UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 17, 2016

LICENSEE: Duke Energy Progress, LLC

FACILITIES: Shearon Harris Nuclear Power Plant, Unit 1

H. B. Robinson Steam Electric Plant Unit No. 2

SUBJECT: SUMMARY OF THE JULY 12 - 13, 2016 AUDIT SUPPORTING THE U.S. NUCLEAR REGULATORY COMMISSION REVIEW OF DPC-NE-1008-P, "NUCLEAR DESIGN METHODOLOGY USING CASMO-5/SIMULATE-3 FOR WESTINGHOUSE REACTORS" (CAC NOS. MF6648 AND MF6649)

By letter dated August 19, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15236A044), Duke Energy Progress, LLC (Duke Energy), the licensee for Shearon Harris Nuclear Power Plant, Unit 1 (Harris), and H.B. Robinson Steam Electric Plant, Unit 2 (Robinson), submitted a license amendment request (LAR) for the U.S. Nuclear Regulatory Commission (NRC) review and approval of methodology report DPC-NE-1008-P, Revision 0, "Nuclear Design Methodology Using CASMO-5/SIMULATE-3 for Westinghouse Reactors," and adoption of this methodology into the Harris and Robinson Technical Specification (TS) lists of Core Operating Limits Report references. The proposed TS revisions and methodology report would allow Duke Energy to perform reactor physics calculations as part of the core reload design process at Harris and Robinson, replacing the analyses currently performed by the fuel vendor. The purpose of the enclosed audit summary is to document the results of the audit performed July 12 - 13, 2016, associated with this LAR.

The NRC staff determined an audit would be the most effective approach to, (1) review nondocketed information associated with the DPC-NE-1008-P and (2) establish an understanding of the additional docketed information needed to allow the NRC staff to issue a clear request for information and for the licensee to provide quality and timely responses. The audit was held at the licensee's offices in Charlotte, North Carolina. The audit plan dated June 24, 2016, is available in ADAMS under Accession No. ML16180A098.

Please direct any inquiries to me at (301) 415-2760 or Martha.Barillas@nrc.gov.

Sincerely,

Martha Barillas, Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-261 and 50-400

Enclosure:
Audit Summary

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SUMMARY OF REGULATORY AUDIT SUPPORTING

U.S. NUCLEAR REGULATORY COMMISSION REVIEW OF DPC-NE-1008-P,

"NUCLEAR DESIGN METHODOLOGY USING

CASMO-5/SIMULATE-3 FOR WESTINGHOUSE REACTORS"

CAC NOS. MF6648 AND MF6649

1.0 BACKGROUND

By letter dated August 19, 2015[1], Duke Energy Progress, LLC (Duke Energy), the licensee for Shearon Harris Nuclear Power Plant, Unit 1 (Harris), and H.B. Robinson Steam Electric Plant, Unit 2 (Robinson), requested changes to the Harris and Robinson Technical Specifications (TSs). Specifically, Duke Energy requested U.S. Nuclear Regulatory Commission (NRC) review and approval of methodology report DPC-NE-1008-P, Revision 0, "Nuclear Design Methodology Using CASMO-5/SIMULATE-3 for Westinghouse Reactors,"[2] and adoption of this methodology into the TS lists of Core Operating Limits Report references in Robinson TS 5.6.5.b and Harris TS 6.9.1.6.2. The proposed TS revisions and methodology report would allow Duke Energy to perform reactor physics calculations as part of the core reload design process at Harris and Robinson, replacing the analyses currently performed by the fuel vendor.

The NRC staff performed a regulatory audit in an effort to increase review efficiency by helping the NRC staff better understand the DPC-NE-1008-P methodology as well as the CASMO-5 nuclear fuel lattice physics code, and the previously-approved SIMULATE-3 core simulator code.

2.0 SCOPE AND PURPOSE

The audit was held on July 12 and 13, 2016, at Duke Energy's office in Charlotte, NC, and was conducted in accordance with the audit plan provided to the licensee.[3] Specifically, the NRC staff discussed the following topics with Duke Energy staff:

- Details of CASMO-5 models
- Preparation of CASMO-5 inputs
- CASMO-5 interface with SIMULATE-3
- Benchmarks provided in DPC-NE-1008-P for both CASMO-5 alone and the combined CASMO-5/SIMULATE-3 code system
- Calculation of biases and uncertainties for CASMO-5/SIMULATE-3 at Harris, Robinson, and McGuire Nuclear Station (McGuire).

The following NRC staff members participated in the audit:

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[1] Agencywide Documents Access and Management System (ADAMS) Accession No. ML15236A044.
[2] ADAMS Accession No. ML15236A044.
[3] ADAMS Accession No. ML16180A098.

- Reed Anzalone – Lead Technical Reviewer
- Daniel Beacon – Technical Reviewer
- Martha Barillas – Project Manager

The following Duke Energy staff members and vendor participated in the audit:

- Joshua Duc – Duke Energy
- David Bortz – Duke Energy
- Robert Harvey – Duke Energy
- Matthew Rybenski – Duke Energy
- Mike Ferrer – Studsvik, code vendor for CASMO-5 and SIMULATE-3

3.0 AUDIT SUMMARY

At the beginning of the audit, Duke Energy provided a presentation that gave a brief overview of the DPC-NE-1008-P methodology, the differences between the approved CASMO-4 code (which is used in previous Duke neutronics analysis methodologies) and CASMO-5, and the interface between CASMO-5 and SIMULATE-3. Duke Energy also provided a brief discussion of the DPC-NE-1008-P methodology report; the CASMO-5 theory manual and validation report; and a variety of calculation notes supporting the benchmarking and bias/uncertainty calculations for Harris, Robinson, and McGuire.

