



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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION  
RELATING TO TOPICAL REPORT VEP-NE-3, "QUALIFICATION OF THE WRB-1  
CHF CORRELATION IN THE VIRGINIA POWER COBRA CODE"  
VIRGINIA ELECTRIC AND POWER COMPANY  
SURRY AND NORTH ANNA POWER STATIONS, UNITS 1 AND 2  
DOCKET NOS. 50-280, 50-281, 50-338 AND 50-339

1.0 INTRODUCTION

By letter dated January 29, 1987, Virginia Electric and Power Company (VEPCO) submitted the Virginia Power Topical Report VEP-NE-3, "Qualification of the WRB-1 CHF Correlation in the Virginia Power COBRA Code" (Ref. 1), for NRC review. The purpose of this submittal was to qualify the WRB-1 correlation for Departure from Nucleate Boiling Ratio (DNBR) analysis in order to replace the W-3 correlation which has previously been used in DNBR analyses. The improved accuracy of the WRB-1 correlation results in a substantial gain in DNB margin over the use of the W-3 correlation.

The review considered only the issue of whether or not it is appropriate to substitute the VEPCO version of the COBRA code for the Westinghouse THINC code in the thermal-hydraulic analyses using the WRB-1 Critical Heat Flux (CHF) correlation. The question of the appropriateness of the method used to determine the Minimum Departure from Nucleate Boiling Ratio (MDNBR) limit for the CHF correlation, regardless of which thermal-hydraulic code is used, was not addressed. The WRB-1 correlation and its MDNBR limit were previously approved by the NRC (Ref. 2).

2.0 EVALUATION

The staff has coordinated this subject review through our consultant, Pacific Northwest Laboratories (PNL). The Technical Evaluation Report (Ref. 3) from PNL provided the staff with recommendations on the subject review. Our finding indicates that the COBRA code is an acceptable substitute for the THINC code in the thermal-hydraulic analysis of CHF data and in MDNBR calculations for reactor operating conditions and operational transients. The codes solve the same set of conservation equations, have many of the same constitutive models, and use similar numerical solution algorithms. In addition, the VEPCO thermal-hydraulic analysis method, as documented in VEP-FRD-33-A, (provided in response to our request for additional information (Ref. 4)) shows that the code is being applied in a manner consistent with its assumptions and capabilities.

VEPCO has shown that the COBRA code produces essentially the same values of measured-to-predicted (M/P) CHF ratio for the WRB-1 correlation's data base as obtained in calculations with the THINC code. This was demonstrated by applying the WRB-1/COBRA combination to the entire WRB-1 data base and comparing the predicted DNB ratios with those obtained in the qualification of WRB-1 with the THINC code. Twenty-five points were deleted from the data base because of suspected typographical errors in the transcription of the data as reported in EPRI-NP-2609. Response to our request for additional information (Ref. 5) on the identification of these errors indicates that the method used was reasonable, and unlikely to result in the deletion of valid data.

Using the COBRA code will not materially change the MDNBR results, in comparison with those obtained with THINC, over the intended range of application of the correlation. The report VEP-NE-3 states only that the correlation will be applied over the same range as in the THINC code.

The intended range of application of the WRB-1 correlation with COBRA-IIIC/MIT is as follows:

$$\begin{aligned} 1440 &\leq \text{pressure (psia)} \leq 2490 \\ 0.9 &\leq \text{mass flux (Mlbm/hr-ft}^2\text{)} \leq 3.7 \\ &\quad \text{local quality} \leq 0.30 \\ &\quad \text{local heat flux (MBtu/hr-ft}^2\text{)} \leq 1.0 \\ &\quad \text{mixing vane grid spacing} > 13.0 \text{ inches} \end{aligned}$$

Because of questions raised concerning the nonconservative behavior of the correlation of high critical heat fluxes, (i.e., above 1.0 MBtu/hr-ft<sup>2</sup>), and for 13" grid spacing, additional constraints were placed on the range of applicability of the WRB-1/COBRA combination. The maximum heat flux expected for the North Anna and Surry plants is 0.82 MBtu/hr-ft<sup>2</sup>, so the correlation will not be applied in the nonconservative region when used with COBRA. Similarly, the behavior for 13" grid spacing is not a concern since the fuel for these plants has a grid spacing of 20" and 26", respectively. Within these constraints the COBRA code can be used with the WRB-1 CHF correlation for analysis of the Westinghouse 17x17 standard "R" grid fuel, 17x17 Vantage 5H zircaloy fuel at the North Anna plant, and the 15x15 OFA-type fuel at the Surry plant.

### 3.0 CONCLUSION

VEPCO has adequately demonstrated that the WRB-1 CHF correlation yields essentially the same MDNBR results when the COBRA code is substituted for the THINC code in the thermal-hydraulic calculations. Therefore, the VEP-NE-3 topical report is acceptable for VEPCO plant-specific application with constraints that the critical heat fluxes shall not exceed 1.0 MBtu/hr-ft<sup>2</sup> and that no grid spacing shall be less than 13".

Dated: July 25, 1989

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#### 4.0 REFERENCES

1. Letter, W. L. Stewart (VEPCO) to USNRC, Virginia Electric and Power Company, Surry Power Station Units 1 and 2, North Anna Power Station Units 1 and 2, "Qualification of the WRB-1 CHF Correlation in the Virginia Power COBRA Code," VEP-NE-3, January 29, 1987.
2. F. E. Motley, et al., "New Westinghouse Correlation WRB-1 for Predicting Critical Heat Flux in Rod Bundles with Mixing Vane Grids," WCAP-8762-P-A (Proprietary) and WCAP-8763-A (Non-Proprietary), July 1984.
3. J. M. Cuta and W. K. Winegardner, "Review of Virginia Electric and Power Corporation submittal VEP-NE-3, "Qualification of the WRB-1 CHF Correlation in the Virginia Power COBRA Code," March 1989.
4. Memorandum, M. W. Hodges to H. N. Berkow, Request for Additional Information for the Virginia Power Topical Report VEP-NE-3, "Qualification of the WRB-1 CHF Correlation in the Virginia Power COBRA Code," December 8, 1988.
5. Letter, W. R. Cartwright (VEPCO) to USNRC, Virginia Electric and Power Company North Anna Power Station Units 1 and 2, Surry Power Station Units 1 and 2, Topical Report VEP-NE-3, "Qualification of the WRB-1 CHF Correlation in the Virginia Power COBRA Code," December 19, 1988.