March 23, 2004

Mr. James A. Gresham, Manager
Regulatory and Licensing Engineering
Westinghouse Electric Company
P.O. Box 355
Pittsburgh, PA 15230-0355

SUBJECT: DRAFT SAFETY EVALUATION FOR WCAP-14565-P-A, ADDENDUM 1, AND WCAP-15306-NP-A, ADDENDUM 1, "QUALIFICATION OF ABB CRITICAL HEAT FLUX CORRELATION WITH VIPRE-01 CODE" (TAC NO. MB9509)

Dear Mr. Gresham:

On June 4, 2003, Westinghouse Electric Company submitted topical reports (TRs) WCAP-14565-P-A, Addendum 1 and WCAP-15306-NP-A, Addendum 1, "Qualification of ABB Critical Heat Flux Correlations with VIPRE-01 Code," to the staff for review. Enclosed for Westinghouse's review and comment is a copy of the staff's draft safety evaluation (SE) for the TRs.

Pursuant to 10 CFR 2.390, we have determined that the enclosed SE does not contain proprietary information. However, we will delay placing the draft SE in the public document room for a period of ten working days from the date of this letter to provide you with the opportunity to comment on the proprietary aspects. If you believe that any information in the enclosure is proprietary, please identify such information line-by-line and define the basis pursuant to the criteria of 10 CFR 2.390. After ten working days, the draft SE will be made publicly available, and an additional ten working days are provided to you to comment on any factual errors or clarity concerns contained in the SE. The final SE will be issued after making any necessary changes and will be made publicly available. The staff's disposition of your comments on the draft SE will be discussed in the final SE.

To facilitate the staff's review of your comments, please provide a marked-up copy of the draft SE showing proposed changes. Number the lines in the marked-up SE sequentially and provide a summary table of the proposed changes.

If you have any questions, please contact Brian Benney at (301) 415-3764.

Sincerely,

/RA/

Stephen Dembek, Chief, Section 2
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 700

Enclosure: Draft Safety Evaluation

cc w/encl: See next page

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Stephen Dembek, Chief, Section 2
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Project No. 700

Enclosure: Draft Safety Evaluation

cc w/encl:
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DRAFT SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

TOPICAL REPORT WCAP-14565-P-A, ADDENDUM 1, AND WCAP-15306-NP-A,

ADDENDUM 1, "QUALIFICATION OF ABB CRITICAL HEAT FLUX

CORRELATION WITH VIPRE-01 CODE"

WESTINGHOUSE ELECTRIC COMPANY

PROJECT NO. 700

1.0 INTRODUCTION

By letter dated June 4, 2003, Westinghouse Electric Company LLC (Westinghouse) submitted topical reports (TRs) WCAP-14565-P, Addendum 1, and WCAP-15306-NP, Addendum 1, "Qualification of ABB Critical Heat Flux Correlations with VIPRE-01 Code," to the NRC for review and approval. The objective of this addendum to the approved TRs was to provide the information and data necessary to license the VIPRE-01 code incorporating the ABB critical heat flux (CHF) correlations (ABB-NV and ABB-TV) that have been previously licensed in CENPD-387-P-A for use with the TORC thermal-hydraulic code (CENPD-206-P-A). Thus, the ABB critical heat flux correlations are not new, but are being incorporated into the approved VIPRE-01 code with the same 95/95 correlation limit as licensed in TORC. The VIPRE-01 code was licensed by the NRC with the Westinghouse correlations WRB-1 and WRB-2. In WCAP-15025-P-A, the WRB-2M correlation was licensed and incorporated into VIPRE-01. The addition of the ABB CHF correlations into VIPRE-01 falls under the guidelines of Generic Letter (GL) 83-11, Supplement 1, "Licensee Qualification for Performing Safety Analyses," since neither the form of the correlation nor the 95/95 correlation limit are being changed.

2.0 REGULATORY EVALUATION

Section 34 of Title 10 of the Code of Federal Regulations (CFR) Chapter 50, "Contents of Applications; Technical Information," requires that Safety Analysis Reports be submitted that analyze the design and performance of structures, systems, and components provided for the prevention of accidents and the mitigation of the consequences of accidents. As part of the core reload design process, licensees (or vendors) perform reload safety evaluations to ensure that their safety analyses remain bounding for the design cycle. To confirm that the analyses remain bounding, licensees confirm that key inputs to the safety analyses (such as the CHF) are conservative with respect to the current design cycle. If key safety analysis parameters are not bounded, a re-analysis or a reevaluation of the affected transients or accidents is performed to ensure that the applicable acceptance criteria are satisfied.

