ENCLOSURE

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATING TO THE REVIEW OF TOPICAL REPORT TR-87

CORE THERMAL HYDRAULIC METHODOLOGY USING VIPRE/BWC FOR

THREE MILE ISLAND NUCLEAR STATION UNIT NO 1

DOCKET NO 50-289

1.0 INTRODUCTION

By letter dated April 25, 1995, GPU, the licensee for Three Mile Island, Unit 1 (TMI-1) submitted topical report TR-087, Revision 0, "TMI-1 core thermal-hydraulic Methodology Using the VIPRE-01 Computer Code," for staff review and approval. The topical report presents the methods for performing steady-state and transient thermal-hydraulic analyses of the nuclear reactor core for normal operating conditions and several accident conditions.

This topical report is GPU's demonstration of their ability to use the BWC rod bundle critical heat flux (CHF) correlation in conjunction with the VIPRE thermal-hydraulic subchannel computer code to determine the 95/95 thermal limit for Westinghouse fuel types.

VIPRE-01 is an open channel code designed to evaluate departure from nucleate boiling (DNB) and coolant state for steady state and transient core thermal-hydraulic analyses. The VIPRE-01 computer code was approved, by letter dated May 1, 1986, for licensing calculations for heat transfer scenarios up to CHF for pressurized water reactors.

BWC is a correlation that is used in conjunction with VIPRE to calculate the CHF. It is correlated as a function of local conditions, geometry, and power distribution. The BWC correlation was reviewed and approved by the staff by letter dated June 1, 1984.

Based on the acceptance SER for the VIPRE-1 code, the licensee is required to submit documentation describing how they intend to use VIPRE and provide justification for its specific modeling assumptions, choices of particular models and correlation, input values of plant-specific data such as turbulent mixing coefficient and grid loss coefficient. Generic Letter 83-11 requests that each licensee who intends to use large, complex computer codes to perform their own safety analyses demonstrate their proficiency to use the codes by submitting code verification performed by themselves. The staff has reviewed the licensee's submittal for compliance in the areas mentioned above.

2.0 EVALUATION

The BWC CHF correlation was originally developed for 17x17 Mark-C fuel and later justified for and 15x15 Zircaloy spacer grid Mark-BZ fuel by using the

LYNX2 computer code. The approval of the BWC required actual testing in which results of average conditions for pressure, power, flow and inlet enthalpy were reported for each point on the bundle. The rod and axial location of the observed DNB were also reported. The test data consisted of 211 points with the following ranges of conditions:

Table 1

Applicable Range of System Conditions for VIPRE-01/BWC	
Operational Parameters	**Applicable Range of Parameters**
Pressure (psia)	1600 to 2600
Mass Velocity ($Mlbm/hr-ft_2$)	0.43 to 3.8
Quality	-.20 to +0.26

In order for GPUN to prove their ability to correctly apply the VIPRE code for performing licensing calculations, they compared the VIPRE/BWC predictions with the actual test data. This analysis consisted of modelling the TMI core into the VIPRE and benchmarking the model against the CHF test data and vendor predictions, and the application of the VIPRE code to the thermal hydraulic design and setpoint determination.

Model Design and DNB Limit

The VIPRE model designed for the TMI-1 core consists of eighth-core symmetry and uses a detailed varying axial node length with one inch applied to the rod elevations where the minimum DNBR (MDNBR) is expected to occur. This nodalization was consistent with the nodalization GPU used in the LYNX analysis. The VIPRE-01 manual states as a general rule nodes should be 2 or 3 inches long in the region where MDNBR is likely to occur. GPUN performed a sensitivity study to verify that the model had sufficient detail to maintain accuracy and although the chosen node size of one inch requires more computer processing time and only a 0.1% difference in MDNBR, GPU maintained the detailed noding scheme to improve accuracy in relative power and pressure.

