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December 2, 2003

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

Subject: Catawba Nuclear Station Units 1 and 2; Docket Nos. 50-413, 50-414
McGuire Nuclear Station Units 1 and 2; Docket Nos. 50-369, 50-370
Additional Information Related to Duke Topical Report DPC-NE-1005P, *Nuclear Design Methodology Using CASMO-4/SIMULATE-3 MOX* (TAC Nos. MB2578, MB2579, MB2726 and MB2729)

The Nuclear Regulatory Commission (NRC) is currently reviewing the Duke Power (Duke) Topical Report DPC-NE-1005P (Reference 1), which among other things addresses the application of the CASMO-4, SIMULATE-3 MOX, and SIMULATE-3K MOX computer codes to dynamic rod worth measurement (DRWM) at the McGuire and Catawba Nuclear Stations. In a telephone conversation on November 10, 2003, NRC personnel noted that, in a few instances, Duke DRWM calculations differed from Westinghouse DRWM predictions by an amount greater than the acceptance criteria for such comparisons. NRC requested that Duke provide an explanation for the deviations. The explanation is provided in the attached write-up.

If you have any questions regarding this matter, please contact G. A. Copp at (704) 373-5620.

Sincerely,

K. S. Canady

Attachment

A001

cc: L. A. Reyes, Regional Administrator, Region II
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Dynamic Rod Worth Measurement
Acceptance Criteria

The Nuclear Regulatory Commission (NRC) is currently reviewing the Duke Power (Duke) Topical Report DPC-NE-1005P (Reference 1), which among other things addresses the application of the CASMO-4, SIMULATE-3 MOX, and SIMULATE-3K MOX computer codes to dynamic rod worth measurement (DRWM) at the McGuire and Catawba Nuclear Stations. In Reference 2 Westinghouse proposed five criteria "... for a utility to use to demonstrate competencies to perform Dynamic Rod Worth Measurement (DRWM) design calculations." Criterion 4 addresses comparison calculations and states:

> Prior to the first application by a utility using their own methods to perform physics calculations in support of DRWM for LPPT, the utility will demonstrate its ability to use the methods supplied by Westinghouse by comparing its calculated results with the analyses and results obtained by Westinghouse during the first, or subsequent, application(s) of DRWM at the utility's plant.

In Reference 3 Westinghouse clarified Criterion 4. Among other things, Westinghouse noted that utility calculations exceeding the acceptable variation does not imply that the utility DRWM calculations are unacceptable. In such an instance the utility should report to the NRC the reasons for exceeding the acceptable deviations, and that "the review need not be complicated."

In Reference 4 the NRC transmitted to Westinghouse a Safety Evaluation Report (SER) for WCAP-13360 "Westinghouse Dynamic Rod Worth Measurement Technique" and related submittals with initial DRWM results. In the SER, the NRC accepted the provisions for technology transfer as described in References 2 and 3.

Original Duke DRWM Results

The Duke Power topical report DPC-NE-2012A (Reference 5) included benchmarks against Westinghouse DRWM calculations for six startups. The Duke calculations were performed using the CASMO-3, SIMULATE-3, and SIMULATE-3K computer codes. The report addressed the five acceptance criteria from Reference 2. Concerning Criterion 4, the difference between the Duke and Westinghouse results exceeded the individual rod bank worth criterion in 6 out of 108 instances. In the report, Duke explained that the bank worth differences are consistent with differences in predicted radial power distribution at hot zero power (HZP) between the Duke and Westinghouse methodologies. The NRC approved the Duke application of DRWM to McGuire and Catawba by the Reference 6 SER.

DPC-NE-1005P DRWM Results

Section 6 of Reference 1 includes new DRWM results for the same McGuire and Catawba cycles that were originally benchmarked in Reference 5. As noted above, the more recent Duke work used the CASMO-4, SIMULATE-3 MOX, and SIMULATE-3K MOX codes. As before, the Duke calculations showed good agreement with the Westinghouse results, especially when considering the independence of the underlying physics methods. In most but not all cases, Acceptance Criterion 4 was satisfied. Table 6.1 of Reference 1 shows the comparison between SIMULATE-3 MOX and Westinghouse predicted bank worths. The ± 2% or ± 25 pcm criterion were met in 116 of the 120 comparisons (54 predicted bank worths, 54 measured bank worths, six predicted total bank worths, and six measured total bank worths). The four comparisons that do not meet the criterion are:

- two predicted bank worths from McGuire 2, Cycle 13 (M2C13) (Banks CD and SA),
- one predicted bank worth from Catawba 1, Cycle 12 (C1C12) (Bank CD), and
- one total predicted bank worth (C1C11).

