July 25, 2003

Mr. Michael S. Tuckman
Executive Vice President
Duke Energy Corporation
526 South Church St
Charlotte, NC 28201-1006

SUBJECT: WILLIAM B. MCGUIRE NUCLEAR STATION, UNITS 1 AND 2 AND CATAWBA NUCLEAR STATION, UNITS 1 AND 2 RE: MIXED OXIDE LEAD FUEL ASSEMBLIES (TAC NOS. MB7863, MB7864, MB7865, AND MB7866)

Dear Mr. Tuckman:

By letter dated February 27, 2003, you submitted applications for amendment to the operating licenses for McGuire Nuclear Station, Units 1 and 2 and Catawba Nuclear Station, Units 1 and 2. The proposed amendments would revise the Technical Specifications to allow the use of four mixed oxide fuel assemblies at either the Catawba or McGuire station. The Nuclear Regulatory Commission staff has reviewed the information provided and has determined that additional information is required as identified in the Enclosure.

We discussed these questions with your staff on July 24, 2003. Your staff indicated that a response to these issues could be provided by October 31, 2003. Please contact me at (301) 415-1493, if you have any other questions on these issues.

Sincerely,

/RA/

Robert E. Martin, Senior Project Manager, Section 1
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-369, 50-370, 50-413, and 50-414

Enclosure: Request for Additional Information

cc w/encl: See next page

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Duke Energy Corporation
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DATE	07/24/03	07/24/03	07/18/03	07/16/03	07/25/03

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REQUEST FOR ADDITIONAL INFORMATION

ON APPLICATION FOR MOX LEAD TEST ASSEMBLIES

DUKE POWER COMPANY

WILLIAM B. MCGUIRE NUCLEAR STATION, UNITS 1 AND 2

DOCKET NOS. 50-369 AND 50-370

CATAWBA NUCLEAR STATION, UNITS 1 AND 2

DOCKET NOS. 50-413 AND 50-414

Reactor Systems

Section numbers in the following requests for information refer to sections of the attachments to the licensee’s application dated February 27, 2003.

1. With respect to section 3.1, provide a full description of the post-irradiation examination planned to verify the mechanical properties of the lead test assemblies (LTAs) following irradiation. Describe the test methods planned and the acceptance criteria for each test as well as the frequency of each test. Additionally, please provide the same information for the hot cell examinations that will be performed following irradiation.

2. With respect to section 3.5.1.1, what is the calculated shoulder gap for the LTAs following a third cycle of irradiation? How does it compare to the limit?

3. Provide the specific burnup limit that is being requested for the LTAs.

4. Section 3.5.1.2 of the submittal states that the reduction in total plutonium concentration ensures that the macroscopic plutonium effects on fuel performance are bounded. Please define the subject macroscopic plutonium effects.

5. Provide the appropriate regulatory criteria used for the parameters discussed in section 3.5.1.

6. Provide a statistical analysis showing that the distribution of fissile material for the weapons-grade (WG) mixed oxide (MOX) fuel is the same as the distribution of fissile material for reactor-grade (RG) MOX fuel.

7. With respect to section 3.5.1.2, provide additional information on how the fuel pellet radial power profile for WG MOX is bounded by the profile for RG MOX.

8. In section 3.5.3, the statement is made that the Mark-BW/MOX1 fuel assembly design meets all applicable criteria to maintain safe plant operation. Specify all of the regulatory criteria being referred to in this statement.

9. Section 3.5.3 refers to fuel rod analyses which follow previously approved methods. Please state the methods being referred too.

10. Section 3.5.3 states that the Mark-BW/MOX1 design preserves the original plant licensing bases for all reactor internal components. Specify the components and the bases for them that are being referred too in this statement. Also explain how the MARK-BW/MOX1 design preserves them.

11. Please respond to the following items related to section 3.6.1, so that the Nuclear Regulatory Commission (NRC) staff may evaluate the conclusion that the vessel fluence increase is limited:

    (A) Identify the location of the LTAs.

    (B) Identify the existing peak fluence azimuthal location of the vessel.

12. Provide the appropriate regulatory criteria to be satisfied by the information in section 3.7, i.e., how this section meets the general design criteria specified in the Standard Review Plan.