There are no specific regulatory requirements for the review of TR revisions, supplements, or addendums. Guidance for TR reviews is provided in NRR Office Instruction LIC-500, Revision 2, "Processing Requests for Reviews of Topical Reports" and in LIC-101, "License Amendment

Review Process." The staff's review was based on the evaluation of the technical merit of the submittal and compliance with any applicable regulations associated with the TRs.

3.0 TECHNICAL EVALUATION

VIPRE-01 is a subchannel thermal-hydraulic computer code developed by Battelle Pacific Northwest Laboratories (PNL) under the sponsorship of the Electric Power Research Institute (EPRI). The basic computational model of VIPRE-01 comes from the PNL COBRA-IIIC code.

VIPRE-01 is typically used to describe the reactor core of a nuclear power plant in order to evaluate the thermal-hydraulic safety margin. The code requires that users enter the boundary conditions describing the coolant entering the core, the power generation, and the dimensional and material properties of the nuclear fuel. The boundary conditions for the coolant entering the core include either the inlet flow rate, enthalpy and pressure, or the pressure, inlet enthalpy and differential pressure from which the inlet flow rate can be derived. The core power generation input includes spatial as well as temporal variations. The code input is versatile and flexible, providing the user with numerous options. These include choices among correlations for heat and mass transfer that are built into the code. Multiple channels can be described and cross flow is calculated based on user supplied input.

The VIPRE-01 code was initially submitted for NRC staff review by the Utility Group for Regulatory Applications (UGRA) and was accepted for referencing in license applications to the extent specified and under the limitations delineated in the safety evaluation.

3.1 Use of VIPRE-01 by Westinghouse

Westinghouse intends to use the VIPRE-01 code as a replacement for the TORC code for departure from nucleate boiling (DNB) analyses of the Combustion Engineering (CE) pressurized-water reactor (PWR) fuels using the current NRC-approved methodology. The ABB CHF correlations will be used with the VIPRE-01 code for calculating the DNB ratio (DNBR), similar to the current applications with the TORC code. The DNB analyses include defining safety limits that provide the basis for reactor protection system setpoints and predicting minimum DNBR in non-LOCA transient analyses.

Westinghouse will apply the VIPRE-01 code with the ABB CHF correlations under the following conditions consistent with the requirements in the CENPD-387-P safety evaluation:

1. The 95/95 DNBR limits of the ABB-NV and ABB-TV correlations are not lower than the current NRC-approved limit of 1.13 for the CE-PWR fuels.

2. The ABB-NV and ABB-TV correlations are used with the VIPRE-01 code, in addition to the TORC and CETOP-D codes currently used for CE-PWRs. This addendum demonstrates the VIPRE-01 equivalency to TORC for DNBR calculations.

3. The ABB-NV and ABB-TV correlations are used with the optimized F_C shape factor to account for the effects of non-uniform axial power shapes.

4. The current range of applicability for the ABB-NV and ABB-TV correlations as shown in Table 2-1 of the TR remains applicable.

5. The ABB-NV and ABB-TV correlations are used only for CE-PWR fuel designs with NRC-approved methodology for PWR safety analysis.

6. Technology transfer is accomplished through a process that meets the guidance of GL 83-11, Supplement 1.

The events analyzed using VIPRE-01 will be the same as those presently analyzed using the TORC code, which have been approved by the NRC staff. The TORC code performs thermal-hydraulic calculations within the fuel channels, including DNBR evaluation at the fuel pin surface. For calculations in which transient heat conduction within the fuel pins is important, this calculation is performed by other codes.

3.2 VIPRE-01 Models

3.2.1 Modeling the ABB-NV and ABB-TV Correlations

Westinghouse performed VIPRE-01 calculations with the entire ABB-NV and ABB-TV experimental databases, consisting of test data for the correlation development and validation. Similar to the TORC code, VIPRE-01 was used for predicting local fluid condition at each axial node in each subchannel of a CHF test section. Local mass velocity and local quality are inputs to the ABB-NV and ABB-TV correlations for a CHF calculation. A VIPRE-01 model for each correlation was prepared in the same way as originally prepared in the TORC model for each test section based on the geometry and power distribution of the rod bundle. Representative VIPRE-01 geometric models for the CE 14x14 and 16x16 fuel designs are presented in the submittal of the TR. The VIPRE-01 turbulent mixing correlation is the same as that performed by the TORC correlation model.