Topics discussed during the audit, specifically related to the CASMO-5 nuclear physics code, included thermal expansion calculations, nuclear data manipulation and adjustment, reflector and spacer grid modeling, and detailed solution techniques. Duke Energy staff provided clarification on CASMO-5 code capabilities and how Duke Energy plans to use the CASMO-5 code in the proposed license amendment request (LAR) for Harris and Robinson. Duke Energy also provided clarification on the models used when the CASMO-5 code provides inputs to the SIMULATE-3 code. The NRC staff had several questions on specific modeling details of CASMO-5 that were referred to Studsvik. A representative from Studsvik was able to provide answers to the NRC staff's questions and no open items resulted from this portion of the audit.

The NRC staff reviewed the CASMO-5 user's manual and the calculations that supported the benchmarking analysis provided in DPC-NE-1008-P. Duke also provided calculation notes that presented the model setup and initialization. The NRC staff reviewed DPC-1553.05-00-0238, "CASMO-5/SIMULATE-3 Model Setup for Harris Unit 1 Cycles 13 through 18," which discussed the core modeling for Harris. Duke explained that analysts are only allowed to make certain changes to the core model, such as selecting fuel lattice designs from a pre-selected list.

The critical boron concentration and control rod worth calculations were discussed in:

- DPC-1553.05-00-0243, "CASMO-5/SIMULATE-3 Harris Reactivity Benchmark"
- DPC-1553.05-00-0245, "Robinson Unit 2 CASMO5/SIMULATE-3 Reactivity Benchmark"

In discussions with Duke Energy, the NRC staff requested clarification on the CASMO-5/SIMULATE-3 code system's ability to predict critical boron concentration, since critical boron varied significantly from plant to plant and was dependent on each plant's core

burnup. Duke clarified that burnup-dependent biases are independently calculated for each plant using the CASMO-5/SIMULATE-3 methodology. The NRC staff will follow up with a request for additional information (RAI) that will supplement Duke Energy's LAR on this topic in order for the staff to reach a regulatory conclusion.

The NRC staff also reviewed the power distribution calculations supporting the development of Observed Nuclear Reliability Factors (ONRFs) in DPC-NE-1008-P, which were provided in the following documents:

- DPC-1553.05-00-0247, "CASMO-5/SIMULATE-3 Harris Power Distribution Uncertainty Factors"
- DPC-1553.05-00-0248, "Robinson Unit 2 CASMO5/SIMULATE-3 Power Distributions"
- DPC-1553.05-00-0249, "CASMO-5/SIMULATE-3 McGuire Unit 1 Benchmark"

The NRC staff also reviewed the simulation of the Babcock and Wilcox (B&W) critical experiments, which were provided in DPC-1553.05-00-242, "B&W Critical Experiment and MxN Comparisons for CASMO5/SIMULATE-3."

Duke Energy provided a presentation on the overall core design process, and discussed how the methodology under review fit into that process. NRC staff discussed with the licensee about how peaking factors are calculated and how power distribution limits are developed and applied during operation.

The NRC staff walked through DPC-NE-1008-P to discuss a variety of questions and the staff's overall understanding of the methodology. The NRC staff asked what changes Duke considers to be acceptable under Title 10 of the *Code of Federal Regulations,* Part 50, Section 59, without further NRC review. Duke Energy explained that while it is unlikely that uncertainties would need to be changed over time, biases may need to be modified. These parameters are convoluted into a single statistically combined uncertainty factor (SCUF) that is used in safety analyses. Duke Energy's intent for the methodology is that SCUFs greater than those approved in the methodology report may be used without further NRC review. However, SCUFs that are smaller than those provided in the methodology report would require NRC review before they could be implemented in safety analyses. Duke Energy also stated that smaller biases or uncertainties would be considered acceptable and could be used without NRC review if the overall SCUF were limited to be greater than or equal to the equivalent value approved in the methodology report.

The NRC staff also asked about how multi-assembly CASMO-5 calculations would be used in licensing applications. Duke Energy explained that the CASMO-5 calculations would be used in assessing peaking penalties in reconstituted fuel assemblies and other special studies. The NRC staff also discussed with the licensee, (1) fuel temperature inputs and their relationship with thermal conductivity degradation, (2) critical boron calculations and the biases Duke Energy developed, (3) isothermal temperature coefficient measurements, (4) control rod worth measurements, and (5) the statistical techniques used to calculate the ONRFs and SCUFs.

4.0 CONCLUSION

The NRC staff found that the audit provided a better understanding of the licensee's CASMO-5/SIMULATE-3-based neutronics analysis methodology and how this methodology fits into the overall framework of Duke's reload core design process. NRC staff also gained a better understanding of the CASMO-5 code and its models and capabilities, as well as how Duke Energy plans to use the CASMO-5 code within the DPC-NE-1008-P methodology. The NRC staff is currently in the process of developing draft RAIs for the review.

Please direct any inquiries to me at (301) 415-2760 or Martha.Barillas@nrc.gov.

Sincerely,

/RA/

Martha Barillas, Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-261 and 50-400

Enclosure:
Audit Summary

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ADAMS Accession No.: PKG: ML16235A246; Summary: ML16235A238 *by memo

OFFICE	NRR/DORL/LPLII-2/PM	NRR/DORL/LPLII-2/LA	NRR/DSS/SNPB/BC*
NAME	MBarillas	BClayton	JDean
DATE	10/07/2016	9/30/2016	7/28/2016
OFFICE	NRR/DORL/LPLII-2/BC	NRR/DORL/LPLII-2/PM	
NAME	JDion	MBarillas	
DATE	10/17/2016	10/17/2016	

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