13. To allow the NRC staff to perform confirmatory analysis, please provide both the McGuire and Catawba loss-of-coolant accident (LOCA) input decks for the low enriched uranium (LEU) as well as the MOX fuel rods. Provide the decks in an electronic format, including nodalization diagrams.

14. Provide the reference to the best estimate LOCA model noted in section 3.7.1.7.

15. Provide the uncertainty analysis that was performed for the LEU and MOX LTA demonstrating that the 95/95 peak cladding temperature has been calculated for the core. The response is expected to include a complete discussion of the statistical methodology used.

16. Section 3.7.1 states that the LOCA model used for the LEU fuel is a best estimate model. Provide the Phenomena Identification and Ranking Table for the LOCA analyses performed with the best estimate model and reference the best estimate model used for the analysis.

17. Provide the experimental data base used to assess the biases and to determine the uncertainties in the fuel rod behavior for the MOX LTA.

18. In sub-section 3.7.1.1.1, nothing is mentioned about the MOX/LEU interface behavior. Provide a qualitative and quantitative discussion regarding the neutron flux behavior at the interface of the MOX and LEU fuel assemblies.

19. Section 3.7.1.1.1 discusses a variety of neutronic parameters. Provide additional detail about the differences between LEU and MOX parameters. Please use graphs, data, or any other visual representations to help clarify the impact of these parameter differences.

20. Also, in the second paragraph of sub-section 3.7.1.1.1, the change in the delayed neutron fraction is discussed at beginning of life. However, the behavior of the delayed neutron fraction at middle of life and end of life is not addressed. Provide a discussion on the delayed neutron factor change with respect to burnup.

21. How does the lower fuel conductivity of the MOX fuel impact the maximum pellet centerline temperature during a LOCA as compared to LEU fuel? Please provide a qualitative and quantitative discussion of the differences.

22. The first paragraph of section 3.7.1.1.2 states that "The result, including appropriate uncertainties, is that .." Please state the uncertainties that are being referred too in this section along with what is considered to be appropriate.

23. All operating plants must have sufficient shutdown margin at the beginning and throughout a fuel cycle. Provide the predicted shutdown margin in graphical or tabulated form for the cores including the four MOX lead test assemblies. Show that the predicted shutdown margin will meet the Technical Specification limit for each of the plants that may load the LTAs.

24. Section 3.7.1.1.4 discusses the LOCA transient initialization and the changes made to accommodate using the COPERNIC code instead of the TACO3 code, including the adjustments made to some of the parameters. Provide additional information on the adjustments made, how the adjustments were developed and include any data used to develop the adjustment. Additionally, since these values are used in RELAP5 initialization, please show that throughout the fuel lifetime, the TACO3 and COPERNIC codes predict consistent values for the different fuel parameters used as input for the LOCA analysis.

25. Section 3.7.1.1.4 discusses RELAP5 initialization, stating that the core model will not be in steady state at transient initialization. Since a false declared steady state can lead to errors from an imbalance, please provide justification for why the RELAP5 model will not be in steady state at transient initiation and how steady state conditions for initialization are assured.

26. Provide the basis for assuming that the uncertainty distribution for COPERNIC is a normal distribution.

27. Please provide the basis for the COPERNIC temperature adjustments for core initialization in section 3.7.1.1.4. Additionally, please provide the basis for why the TACO3 temperature predictions are reasonable for application to COPERNIC predictions.

28. In sub-section 3.7.1.6, the subject of mixed cores is discussed. In the middle of the paragraph it is stated that the MOX LTA pressure drop is less than four percent lower than the pressure drop for a resident Westinghouse fuel assembly at design flow rates. Please provide additional detail on the cause of this pressure drop difference, how it was calculated, and the impact including the consequences of this pressure drop. Also, please provide the design flow rate used for this analysis.

29. The staff presumes that a mixed core analysis will be performed to account for the use of four MOX LTAs in the core. Therefore, provide the mixed core penalty that was calculated. If a mixed core calculation was not performed, provide a technical justification for not performing the analysis.