The VIPRE-01 two-phase flow and crossflow correlations are kept the same as that for Westinghouse PWR applications in WCAP-14565-P-A. The VIPRE-01 versus TORC modeling results are summarized in tabular form in the TR. The VIPRE-01 calculations used the same measured values of pressure, inlet temperature, bundle average mass velocity and bundle average heat flux from the CHF tests as those used in the TORC calculations. The VIPRE/ABB-NV and VIPRE/ABB-TV results for both entire databases are listed in Appendix A and Appendix B, respectively of WCAP-14565-P-A.

3.2.2 Comparison of VIPRE-01 Results with TORC Results

The accuracy of CHF predictions is measured as the ratio of the measured CHF to the predicted CHF (M/P). Comparison results provided in the TR show mean and standard deviations of VIPRE/ABB-NV and VIPRE/ABB-TV M/P values for each test section for each of the points in the correlation database, the validation database, and the entire database, as compared to the TORC/ABB-NV and TORC/ABB-TV results. The VIPRE-01 based M/P value for each data point was determined at the same location in the hot subchannel as the TORC-based value in the TR. The comparisons show that the VIPRE/ABB-NV and VIPRE/ABB-TV M/P results are in good agreement with the original TORC values. A plot of

measured CHF versus VIPRE/ABB-NV and VIPRE/ABB-TV predicted CHF results are also included in the TR. Plotted results show no particular bias in the CHF predictions for either the VIPRE/ABB-NV or the VIPRE/ABB-TV M/P versus pressure, local mass velocity and local quality.

The number of VIPRE/ABB-NV data points within the correlation range for several test sections is slightly different from the TORC-based database due to differences in local fluid conditions predicted by the two codes. The overall VIPRE/ABB-NV database contained 718 data points, including an additional three data points that are within the applicable range of the ABB-NV correlation, as compared to 715 data points in the TORC/ABB-NV database. On the other hand, the overall VIPRE/ABB-TV database contained the same number of data points, 296, as the TORC/ABB-TV database in the applicable range of the ABB-TV correlation. The statistical tests described in Section 6.0 of the TR were applied to both VIPRE/ABB-NV and VIPRE/ABB-TV databases to determine the 95/95 DNBR limit for application of the ABB-NV and ABB-TV correlations with the VIPRE-01 code.

Based upon this analysis, the current 95/95 DNBR limit of 1.13 remains unchanged for both ABB-NV and ABB-TV application with the VIPRE-01 code. The overall M/P is slightly higher for the VIPRE/ABB-NV compared to the TORC/ABB-NV, resulting in an improvement in CHF performance. However, the standard deviation is slightly higher. The difference in the M/P statistics has a negligible impact on the 95/95 DNBR limit. The M/P CHF ratio corresponding to the 1.13 DNBR limit is 0.885 for both ABB-NV and ABB-TV correlations. For the entire VIPRE/ABB-NV database only nineteen data points fall below the value of 0.885, similar to the number of data points (18) in the TORC/ABB-NV database below the limiting value. Similarly, for the entire VIPRE/ABB-TV database, only 5 data points fall below the value of 0.885, the same as the number of data points in the TORC/ABB-TV database below the limiting value. These similar comparisons of the number of points below the limiting M/P value provides additional technical basis for using the same 95/95 DNBR limit of 1.13.

4.0 CONDITIONS AND LIMITATIONS

The NRC-approved ABB CHF correlations were developed based on the TORC code. The Westinghouse VIPRE-01 code and model have been approved by the NRC for PWR licensing applications. Coupling the ABB correlations with the VIPRE-01 code does not result in any change to the current NRC-approved methodology. This addendum demonstrates that VIPRE-01 is equivalent to TORC for ABB-NV and ABB-TV DNBR calculations under the following conditions:

1. Addendum 1 to the WCAP-14565-P-A VIPRE-01 model must remain consistent with that for the DNB data analysis described in WCAP-14565-P-A VIPRE-01;

2. The current 95/95 DNBR limit of 1.13 remains unchanged; and

3. DNBR calculations for CE-PWR fuels are within the current applicable range defined in Table 2-1 of the TR.

As such, the NRC staff finds the application of the ABB correlations within the VIPRE-01 code to be acceptable.

5.0 CONCLUSION

Based on the foregoing considerations, the NRC staff concludes that the implementation of the ABB-NV and ABB-TV correlations into the VIPRE-01 code as described in WCAP-14565-P-A, Addendum 1, and WCAP-15306-NP-A, Addendum 1, is acceptable for licensing calculations and may be used to replace the TORC computer code in the Westinghouse approved refueling methodology.

Principal Contributor: A. Attard

Date: