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U. S. Nuclear Regulatory Commission
Washington, D. D. 20555

Attention: Document Control Desk

Subject: McGuire Nuclear Station
Docket Numbers 50-369 and -370
Catawba Nuclear Station
Docket Numbers 50-413 and -414
Use of BWU-Z Correlation by Duke Power;
Supplemental Information

By letter dated April 26, 1996, Duke Power requested NRC approval for use of the BWU-Z correlation at its McGuire and Catawba nuclear stations. A supplement was provided by letter dated December 4, 1995. The December 4, 1996 letter (paragraph 4) stated that the better thermal performance of the fuel can be used to reduce cycle fuel costs. This is due to fact the licensed BWU-Z correlation conservatively quantifies the inherent thermal margin of the Mark-BW17 fuel. This margin can be used in fuel cycle analyses to raise peaking, thereby saving fuel costs. Additionally, the December 4, 1996 letter contained a typographical error in the last sentence of Paragraph 5. The references identified should be 5 and 6, not 6 and 7 as the letter stated.

During telcons on August 21 and 27, 1996, between the NRC staff and Duke, additional information/clarification was requested by the Staff. Attached are the questions and associated responses.

Note that upon approval of the new Appendix C (to topical report DPC-NE-2005), which was transmitted by the April 26, 1996 letter and contains the technical basis for the use of BWU-Z, the topical report will be republished, including the new Appendix C, as DPC-NE-2005, Revision 1.

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If there are any questions or additional information is required, please call Scott Gewehr at (704) 382-7581.

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Request for Additional Information To Topical Report DPC-NE-2005P, Appendix C

The questions are shown in italics and the responses immediately follow.

1) *What fuel type and core configuration are currently operating at McGuire and Catawba?*

McGuire and Catawba are both operating with a full (homogenous) core of Mark-BW17 fuel assemblies, also called Mark-BW 17x17. This will be the fuel type until a transition, beginning in the year 2000, to Westinghouse 17x17 mixing vane fuel. Transition to Westinghouse fuel will require licensing of a different critical heat flux correlation and corresponding statistical design limit applicable to that fuel type.

2) *Table C-1 lists the statistical results of the CHF test data base analysis with the VIPRE-01 thermal-hydraulic computer code. Explain the differences in values between this table and the table in BAW-10199P-A which documents the same data analysis with the LYNXT or LYNX 2 code.*

The information provided for the Mark-BW17 data base using the BWU-Z correlation on the top of page 4-3 in BAW-10199P-A shows the average M/P, Standard Deviation (corrected for N), and Design Limit DNBR (denoted DNBR(L)) for the test data when analyzed with LYNXT or LYNX 2. Table C-1 of the DPC-NE-2005 Appendix C is a direct comparison of the same analysis and the same test data with VIPRE-01 code. The VIPRE-01 code has a slightly higher average M/P and slightly lower standard deviation for the entire test data base when compared to LYNXT or LYNX 2. The combination of these two parameters gives the VIPRE-01 code a slightly lower Design Limit DNBR for the test data base.

The more conservative value for the parameter is selected by Duke Power Company (DPC) when performing an analyses. For example, the standard deviation listed in Table C-3 (DPC-NE-2005 Appendix C) for the correlation uncertainty is the higher of the LYNX and VIPRE-01 values rounded to two significant figures. The Design Limit DNBR calculated with VIPRE-01 is presented in Table C-1 for comparison only. The standard deviation is the only value that impacts the SCD calculation. If the BWU-Z form of the BWU correlation is used by DPC in non-SCD analyses, the larger of the two non-statistical correlation limits (the LYNX value listed on page 4-3 of BAW-10199P-A) will be used.

3) *Explain the method used to calculated the 500 and 5000 case statistical DNBR values for each statepoint and how the statistical limit is used.*

The method used to evaluated the BWU-Z form of the BWU correlation in Appendix C is identical to the procedure outlined in the main body of the DPC-NE-2005 report. This procedure is outlined starting in Section 2.0 on page 5. The key parameters listed in Section 2.1, page 6, are identical in Appendix C. The statepoints in Table C-2 of Appendix C were selected to bound the range of key parameters where the SCD analyses with BWU-Z will be applied.