30. Page 3-29 of section 3.7.2.1 lists the transients and accidents that were analyzed.

    (A) Results were not provided for review with the application; therefore, submit the results of the analyses along with a discussion of each analysis and any data used for determining the impact of using MOX fuel.

    (B) Was the small break LOCA boron dilution event analyzed? If not, please provide technical justification for why it was not analyzed.

31. Section 3.7.2.2 discusses the thermal-hydraulic differences for the different co-resident fuel types. Please provide the limits analyzed for the different fuel types, including a discussion on how they were obtained.

32. On page 3-31, the first paragraph states that no MOX assembly will be rodded. Will that always be true for both LTAs and batch loading? Also, is there a scenario where the MOX assembly rod ejection energy deposition will be higher than that for an LEU? Please provide the worth of the most reactive rod for an all-LEU core and for a core with four MOX assemblies. Also, provide a discussion on what are considered to be the appropriate conservatisms for the ejected rod analysis.

33. On page 3-31, the second paragraph states that the rod ejection accident was conducted at the end-of-cycle hot zero power condition. Is this supposed to indicate that this condition provides the most limiting event? If so, provide an explanation on how and why it is the most limiting condition for the rod ejection accident with four MOX LTAs in the core.

34. Section 3.7.3 discusses the radiological consequences of selected postulated accidents where MOX fuel lead assemblies have the potential to affect the dose consequences. Please explain how the source term used for these analyses was developed?

35. Provide information on how the peaking factor limits used for MOX fuel were developed.

36. Attachment 3-1 contains the criticality evaluation for MOX fuel storage in the spent fuel pools. For each of the spent fuel pool criticality analyses, provide the appropriate regulatory criteria used for the analysis and show how the criteria are met.

37. Table A3-1 on page A3-3 lists the minimum required boron concentration in each of the spent fuel pools. Is this concentration required to maintain the k-effective < 0.95, or is this the concentration in the refueling water storage tank?

38. On page A3-6, reference is made to bench-marking calculations by Duke. (A) What were the highest MOX and LEU enrichments assumed in the calculations? (B) Was the MOX weapons-grade MOX?

39. On page A3-7, reference is made to the method bias and uncertainty with respect to the MOX fuel critical experiments. Is this the KENO model calculational bias or the uncertainty associated with the experiments? Please clarify what the bias and uncertainty are related to. In addition, for each spent fuel pool criticality calculation, provide, in a tabulated form, a list of all the uncertainties accounted for in each of the k-effective calculations. Please provide the information for the cases with and without boron. In each case, please state the regulatory criteria associated with spent fuel criticality that needs to be satisfied, and how this criteria has been met.

40. Page A3-8 discusses the spent fuel pool racks in the third paragraph. Please state if MOX fuel (new and spent) will be stored in racks specifically designed for MOX fuel or will they be stored in regular storage racks?

41. Page A3-8 frequently references a nominal model. Please specify all of the parameters for the nominal model, including enrichment, size, etc.

42. On page A3-9, the second and third paragraphs make reference to criticality calculations and boron concentrations for various analyses without specifying actual values. Provide the actual values of k-effective calculated (including all the uncertainties) for each case, and the respective boron concentration needed to meet the applicable k-effective value. Provide an example of one of the calculations performed.

43. Provide the reference for the plutonium concentration uncertainty value used on page A3-11.

44. Page A3-11 contains a discussion of the fuel density manufacturing uncertainty. Was the maximum tolerance used in the calculation for maximizing the fuel density?

45. Provide the technical basis for the fuel density manufacturing, storage rack cell wall thickness, and storage rack center-to-center cell spacing tolerances referred to on page A3-11.

46. Pages A3-9 thru A3-12 present the 95/95 calculation that was performed for the spent fuel pool criticality analysis. Please clarify whether the 95/95 calculation presented is the upper bound calculation.

47. Attachment 6 contains the justification for exemptions to the regulations to use M5 cladding and MOX fuel. As stated in the attachment, exemptions are allowed under Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.12 (a)(2)(ii) if the proposed change meets the underlying purpose of the regulation. Therefore, please provide a more detailed discussion of the underlying purpose of the individual requirements of the regulation (i.e. Baker-Just equation) that apply to the exemption and how the proposed change meets the underlying purpose of that individual requirement of the regulation.