Individual Rod Bank Worths

The M2C13 and C1C12 predicted bank worth differences are slightly larger than the other cycle comparisons, although the magnitude of the differences is small and acceptable. No deficiencies were identified in either the Duke or Westinghouse nuclear models that explain the slightly larger power distribution and bank worth differences for those cycles. The differences are likely the result of code and methodology differences between SIMULATE and ANC (the Westinghouse nodal code). A review of the radial power distribution predictions showed slightly higher differences in the power distribution comparison for assemblies that operated near the periphery for more than one cycle. Both M2C13 and C1C12 contained more assemblies of these types, located at or near control rod locations, than the other benchmarked cycles. It is possible that the different spectral history treatments between ANC and SIMULATE are partially responsible for the larger differences in the predicted power distributions.

In all cases in which the acceptance criterion on differences in predicted individual bank worth were not met, Duke predicted a lower bank worth than Westinghouse. Furthermore, all measured individual bank worths easily met the acceptance criterion.

Total Worths of All Banks

The differences between the Duke and Westinghouse predicted total bank worths met the ± 2% criterion in all but one instance (five out of six predicted worths and six out of six measured worths met the criterion). The C1C11 core exceeded the criterion with a 2.2% difference in total predicted bank worth. A review of the Duke and Westinghouse C1C11 HZP radial power distribution predictions shows that the powers of many of the assemblies in peripheral region of the core were over predicted by Westinghouse, relative to the Duke predictions. More of the control banks are located near the periphery; this tends to emphasize the contribution of the peripheral assemblies to the calculation of the total bank worth. Therefore, the trend of Westinghouse's predicted total bank worth being slightly higher than the Duke prediction is consistent with the HZP radial power distribution differences.

For all six of the benchmark cores the Duke total bank worth predictions were lower than the Westinghouse total bank worth predictions, including the single case in which the total bank worth acceptance criterion was not met. Furthermore, all measured total bank worths easily met the acceptance criterion.

Conclusions

The trend in predicted bank worth deviations is consistent with the observed differences in the predicted redial Hot Zero Power (HZP) power distribution between Duke and Westinghouse. Relative to Westinghouse, Duke typically under predicts the relative power of assemblies located near the core periphery (assemblies containing banks SA, CD, SD, and SC), and over predicts the powers of assemblies near the core interior (assemblies containing banks CC, CA and SB). Duke typically predicts lower worths for banks SA, CD, SD and SC than Westinghouse due to differences in the radial power distribution.

The four deviations represent only a small deviation from an extremely tight criterion, and they are a very small percentage of the total benchmarking data. The slight differences observed are well within the expected range for a comparison of two independent core analysis methodologies.

The DRWM results with the Reference 1 methodology are very similar to the results obtained using the previously approved Westinghouse and Duke methodologies. Most importantly, the Duke and Westinghouse measured bank worths were in excellent agreement, with the largest difference between Duke and Westinghouse total measured bank worth for the six cycles being only 0.2%. This clearly demonstrates that Duke has implemented the DRWM analytical factor methodology consistent with the Westinghouse approved methodology.

References

1. DPC-NE-1005P, *Duke Power Nuclear Design Methodology Using CASMO-4/SIMULATE-3 MOX*, August 2001.
2. Letter, N. J. Liparulo (Westinghouse) to R. C. Jones (NRC), December 9, 1996.
3. Letter, N. J. Liparulo (Westinghouse) to R. C. Jones (NRC), October 2, 1997.
4. Letter, T. H. Essig, (NRC) to N. J. Liparulo (Westinghouse), July 30, 1998.
5. DPC-NE-2012A, *Dynamic Rod Worth Measurement Using CASMO/SIMULATE,* August 1999.
6. NRC Safety Evaluation Report on DPC-NE-2012A dated Febuary 15, 2000.