VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

W. L. STEWART
VICE PRESIDENT
NUCLEAR OPERATIONS

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United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Serial No.	85-688A
E&C/RCA/cdk	
Docket Nos.	50-280
	50-281
	50-338
	50-339
License Nos.	DPR-32
	DPR-37
	NPF-4
	NPF-7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNITS 1 AND 2
NORTH ANNA POWER STATION UNITS 1 AND 2
STATISTICAL DNBR EVALUATION METHODOLOGY

Virginia Electric and Power Company letter dated October 8, 1985 (Serial No. 85-688) submitted Topical Report VEP-NE-2, "Statistical DNBR Evaluation Methodology." During the course of your staff's review, they provided several questions to our Nuclear Engineering staff. Our response to those questions is provided in the attachment.

Very truly yours,

W. L. Stewart

Attachment

A001
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cc: U. S. Nuclear Regulatory Commission
101 Marietta Street, N.W.
Suite 2900
Atlanta, GA 30323

Mr. W. E. Holland
NRC Senior Resident Inspector
Surry Power Station

Mr. J. L. Caldwell
NRC Senior Resident Inspector
North Anna Power Station

ATTACHMENT

Question:

Why was the DNBR correlation uncertainty multiplied, rather than added, in equation (2.4.1)?

Answer:

1) Multiplication is conservative, compared to addition, because the average Monte Carlo DNBR is greater than one.

2) An additive uncertainty would yield essentially the same results as a Root Sum Square combination of the parameter and the correlation standard deviations. A more conservative approach is consistent with VEP-NE-2, although the Root Sum Square combination may well be valid.

Question:

The measured-to-predicted (M/P) Critical Heat Flux ratio is the reciprocal of the DNBR. Since an additive M/P uncertainty is more conservative than a multiplicative M/P uncertainty, how can the latter be justified?

Answer:

1) First, we will note that when the M/P uncertainty is added, the result is a non-normal, positively skewed DNBR distribution with a larger but meaningless standard deviation. It is preferable to choose a valid uncertainty treatment which results in a normally distributed DNBR, as is obtained with the multiplicative DNBR uncertainty.

2) Second, we will note that the multiplicative uncertainty on M/P adequately reflects the behavior of the correlation's data base, as illustrated by the following discussion.

If a correlation which perfectly predicted data was available, then we would calculate

$$DNBR = \frac{CHF}{HF} \tag{1}$$

in which HF is the local heat flux and CHF is the true, measurable Critical Heat Flux; here, we may denote CHF as M, the measured Critical Heat Flux, and write

$$DNBR = \frac{M}{HF} \tag{2}$$

The available correlations are not perfect, however. Each correlation has an uncertainty which results in the calculation of

$$DNBR' = \frac{P}{HF} \tag{3}$$

in which P is the correlation's prediction of the true CHF, and DNBR' is a number which approximates the true DNBR as given in equation (1). Virginia Power's Statistical DNBR Methodology estimates the standard deviation of DNBR', which includes the random effects of the correlation uncertainty. We may divide (2) by (3) to find

$$\frac{DNBR}{DNBR'} = \frac{M}{P} \tag{4}$$

Critical Heat Flux correlations generally have normally distributed M/P ratios with a mean of approximately 1.0, and some standard deviation s. The Standard Normal Random Variable (SNRV) corresponding to each M/P ratio may be found by the relation

$$z = \frac{(M/P) - 1}{s} \tag{5}$$

which is equation (2.6.1) in VEP-NE-2. The Standard Normal Random Variable z has mean zero and standard deviation one. Combining equations (4) and (5) to eliminate M/P yields

$$z = \frac{(DNBR/DNBR') - 1}{s} \tag{6}$$

We may rewrite equation (6) to find

$$DNBR' = \frac{DNBR}{1 + (z \times s)} \tag{7}$$

The DNBR is calculated by the COBRA code, and its standard deviation includes the effect of the parameter uncertainties; however, the DNBR standard deviation has no way of reflecting the correlation uncertainty. When the DNBR is randomized to obtain DNBR', then the DNBR' standard deviation does include the effect of the correlation uncertainty.

Equation (7) is the proposed randomizing function for the implementation of VEP-NE-2. The COBRA/WRB-1 standard deviation s is known from VEP-NE-3, "Qualification of the WRB-1 CHF Correlation in the Virginia Power COBRA Code," and z may be simulated by the Statistical Analysis System (SAS) normal random number generator RANNOR.

In a qualitative sense, the use of a multiplicative uncertainty on the M/P ratio preserves the percentage of random variation in each DNBR due to correlation uncertainty, whereas the additive uncertainty preserves the absolute value of the random variation.