<u>Radiological Consequences</u>

The following additional information is needed for the NRC staff to determine that the analyzed radiological consequences of design basis accidents at the affected plants, as modified by the

proposed changes, will continue to comply with applicable dose limits. As explained in Regulatory Information Summary 2001-19, “Deficiencies in the Documentation of Design Basis Radiological Analyses Submitted in Conjunction with License Amendment Requests,” the NRC staff bases its finding on the acceptability of an amendment on its assessment of the licensee’s analysis. This is necessary since it is the licensee’s analysis that becomes part of the facility’s design basis and will be the basis for future 10 CFR 50.59 evaluations. For the NRC staff to make a finding of acceptability, the licensee must provide adequate information regarding analysis assumptions, inputs, and methods in its submittal dated February 27, 2003:

1. On Page 2 of the cover letter for the submittal, it is stated that the implementation of this amendment is not expected to require changes to the plant’s Updated Final Safety Analysis Reports (UFSARs). Later, the submittal states that the re-analysis of the radiological consequences of various design basis events has shown increases in the postulated consequences. 10 CFR 50.71(e) requires that the UFSAR be updated to reflect the information and analyses submitted to the Commission, including all safety analyses and evaluations performed by the licensee in support of approved license amendments. The NRC staff believes that changes will be necessary to the UFSAR. Please explain the basis for the statement that changes will not be needed for the UFSAR.

2. On Page 3-2 of the submittal, the last paragraph addresses the post-irradiation evaluations to be performed on the lead test assemblies. The discussion states that these evaluations are being performed to verify the validity of the licensee’s models to predict fuel assembly performance and confirm the applicability of the European database to the licensee’s use of weapons-grade MOX fuel. This discussion doesn’t explicitly address verification of the licensee’s assumptions with respect to fission product inventory and transport within the fuel pins (gap fractions) or the impact of higher burnups on these parameters. Will the licensee be performing post-irradiation evaluations of fission product releases from the irradiated LTAs? If not, what verification will be performed to validate these assumptions, especially those related to (a) the extension of US experience with LEU fuels, and (b) the extension of European experience with reactor-grade MOX, to the proposed weapons-grade MOX?

3. Section 3.7.3 addresses the radiological consequences of postulated design basis accidents. The analysis descriptions provided are insufficient to support the requisite determination by the NRC staff. Please provide the following information for any radiological analysis that forms the basis for any result or conclusion stated in Sections 3.7.3, 4.2.1.3, and 5.6.3.1 in the submittal.

    a. A tabulation of analysis inputs and assumptions and their bases and justifications for Catawba or McGuire. Please provide this information in sufficient detail for the staff to perform confirmatory calculations.

    b. Provide the numeric results of the analyses discussed in Sections 3.7.3, 4.2.1.3, and 5.6.3.1 in terms of the whole body and thyroid dose quantities, or total effective dose equivalent (TEDE), as appropriate to the licensing basis of Catawba and McGuire. Include offsite and control room doses.

c. If the analyses utilized atmospheric dispersion coefficients (χ/Q) that were generated in support of this amendment request, please describe the assessment method used and provide all inputs and assumptions used in the assessment. Please provide a computer readable copy (e.g., CD) of site meteorological data used in the assessment.

d. Provide the requested information item 1(a) of Generic Letter 2003-01, “Control Room Habitability.” Please note that the response to this particular question does not relieve the licensee of the responsibility of responding to Generic Letter 2003-01.

e. If the analyses used methods, inputs, or assumptions different from that in the current licensing basis (CLB) for Catawba or McGuire, provide a justification for each change from the CLB.

f. Please provide a tabulation of the isotopic core inventory, in Curies (Ci) or micro-Curies (uCi). Please identify the computer code used to determine these values. Please explain the derivation of the fuel-specific code libraries used in this assessment. If LEU libraries were used, please provide a scrutable justification of why the results should be considered applicable to the proposed MOX LTAs.

