Arkansas Nuclear One - Unit 2

Docket 50-368

CEN-157(A)-NP

Amendment 2-NP

Response to Questions on Documents Supporting The ANO-2 Cycle 2 License Submittal

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ABSTRACT

This amendment to CEN-157(A)-P, -NP, amendment 2, is an expansion of the previously supplied answers to questions 492.15 and 492.16. The first provides the reason for a change in the numerical value of the power uncertainty factor E from that reported in CEN-143(A)-P, -NP to that cited in recent discussions between the NRC staff and C-E. The second provides a discussion of the method of combining uncertainties to generate the CPC parameter BERR1.

Table of Contents

Response to Questions

INTRODUCTION

The procedure for incorporating the power uncertainty intc the online protection system for the second cycle of Arkansas Nuclear One Unit 2 has been discussed by C-E and the NRC staff in both formal and informal sessions. Some of the informal oral discussions resulted in identifying a difference between the value of the power uncertainty factor E reported in CEN-143(A)-P, -NP (Reference 1) and that included in the online protection system. In this amendment to CEN-157(A)-P, -NP, (Reference 2) the expansion of the answer to question 492.15 provides the reason for this change. Other oral discussions asked for more detailed explanations of the method for incorporating uncertainties into BERR1. The expansion of the answer to question 492.16 provides the required information. The materials described here are supplements to the answers provided in Reference 2, not replacements for them.

Supplement to Response to NRC Question 492.15

Question 492.15

How is the value of power uncertainty factor of [ ] obtained for DNBR calculation?

Supplement to Response

The value of the algorithm uncertainty factor (E) in CEN-143(A)-P has been changed. The new value which is installed in the CPC software is [ ]. The value of [ ] is the 95/95 one sided tolerance factor determined from the distribution of the ratio of CETOP-2 to CETOP-D overpower margins (see Figure S-1). The change in the E value is due to the following reason:

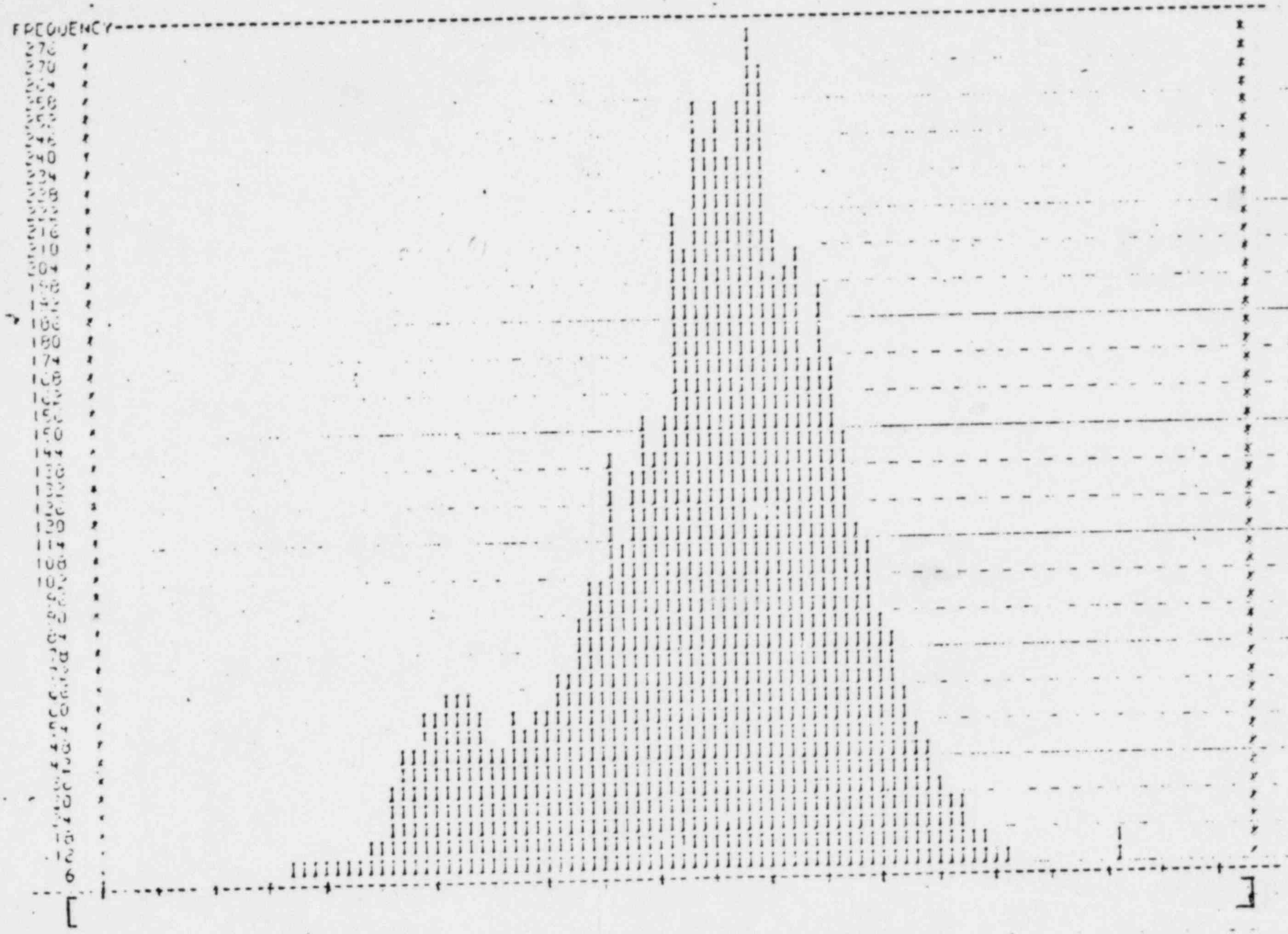
The CETOP2 code is written to use the hot channel peaking factor (hot channel power/core average power) as input. In the original analysis this input was used and the CETOP2 vs. CETOP-D analysis yielded a 95/95 tolerance factor of [ ] During a quality assurance review of the CPC module interfaces it was discovered that the CPC power algorithm calculates a [ ] peaking factor, rather than the [ ] peaking factor, for use in the static DNBR calculation. The [ ] peaking factor is [ ] than the [ ] peaking factor.

