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CNS-15-078

November 16, 2015

10 CFR 50.90

U. S. Nuclear Regulatory Commission (NRC)
Attention: Document Control Desk
Washington, D. C. 20555-0001

Subject: Duke Energy Carolinas, LLC (Duke Energy)
Catawba Nuclear Station, Units 1 and 2
Docket Numbers 50-413 and 50-414
License Amendment Request (LAR) for Measurement Uncertainty Recapture (MUR) Power Uprate
Response to NRC Requests for Additional Information (RAIs)
(TAC Nos. MF4526 and MF4527)

References:
1. Letters from Duke Energy to NRC, dated June 23, 2014 (ADAMS Accession Number ML14176A109), August 26, 2014 (ADAMS Accession Number ML14245A059), December 15, 2014 (ADAMS Accession Number ML14353A027), January 22, 2015 (ADAMS Accession Number ML15029A417), and April 23, 2015 (ADAMS Accession Number ML15117A011)
2. Letters from NRC to Duke Energy, dated November 4, 2014 (ADAMS Accession Number ML14303A279), November 26, 2014 (ADAMS Accession Number ML14325A667), February 9, 2015 (ADAMS Accession Number ML15030A460), and August 13, 2015 (ADAMS Accession Number ML15201A512)

The Reference 1 letters submitted and supplemented a LAR for the Renewed Facility Operating Licenses (FOLs) for Catawba Nuclear Station (CNS) Units 1 and 2 NPF-35 and NPF-52 and the subject Technical Specifications (TS) to support a MUR power uprate for Catawba Unit 1. The Reference 2 letters transmitted four sets of RAI questions from the NRC associated with the LAR.

The purpose of this letter is to formally respond to the RAI questions contained in the August 13, 2015 Reference 2 letter. The attachment to this letter constitutes Duke Energy's response to this RAI. The format of the attachment is to re-state each RAI question, followed by its associated response.

A001
NRR

The conclusions of the original Regulatory Evaluation and Environmental Consideration are unaffected as a result of this RAI response.

There is one regulatory commitment associated with the response to RAI question EEEB 8 contained in this letter as indicated below:

The affected Unit 1 Annulus penetrations will be remediated by filling the penetrations with lead wool and/or brick, or other shielding material as determined appropriate, prior to implementation of the MUR power uprate.

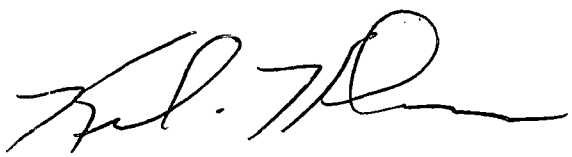
Pursuant to 10 CFR 50.91, a copy of this amendment request supplement is being sent to the designated official of the State of South Carolina.

Inquiries on this matter should be directed to L. J. Rudy of Catawba Regulatory Affairs at (803) 701-3084.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on November 16, 2015.

Very truly yours,



Kelvin Henderson
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LJR/s

Attachment

xc (with attachment):

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Attachment

Response to NRC Requests for Additional Information (RAIs)

REQUEST FOR ADDITIONAL INFORMATION

LICENSE AMENDMENT REQUEST TO SUPPORT THE

MEASUREMENT UNCERTAINTY RECAPTURE POWER UPRATE

DUKE ENERGY CAROLINAS, LLC

CATAWBA NUCLEAR STATION, UNITS 1 AND 2

DOCKET NOS. 50-413 AND 50-414

TAC NOS. MF4526 AND MF4527

By letter dated June 23, 2014, Duke Energy Carolinas, LLC, the licensee for Catawba Nuclear Station, Units 1 and 2 (Catawba), requested a measurement uncertainty recapture (MUR) power uprate (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14176A109). The proposed revision would increase the Catawba, Unit 1, authorized core power level from 3411 megawatts thermal (MWt) to 3469 MWt, an increase of 1.7 percent rated thermal power (RTP).

Based on the review of the amendment request, the NRC staff has determined that additional information is required regarding the MUR power uprate.

Reactor Systems Branch (SRXB) - RAI 8

SRXB - RAI 11

The basis of review for RAPTOR-M3G is Regulatory Guide (RG) 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence." RG 1.190 intends to ensure the accuracy and reliability of the neutron fluence determination required by General Design Criteria (GDC) related to the reactor coolant pressure boundary. RG 1.190 describes methods and assumptions acceptable to the NRC staff for determining the pressure vessel neutron fluence. RG 1.190 specifies that the neutron transport methods should be benchmarked to a statistically significant data base of measurement-to-calculation ratios (M/C) and that an overall neutron fluence bias and uncertainty be estimated. The NRC staff requests that the licensee provide an explanation for how RAPTOR-M3G satisfies this portion of RG 1.190.

