May 19, 2005

Mr. David A. Christian
Sr. Vice President and Chief Nuclear Officer
Virginia Electric and Power Company
Innsbrook Technical Center
5000 Dominion Blvd.
Glen Allen, Virginia 23060-6711

SUBJECT: NORTH ANNA AND SURRY POWER STATIONS, UNITS 1 AND 2 AND MILLSTONE POWER STATION, UNITS 2 AND 3 - REQUEST FOR ADDITIONAL INFORMATION REGARDING TOPICAL REPORT DOM-NAF-2, “REACTOR CORE THERMAL HYDRAULICS USING THE VIPRE-D COMPUTER CODE” (TAC NOS. MC4571 THROUGH MC4576)

Dear Mr. Christian:

By letter dated September 30, 2004, as supplemented by letter dated January 13, 2005, Virginia Electric and Power Company and Dominion Nuclear Connecticut (the licensee) requested generic approval of Topical Report DOM-NAF-2, “Reactor Core Thermal Hydraulics Using the VIPRE-D Computer Code.” The licensee has requested to use Topical Report DOM-NAF-2 as a new thermal-hydraulic analysis computer program used to analyze multiple fuel types. Based on its review of the submittals, the NRC staff has determined that additional information is required to complete its review.

The NRC staff’s questions are provided in the Enclosure. The NRC staff requests a response to this request for additional information within 45 days of the date of this letter.

Sincerely,

/RA/
Stephen R. Monarque, Project Manager, Section 1
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-280, 50-281, 50-338, 50-339,
50-336, and 50-423

Enclosure: As stated

cc w/encl: See next page

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REQUEST FOR ADDITIONAL INFORMATION

PROPOSED TOPICAL REPORT DOM-NAF-2

VIRGINIA ELECTRIC AND POWER COMPANY AND DOMINION NUCLEAR CONNECTICUT

1. Departure from Nucleate Boiling Ration (DNBR) is sensitive to the turbulent mixing coefficient. Please justify the value of the turbulent mixing coefficient. Stating it is conservative is insufficient. Please show the sensitivity of the DNBR to the turbulent mixing coefficient.

2. Please describe the basis for the use of the drift flux correlations employed as part of the Electric Power Research Institute (EPRI) void model. Please describe the flow regime/regimes that the EPRI drift velocity correlation is applicable to and show that this applies to the flow regimes experienced during DNB in the plant analyses. Comparisons of the drift velocity correlation/correlations to void data in rod bundles and small pipes would be desirable. This could be done using all other particular inputs and correlation choices (and code corrections) included to show the effect/ability to continue to the predict test data presented in Volume 4 of the VIPRE Manual entitled “Applications” dated 1987. Since the EPRI void model appears to employ only the drift velocity correlation applicable to churn turbulent bubbly flow (for void fractions less than 0.3), please explain and justify why this correlation is applied to slug and annular flow where Critical Heat Flux (CHF) can occur. Define the limitations of the drift flux correlations (i.e pressure range, flow conditions, etc.). What distribution parameter is assumed? Since more voiding may occur near the walls of the hot rods, how does the distribution parameter account for this condition in the drift flux modeling? Please explain.

3. Please explain the basis for choosing the EPRI bulk void model. Please describe the transient test cases employed to determine the values given in Table 5.4-1 and show the void distributions for the VIPRE and LYNXT codes at the initiation of DNB in some example cases. Also provide justification for the choice of the subcooled boiling model as well as the two-phase friction multiplier. Please show comparisons of the VIPRE-D code to data for these models. Please also describe the limitations and identify the ranges of applicability of each of these correlations.

4. In section 4.12, please explain what “nearly identical” means. Identifying the percent difference between the two results would be helpful or show the plot of the two DNBR calculations.

5. Section 5.3 describes a comparison with the COBRA code but states the Minimum DNBR (MDNBR) results are different because the analyses use different fuel types and CHF correlations. Please provide the latest comparisons between the codes using the same fuel type and CHF correlations. Please show the channel void distribution and quality at several selected times during the events. Show the steamline break, feedline break, and loss-of-flow events.

6. The qualification document identifies the DNBR limits for the correlations for several pressure groups. Please explain what DNBR limit is applied or how the situation is

handled when the range of validity is exceeded for the other parameters identified in Table A.5.2. Please also define the quality range for the correlation.

7. CHF is also sensitive to the axial power distribution. Since the correlations were developed from data with uniform or symmetric power distributions, please justify applicability of the correlations to the asymmetric power distributions that may be limiting in the plant calculations. Explain how the correlations are applied and describe any corrections factors that may be applied to accommodate skewed distributions.

8. Please justify applicability of the steady-state DNB correlations to steamline breaks since these events have rapid depressurizations where the steady-state correlations may not be applicable. These transients may also transition through slug and annular flow. As such, please justify the use of the EPRI bulk boiling drift flux model since it only applies to bubbly flow.

9. Please discuss whether the slip option will be used and if so justify the slip ratio employed in the DNBR calculations.

10. Since the conduction model will not be used, please explain how the stored energy in the rod is accounted for. Please explain why use of the dummy rod model is conservative since the conduction model does not include the effects of gap conductance and initial stored energies. Please also describe how the heat flux is calculated for use as input to the VIPRE/D code.

<u>Appendix A</u>

1. The appropriate statistical analysis of the data, which form Tables A.3.1-1, A.3.2-1, and A.3.3-1 is an analysis of variance of a mixed-effects model.

a) Give the appropriate analysis of variance tables for these mixed-effects models.

b) Formulate the appropriate statistical hypothesis tests to justify the values for M/P and $\mathbf{F}_{M/P}$ used in Eq. A.1.1 based on the data in Tables A.3.1-1, A.3.2-1, and A.3.3-1.

c) For those cases where individual DNBR design limits were developed for each low pressure group, how were the results of the above analysis of variance taken into account?

2. As in Appendix B, you state that the plots show that there are no biases in the M/P ratio distributions, and that the performance of the CHF correlations is independent of the three variables of interest. The plots show a mostly uniform scatter of the data and no obvious trends or slopes. The plots again <u>*suggest*</u> but do not demonstrate that the claims made in those sentences are true. Please give the appropriate <u>*statistical analysis*</u>, that demonstrates the truth of the claim.

3. Please show the empirical probability density functions for the M/P values used in the analyses together with the estimate of the 95-percent fractile for each correlation.

Appendix B

1. The appropriate statistical analysis of the data that form Table B.6-1 is an analysis of variance of a mixed-effects model.

a) Give the appropriate analysis of variance table for this mixed-effects model.

b) Formulate the appropriate statistical hypothesis tests to justify the values for M/P and $\mathbf{F}_{M/P}$ used in Eq. B.6.1.

2. On page B-14 you state, "These plots show that there are no biases in the M/P ratio distributions, and that the performance of the WRB-1 CHF correlation is independent of the three variables of interest. The plots show a mostly uniform scatter of the data and no obvious trends or slopes." The plots *suggest* but do not demonstrate that the claims made in those sentences are true. Please give the appropriate *statistical analysis* that demonstrates the truth of the claim.

3. Please show the empirical probability density function for the M/P values used in the analyses together with the estimate of the 95-percent fractile.

cc:

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