This input discrepancy was discovered late in the software design process and therefore an algorithm change to correct the discrepancy was not feasible. Instead, the uncertainty assessment was repeated for CETOP2 with the input changed to [ ] to be consistent with the input to the on-line algorithm. The result of the new analysis was that the error distribution shifted by almost [ ]. The new value of [ ] reflects the actual CETOP-2 on-line algorithm performance relative to CETOP-D.

The value for E in the CPC data base for ANO-2 Cycle 2 is [ ]. However, the CETOP2 to CETOP-D [ ] [ ]. This error distribution was included in the [ ]

[ ]

Figure S-1



Ratio of CETOP-2/CETOP-D Overpower Margin

Supplement to Response to NRC Question 492.16

Question 492.16 (A-17)

What is the value of the addressable DNBR uncertainty factor, BERR1, used in the calculation of heat flux at full power?

Supplement to Response

The general formula of BERR1 is defined in equation (1)

$$BERR1 = P_1 * P_2 * P_3 * P_4 \quad (1)$$

Where: P_1 = composite DNB modelling uncertainty

P_2 = state parameter fluctuation and computer processing uncertainties

P_3 = startup test acceptance band uncertainty

P_4 = CETOP2/CETOP-D correction factor

P_1 combines the DNB modelling and the online measurement uncertainty components. Note that the DNB modelling uncertainty also includes the measurement uncertainties of the state parameters: system pressure, core inlet temperature and coolant flow.

$$P_1 = 1 + (\overline{X}_{total} + kS_{total}) \quad (2)$$

Where: $\overline{X}_{total} = \overline{X}_{DNB\text{-}model} * (1 - \overline{X}_{CECOR}) - \overline{X}_{CECOR}$ = [ ] (3)

$$kS_{total} = \left\{(kS_{DNB\text{-}model})^2 + (kS_{CECOR} * SENS1)^2 + (D_F)^2\right\}^{1/2} \quad (4)$$

Where: SENS1 = [ ]

D_F = [ ]

With appropriate values of $kS_{DNB\text{-}model}$, kS_{CECOR}, SENS1 and D_F, equation (4) becomes

$$kS_{total} = \left\{([\quad])^2 + ([\quad])^2 + ([\quad])^2\right\}^{1/2}$$

KS_{total} = [ ] (5)

Therefore,

P_1 = 1 + [ ] = [_____] (6)

+ Consistent with ANO-2 Cycle 1 methodology

In general, P_2 deterministically combines Y_1, Y_2, Y_3, Y_4 and Y_5

Where: Y_1 = [
Y_2 =
Y_3 =
Y_4 =
Y_5 =]

However, since Y_1, Y_3 and Y_4 have already been implicitly accounted for, the expression for P_2 is simplified to:

$$P_2 = (1 + Y_2 * SENS2) * (1 + Y_5 * SENS5), \qquad (7)$$

Where: SENS2 = [ ]

SENS5 = [ ]

With appropriate values of Y_2, SENS2, Y_5 and SENS5, P_2 is evaluated as follows:

P_2 = (1 + [ ]) * (1 + [ ])

P_2 = [ ] (8)

P_3 combines Y_6, Y_7 and Y_8 according to the following formula:

$$P_3 = 1 + \left\{(Y_6)^2 + (Y_7)^2 + (Y_8)^2\right\}^{1/2} \qquad (9)$$

Where: Y_6 = [
Y_7 =
Y_8 =]

With appropriate values of Y_6, Y_7 and Y_8, P_3 is evaluated as

+ Consistent with ANO-2 Cycle 1 methodology

$$P_3 = 1 + \left\{([\quad])^2 + ([\quad])^2 + ([\quad])^2\right\}^{1/2}$$

$$P_3 = 1 + [\quad]$$

$$P_3 = [\quad] \tag{10}$$

Explanation of P_4 in BERR1 calculation

$$P_4 = [\quad] = \left[\quad\right] \tag{11}$$

The value of [ ] is the value of E (CETOP2 algorithm penalty factor). This is the final value included in the CPC software data base previously report as [ ] in CEN-143(A)-P. (Reference 1) This factor accounts for the difference between CETOP2 and CETOP-D. Since this difference has already been accounted for both in the simulation of DNB modelling uncertainty (P_1) and the CPC software (Reference 3 , equations 4.4-13 and 14), this factor must be included to eliminate double accounting.

Using equation (1) and values of P_1, P_2, P_3 and P_4 evaluated via equations (6), (8), (10) and (11) respectively, we have

BERR1 = 1.055

REFERENCE

1. CEN-143(A)-P, -NP, "CPC/CEAC Software Modifications for Arkansas Nuclear One - Unit 2,"December 1980.

2. "Response to Questions on Documents Supporting the ANO-2 Cycle 2 License Submittal," CEN-157(A)-P, April 1981, CEN-157(A)-P Amendment 1 P, June 1981.

3. CEN-147(S)-P, "Functional Design Specification for a Core Protection Calcultor: Response to NRC Question 221.18 and 221.20," January, 1981.