g. The CLB fuel handling and weir gate accidents at Catawba are based on the alternative source term and were performed in accordance with the guidance of Regulatory Guide 1.183, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors.” Footnote 10 on Page 1.183-13 states that “The [source term] data in this section may not be applicable to cores containing mixed oxide (MOX) fuel.” Also, section 3.5.1.1 of the submittal refers to additional fission gas release from MOX fuel. Please provide a scrutable justification for the continued use of the gap fractions in Table 3 with the proposed MOX LTAs. Best-estimate data developed for use in environmental assessments are generally not acceptable in design basis safety evaluations.

h. The CLB fuel handling accident at McGuire is based on the guidance of Regulatory Guide 1.25, “Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors.” Footnote 1 on page 25.2 of the guide states that the assumptions given in the guide are valid only for oxide fuels of the types currently in use. Also, Section 3.5.1.1 of your submittal refers to additional fission gas release from MOX fuel. Please provide a scrutable justification for the continued use of the gap fractions specified in Regulatory Position C.2.d of Regulatory Guide 1.25 with the proposed MOX LTAs. Best-estimate data developed for use in environmental assessments are generally not acceptable in design basis safety evaluations.

i. Section 3.5.1.1 of the submittal refers to additional fission gas release from MOX fuel. Please explain the impact of this increased fission gas production and associated increase in fuel pin pressures on the iodine decontamination factors

provided in Regulatory Guides 1.25 and 1.183 that are predicated on gas pressures less than 1200 psig.

j. The licensee's November 25, 2002, submittal on a full scope alternative source term (AST) at Catawba, currently under NRC staff review, does not address the proposed MOX LTAs. The MOX LTA amendment analyses do not address AST and TEDE. Please explain how these differences are planned to be resolved, and comparable differences for any other proposed license amendments for Catawba or McGuire that are currently pending.

4. The NRC staff has a concern regarding whether the radiological analyses described in the submittal of February 27, 2003, are consistent with the respective licensing bases of Catawba and McGuire. This is a concern since the licensee has stated that the results for Catawba provide a basis for concluding that the doses at McGuire would also be acceptable. Please resolve the apparent discrepancies discussed below in a manner that is consistent with the licensing bases at both sites and that provides a clear understanding of what the licensing basis will be following implementation of this amendment.

a. On Page 3-34 of Attachment 3 of the submittal, the first paragraph states that

> The analyses were conducted in accordance with the regulatory positions of Regulatory Guide 1.25 and the guidelines in Standard Review Plans (SRPs) 15.7.4, 9.4.1, and 9.4.2.

By letter dated December 20, 2001, the licensee requested an amendment for Catawba that would selectively replace the TID14844 source term used in the fuel handling and weir gate accidents with an alternative source term and replace the previous whole body, skin, and thyroid doses with TEDE. As such , the current licensing basis at Catawba includes AST and TEDE and RG 1.183 (as they apply to fuel handling and weir gate accidents). However, the analyses results in this section are reported in terms of whole body, skin, and thyroid, which, while consistent with the licensing basis for McGuire, are inconsistent with the licensing basis for Catawba.

b. Similarly, the dose results for the new accident analyses addressed in section 3.7.3.5 are expressed in terms of TEDE. The licensee has not requested the use of AST and TEDE for McGuire pursuant to 10 CFR 50.67. The licensee re-analyzed the postulated fuel handling and weir gate events in support of its December 20, 2001, application for changes to certain refueling mode technical specifications at Catawba, based on a selective implementation of the AST. That application was the subject of amendment numbers 198 and 191 to the Catawba, Units 1 and 2 operating licenses, as issued on April 23, 2002.

The NRC staff's position is that, unless it is authorized pursuant to 10 CFR 50.67, the TEDE dose quantity cannot be used for demonstrating compliance with Part 50 requirements.

Environmental Impacts of the Proposed Action

In sections 5.6.1, “Plants Effluents,” and 5.6.2, “Impacts to Human Health,” it is concluded that there are "... no anticipated changes in the types or amounts of plant effluents resulting from the use of the four MOX fuel lead assemblies," and that "Plant releases will comply with all regulatory limits with MOX fuel lead assemblies in the reactor, such that there will be no impact on public health and safety."

Please provide a technical basis to support the conclusion that your plant process systems can handle the MOX fuel and that radiological effluents will remain within regulatory limits.

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Catawba Nuclear Station

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