel burnup requirements for the various storage subregions in the McGuire SFPs. The strategy employed for revising the McGuire Region 2A Restricted/Filler storage burnup requirements was to maintain the minimum Filler burnups at or near their previous values, and increase the corresponding Restricted fuel burnup requirements to compensate for the reduction in Boraflex from 50% to 40% of design minimum. This was done because the current Region 2A (50% Boraflex) Filler fuel burnup requirements already have a high burnup / enrichment ratio relative to that of typical McGuire discharge fuel. Thus, to maintain a viable inventory of Filler fuel assemblies in McGuire Region 2A, it is necessary to refrain from increasing Filler fuel burnup requirements any further. Note that, in comparing the Table 9 values of the August 2000 submittal and the present LAR, the differences in Region 2A Filler burnups are minimal (< 0.20 GWD/MTU).

In the supporting criticality calculation, it was noted that the most limiting Region 2A Restricted/Filler configurations (in terms of total 95/95 k_{eff}) occurred with the Filler fuel at 4.75 wt % U-235. First, the minimum burnup requirement for 4.75 wt % U-235 Filler fuel was arbitrarily selected to be 55.90 GWD/MTU. From this, the minimum burnup requirement for 4.75 wt % U-235 Restricted fuel was determined to be 34.50 GWD/MTU.

Subsequently, minimum burnup requirements for all other Filler fuel enrichments were computed, and finally, the burnup requirements for all remaining Restricted fuel enrichments were determined. Note that the iterative procedure employed in determining the minimum burnup requirements for Region 2A Restricted and Filler fuel was coarser (0.1 GWD/MTU increments) than that used previously (0.001 GWD/MTU increments). However, all of the resulting Region 2A Restricted / Filler enrichment and minimum burnup combinations as listed in Tables 8 and 9 of this LAR were evaluated in the supporting calculation, and verified to satisfy the pertinent subcriticality criteria.

Question No.6

In Attachment 6, on page 35, in Table 11, the values for boron credit requirements are less than the values stated in Attachment 6, page 34, Table 11 of the August 1, 2000, submittal. Provide an explanation for these differences.

Response

The only decreases in McGuire Region 2A boron credit requirements, when comparing Table 11 from the August 2000 submittal and the present LAR, occur for the misload and emergency makeup accident conditions. The emergency makeup (SFP water cooled to 32 ºF) boron credit requirement decreased from 20 to 10 ppm in the present submittal, due to the reduction in Boraflex from 50% to 40% of design minimum. A plausible explanation for this effect is that in McGuire Region 2 (which is neutral to slightly overmoderated in the high-burnup, moderate-boron conditions evaluated for this event) a decrease in SFP water temperature increases system reactivity more when larger amounts of Boraflex are present in the storage cells, since the higher water density reduces the overall effectiveness of poison materials external to the fuel lattice.

For the misload accident, however, the boron credit decrease from 710 to 580 ppm is attributable to a change in the way this accident was modeled. For the August 2000 submittal, the Region 2A misload accidents were excessively conservative, as the "misloaded" assembly was modeled in a 2x2 storage array, which was then infinitely reflected radially. In the present submittal the Region 2A misload accidents were modeled with the single "misloaded" fuel assembly in a 6x6 storage array, which was also infinitely reflected radially. Both methods are conservative, since it is only necessary to assume that one storage location is misloaded (with a fresh 4.75 wt % U-235 fuel assembly) for this accident condition.

DEC requests approval of the LAR by December 1, 2002, as previously stated in the April 18, 2002 LAR submittal. Please contact Norman T. Simms of Regulatory Compliance at 704-875-4685 with any questions with respect to this matter.

Very truly yours,

D. M. Jamil

xc:

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Dhiaa M. Jamil, being duly sworn, states that he is Vice President of McGuire Nuclear Station; that he is authorized on the part of Duke Energy Corporation to sign and file with the U.S. Nuclear Regulatory Commission these revisions to the McGuire Nuclear Station Facility Operating Licenses Nos. NPF-9 and NPF-17; and, that all statements and matters set forth therein are true and correct to the best of his knowledge.

Dhiaa M. Jamil, Vice President
McGuire Nuclear Station
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Subscribed and sworn to before me on October 9, 2002.

Deborah S. Rome
Notary Public

My Commission Expires: December 19, 2004 bxc:

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