Once the model was established, the licensee verified the adequacy and their ability to use the model by comparing the model predictions with measurements. GPUN compared the VIPRE/BWC predictions with measured data and determined that the ratio of measured to predicted for all significant parameters indicated no bias. Based on the statistical method of Owen, GPUN determined the thermal limit that assured at least 95% of the population is protected with a confidence level of 95% that DNBR will not be exceeded. That design DNBR limit was determined to be 1.18.

Staff Assurance

By letter dated May 10, 1996, the staff requested additional information to verify that GPUN has (1) an adequate working knowledge of VIPRE-01 and (2) adequate administrative controls for notification and correction of code errors and use of the code within the acceptable range.

GPU response of June 3, 1996, outlined that in addition to their benchmarking abilities, GPU participated in the development of the VIPRE-01 code. This participation included their attendance at EPRI VIPRE-01 workshops and the presentation and discussion of VIPRE-01 analyses results at regular EPRI-sponsored working group meeting. GPU is also developing TMI-1 Fuel Standards which are application procedures conforming to the recommendation in the NRC Generic Letter GL 83-11. As described by the licensee, the Fuel Standards will describe how to prepare VIPRE-01 input decks and to interrupt output data for various application in reload design. GPU further explained the Fuel Standards will become the training basis for the VIPRE-1 applications in reload design.

In the June response, GPU validated that VIPRE-01 analyses fall under the guidance of GPU Nuclear Operational Quality Assurance Plan (1000)-PLN-7200, which has been reviewed and approved by the staff, and therefore complies with the requirements of Appendix B of 10 CFR 50. GPU also indicated that they have GPU Nuclear Procedure, Computer Program Control, 5000-ADM-7340.01, in place for evaluation and implementation of updates (Sections 4.2.4, 4.3, and 5.2) and for informing the code developer of GPU identified errors (Section 4.4).

GPU assured that the VIPRE/BWC will not be used outside of the range of applicability, Table 1 of this report, by the standards set forth in the Fuel Standards discussed above. There will be a Fuel Standard developed stating the limitation and restrictions for the use of VIPRE/BWC in reload design. GPU assures that these limitations and restrictions will be identified as verification items in the analysis verification process.

Site Visit

On September 24 and 25, 1996, the staff met with GPU Nuclear Corporation to verify aspects of the GPU analyses and resolve any outstanding questions. The trip/audit/meeting summary is attached.

During the audit the staff was able to examine the output data of the VIPRE/BWC CHF prediction. All data points appeared within reasonable range of expected values. The staff also examined the GPU Nuclear Operational Quality Assurance Plan, which has been reviewed and approved by the staff, to verify that 5000-ADM-7340.01 Sections 4.2.4, 4.3, 4.4, 5.2 do apply to the VIPRE/BWR code and analyses.

3.0 <u>CONCLUSION</u>

The staff has reviewed the GPU Nuclear Topical Report TR-087 and response to the staff Request for Additional Information dated June 13, 1996. The staff also met with the GPU staff at the Parsippany, NJ facility to review specific documentation. Based on our review, the staff is assured that GPU has approved methodologies in the benchmarking and statistical analysis of the VIPRE/BWC code combination. We are also satisfied that GPU has in place sufficient administrative controls to assure that (1) the code will not be used outside of the acceptable range and (2) that code errors or changes will be communicated between code developer and user and implemented by the user.

Therefore, the staff finds the use of VIPRE/BWC acceptable for use by GPU for core thermal-hydraulic analysis of the TMI Unit 1 within the system condition ranges specified by the licensee in Table 1.

4.0 REFERENCES

1. Letter from T. G. Broughton to NRC, "TMI Unit 1 Core reload Methodology," dated April 25, 1995.

2. Letter from J. Knubel to NRC, "TMI Unit 1 Response to Request for Additional Information - Core Reload Methodology," dated June 13, 1996.

3. Memo from A. Attard, S. Brewer, F. Orr to T. Collins, "Trip/Audit/Meeting Summary - TMI-1 Reload, VIPRE, and RELAP Methodologies," dated October 21, 1996.