Duke Energy Response:

Refer to enclosed WCAP-18060-NP, "*Response to RAIs Concerning the Use of RAPTOR-M3G for the Catawba Unit 1 Measurement Uncertainty Recapture (MUR) Power Uprate Fluence Evaluations*".

SRXB - RAI 12

In Section IV.1.C.ii of the application, the licensee states that Westinghouse has evaluated the latest-available ENDF/B-VII-based cross-section data contained in the BUGLE-B7 library and the results of this evaluation indicate no significant differences between the results of analyses performed using two different cross-section data. This evaluation can be found in Appendix B of WCAP-16083-NP, Revision 1, "Benchmark Testing of the FERRET Code for Least Squares Evaluation of Light Water Reactor Dosimetry," dated April 2013. Appendix B in WCAP-16083-NP, Revision 1, discusses the evaluation of the two cross-section sets by Oak Ridge National Laboratory for applications related to fluence. However, the Westinghouse evaluation only refers to work related to low-energy neutrons. There is an apparent conflict between statements made in the application and Appendix B of WCAP-16083-NP, Revision 1, with respect to the Westinghouse evaluation of two multi-group cross section libraries. The NRC staff requests that the licensee clarify the statements or provide a revision of the relevant paragraph in Section IV.1.C.ii of the application and/or Appendix B of WCAP-16083-NP, Revision 1.

Duke Energy Response:

Refer to enclosed WCAP-18060-NP, "*Response to RAIs Concerning the Use of RAPTOR-M3G for the Catawba Unit 1 Measurement Uncertainty Recapture (MUR) Power Uprate Fluence Evaluations".*

SRXB - RAI 13

The use of S_8 angular quadrature is generally acceptable according to RG 1.190. However, RG 1.190 states that when off-midplane locations are analyzed, the adequacy of the S_8 quadrature to determine the streaming component must be demonstrated with higher-order S_n calculations. It is noted for Catawba, Unit 1, that one of the limiting locations is near the extended beltline. The analysis of Catawba, Unit 1, for the MUR includes an angular discretization "modeled with an S_8 order of angular quadrature or higher." Since some of the locations of interest are on the extended beltline, it must be shown that the angular quadrature for those calculations is adequate. The NRC staff requests that the licensee provide the angular quadrature used for the locations that are off-midplane. Additionally, the NRC staff requests that the licensee provide a justification for the angular quadrature.

Duke Energy Response:

Refer to enclosed WCAP-18060-NP, "*Response to RAIs Concerning the Use of RAPTOR-M3G for the Catawba Unit 1 Measurement Uncertainty Recapture (MUR) Power Uprate Fluence Evaluations".*

SRXB - RAI 14

RG 1.190 requires that the neutron fluence methodology be qualified, and flux uncertainty estimates be determined. One component of the uncertainty is from the analytical sensitivity studies. The important sources of "analytical uncertainty" are listed in RG 1.190, Section 1.4.1, "Analytic Uncertainty Analysis." The analytical sensitivity studies using RAPTOR-M3G are important in determining the overall uncertainty in neutron fluence calculations. The NRC staff requests that the licensee provide justification for the parameters that are important to

performing neutron fluence analysis. Additionally, the NRC staff requests that the licensee provide the resulting uncertainties for each parameter and all parameters combined.

Duke Energy Response:

Refer to enclosed WCAP-18060-NP, "*Response to RAIs Concerning the Use of RAPTOR-M3G for the Catawba Unit 1 Measurement Uncertainty Recapture (MUR) Power Uprate Fluence Evaluations".*

SRXB - RAI 15

The Pool Critical Assembly (PCA) benchmark is a full-scale section mockup of a pressure vessel with dosimetry measurements at the inner surface of the pressure vessel, and at locations within the pressure vessel wall. The PCA benchmark is one of the three suggested RG 1.190 benchmarks for pressure vessel simulator measurements. The PCA benchmark has been calculated using both TORT and RAPTOR-M3G with identical assumptions and the codes produced identical results. The spatial differencing in RAPTOR-M3G can be performed using either theta-weighted (TW) or directional theta-weighted (DTW) options. For the direct comparisons with TORT, the TW option is used in RAPTOR-M3G as TORT does not have the DTW option. The DTW is the normal option used in the Catawba neutron fluence analysis using RAPTOR-M3G. In order to determine the M/C ratios based on the PCA measurements, RAPTOR-M3G should be used with the DTW option. The NRC staff requests that the licensee provide RAPTOR-M3G results for the PCA benchmark, as part of the code validation, using the same modeling assumptions used for the Catawba neutron fluence calculations.

Duke Energy Response:

Refer to enclosed WCAP-18060-NP, "*Response to RAIs Concerning the Use of RAPTOR-M3G for the Catawba Unit 1 Measurement Uncertainty Recapture (MUR) Power Uprate Fluence Evaluations".*

SRXB - RAI 16

The analysis of the H.B. Robinson benchmark using RAPTOR-M3G is provided in Appendix A of WCAP-16083-NP, Revision 1. The analysis is performed using P_5 expansion of the scattering kernel and an S_{12} angular quadrature as compared to P_3 and S_8 quadratures used in the Catawba neutron fluence analysis. In Section A.2 of WCAP-16083-NP, Revision 1, it is stated that the results in Appendix A made no attempt to address power redistribution effects over the course of the fuel cycle when calculating measured reaction rates at saturation, whereas the results presented in Section 3.3 did consider power redistribution. The analysis of the benchmark is atypical, although there is good agreement with the data. The NRC staff requests that the licensee provide the results for the H.B. Robinson benchmark using the standard methodology used for the Catawba neutron fluence analysis for qualification of RAPTOR-M3G.

Duke Energy Response:

Refer to enclosed WCAP-18060-NP, *"Response to RAIs Concerning the Use of RAPTOR-M3G for the Catawba Unit 1 Measurement Uncertainty Recapture (MUR) Power Uprate Fluence Evaluations".*

SRXB - RAI 17

The comparisons of RAPTOR-M3G calculations with capsule data are discussed in Appendix A of WCAP-16083-NP, Revision 1, and in Appendix C of WCAP-17669-NP, Revision 0, "Catawba Unit 1 Measurement Uncertainty Recapture (MUR) Power Uprate: Reactor Vessel Integrity and Neutron Fluence Evaluations," dated June 2013 (ML14353A029). A requirement of RG 1.190 is that the uncertainty and bias in the neutron fluence calculations be assessed based on three components: surveillance measurements, benchmarks, and analytical sensitivity studies.

a) The NRC staff requests that the licensee provide an explanation for how each component of uncertainty will be weighted to arrive at the uncertainty and bias for fast neutron fluence at the limiting vessel locations.

   Duke Energy Response:

   Refer to enclosed WCAP-18060-NP, *"Response to RAIs Concerning the Use of RAPTOR-M3G for the Catawba Unit 1 Measurement Uncertainty Recapture (MUR) Power Uprate Fluence Evaluations".*

b) The component of uncertainty and bias from comparisons of calculations with surveillance capsule data should be from a statistically significant number of measurements. The NRC staff requests that the licensee provide a justification of the use of the database, used to assess RAPTOR-M3G, based on its statistical significance.

   Duke Energy Response:

   Refer to enclosed WCAP-18060-NP, *"Response to RAIs Concerning the Use of RAPTOR-M3G for the Catawba Unit 1 Measurement Uncertainty Recapture (MUR) Power Uprate Fluence Evaluations".*

Electrical Engineering Branch (EEEB) - RAI 8

In Duke Energy's RAI response dated January 22, 2015 for EEEB RAI 6, it stated that "Locations on Elevation 560' were existing EQ HARSH zones due to the overall Total Integrated Dose (TID) with identified EQ equipment. Locations on Elevations 577' and 594' were existing EQ MILD zones that were projected to transition to EQ HARSH dose levels due to this issue."

Please confirm that the replacement of additional lead shielding in the affected equipment areas would transition the locations on Elevations 577' and 594' back from EQ Harsh to EQ Mild. In addition, please verify that with the addition of lead shielding on the Annulus Penetrations on Unit 1, locations on Elevations 577' and 594' will be within the TID values listed in the Catawba EQCM and are qualified for pre-MUR and post-MUR power uprate conditions.

Duke Energy Response:

Duke Energy stated in the April 23, 2015 RAI response for EEEB RAI 6 that "Based on the revised dose calculations and equipment evaluations, Catawba is pursuing the re-establishment of the appropriate lead shielding in the identified Annulus penetrations to restore the dose levels in the locations to values consistent with those currently listed in the Catawba EQCM."

Duke Energy had originally communicated to the NRC that Catawba would remediate the affected Unit 1 Annulus penetrations in the Fall 2015 Refueling Outage. However, due to outage scheduling and resource limitations, Duke Energy has elected to revise its plans and schedule relative to this effort. As a result, Duke Energy is hereby making the following regulatory commitment:

"The affected Unit 1 Annulus penetrations will be remediated by filling the penetrations with lead wool and/or brick, or other shielding material as determined appropriate, prior to implementation of the MUR power uprate."

When the identified penetrations in the Unit 1 reactor building are filled with lead wool and/or brick, or other shielding material as determined appropriate, to provide shielding equivalent to that of the reactor building concrete wall, the areas around these penetrations on the 577' and 594' elevations will be restored to an EQ Mild radiation environment. After the Unit 1 Annulus penetrations are appropriately filled, the calculated Total Integrated Doses (TIDs) for these areas will be within the current Auxiliary Building TID values in Tables 5.0-2 and 5.0-3 of the Catawba EQCM for their associated Radiation Zones (990 Rads). Because the penetration dose evaluation considered an uprated reactor power, the restoration of these areas to EQ Mild would apply for both pre- and post-MUR conditions.