The selection of uncertainties is discussed in Section 2.2, page 7, of DPC-NE-2005. Table C-3 lists the values used in the BWU-Z SCD analyses. These are identical to the values used in the BWCMV analysis (Appendix B of DPC-NE-2005) except for the correlation standard deviation (as explained in Question 2 above) and the FΔH measurement uncertainty which was increased slightly for the BWU-Z analysis.

The method for statepoint propagation is explained in Section 2.3, page 8, of DPC-NE-2005. The calculation of the statepoint statistical limit is explained in Section 2.4, page 9 through 11, of DPC-NE-2005. The equation for the SDL calculation is shown on page 10. Included in the equation are Chi Square and K factor multipliers to ensure a conservative limit based on the number of cases calculated. The mean and standard deviation values for a statepoint fluctuate slightly as the number of cases increase. Increasing the number of cases gives higher confidence that the data analyzed defines bounding behavior, therefore the multipliers are reduced. This ensures the SDL limit is equally conservative even though the final statistical DNBR value is smaller as the number of cases gets larger. An example of the way the values change with an increasing number of cases is shown on Table 1.

The main body of the report lists the number of cases as either 500 or 3000 per statepoint. The propagation method is identical regardless of the number of cases generated. In the response to Question 8 of Attachment II, Request For Additional Information, in DPC-NE-2005, DPC stated that the number of cases may be increased. This number was increased to 5000 for the BWU-Z analysis in Appendix C. As explained in the response to Question 8, this increase is consistent with the methodology and does not in any way reduce the conservatism of the SDL limit calculated.

The 5000 case number was selected as a balance between computer resources required for the calculations and the reduction in statistical uncertainty. For example, increasing the number of cases by two thirds from 3,000 to 5,000 reduces the K factor by 0.011 (from 1.692 at 3,000 to 1.681 at 5,000). Further increasing the number of cases to 10,000 would require another doubling of resources for the same K factor reduction (from 1.681 at 5000 to 1.670 at 10,000).

The 500 and 5000 case results for the BWU-Z analysis are listed in Table C-4 of Appendix C. As described in DPC-NE-2005, the 5000 case statepoints are selected based on the results of the 500 case statepoint propagations. The 5000 case runs are used to determine a conservative Statistical Design Limit (SDL) for the correlation SCD analyses. A value larger than the largest 5000 case statepoint statistical DNBR value is listed on page C-4. This is the statistical design limit that will be used in analyses with the BWU-Z form of the BWU correlation for Mark-BW fuel at McGuire and Catawba. The statistical design limit listed on page C-4 will be applicable to an analysis as long as all statepoint parameters fall between the Maximum and Minimum ranges listed on Table C-5.

TABLE 1

Statepoint 1 Values

Number Of Cases	Coefficient Of Variation*	Chi Square Multiplier	K Factor Multiplier	Statistical DNBR**
500	0.1514	1.05549	1.763	1.392
1000	0.1541	1.03848	1.727	1.382
1500	0.1528	1.03115	1.712	1.369
2000	0.1537	1.02684	1.703	1.368
2500	0.1534	1.02393	1.698	1.364
3000	0.1539	1.02179	1.692	1.363
3500	0.1538	1.02013	1.689	1.362
4000	0.1543	1.01880	1.686	1.361
4500	0.1540	1.01771	1.683	1.358
5000	0.1539	1.01681	1.681	1.357

*** Coefficient of Variation = Standard Deviation / Mean for the number of cases**

$$\textbf{**Statistical DNBR} = \frac{1}{[\,1 - \{(\text{Coeff. of Variation}) * (\text{Chi Square Mult.}) * (\text{K Factor Mult.})\}]}$$