

August 14, 1997 LD-97-024

Document Control Desk U.S. Nuclear Regulatory Commission Washington, DC 20555

Subject: Report pursuant to 10 CFR 21 Regarding Error in the Energy Redistribution Factor Used in LOCA Analysis

References: 1. ABB-CE letter, J. M. West (ABB-CE) to P. A. Morris (NRC), April 1, 1971.

#### Gentlemen:

19005/

7081901 DR ADO

The purpose of this letter is to notify the Nuclear Regulatory Commission of a defect pursuant to 10 CFR 21, "Reporting of Defects and Noncompliance." The identified "defect" is that the energy redistribution factors (ERF) used by ABB-CE in LOCA analyses did not directly reflect the effects of moderator voiding Juring a LOCA and such effects have recently been calculated to be somewhat higher than previously thought. This involves all plants for which ABB-CE performed the LOCA analysis of record (AOR). This defect affects only the Large Break LOCA analysis significantly, since the Small Break LOCA analysis – insensitive to the ERF.

The variation of ERFs with moderator voids was documented in Reference 1 in response to NRC questions. All calculations were performed using the SHADRAC code. These results were used, in part, to derive the ERF value of 0.94 cited in the NRC approved large break LOCA evaluation model topical report. The reported ERF was based on a hot rod pin/box ratio of 1.07 with the hot rod located adjacent to a CEA guide tube location, and was calculated for the Mark V (14x14) assembly type. These assumptions were representative of the core designs existing at the time the ERF was derived. The ERF values reported in the LOCA topical reports were correctly calculated for assembly designs which were typical at that time and included the effects of voiding.

Subsequently, with the implementation of improved assembly designs, lower hot rod pin/box ratios (~1.04) were observed. Lower values of the pin/box ratio yield higher values of the ERF since there is less redistribution of the hot rod power among

### ABB Combustion Engineering Nuclear Systems

2000 Day Hill Road P.O. Box 500 Windsox CT 06095-0500 Telephone (860) 688-1911 Fax (860) 285-5203 neighboring fuel rods. In addition, the implementation of enrichment zoning causes the hot rod location for some core designs to be in locations that are not adjacent to a CEA guide tube. For these reasons, the variation of ERF with pin/box factor for a fuel rod not located adjacent to a CEA guide tube was calculated in 1975 using the MORSE Monte Carlo computer code for both the 14x14 and 16x16 assembly designs.

The 1975 calculation included benchmarking to the Reference 1 (SHADRAC) results for the ERF using the same geometrical configuration, a pin/box ratio of 1.07 and no voids, and was found to be in essential agreement. The MORSE calculation, however, was found to yield somewhat more adverse ERFs for actual lattice geometries. On the basis of the agreement for the benchmark geometry and the more adverse results for actual geometries, MORSE was used to determine ERFs as a function of pin/box ratio for both 14X14 and 16X16 lattice types. However, review of the 1975 calculation indicates that the calculation did not incorporate the effects of voiding during a LOCA.

The results of Reference 1 indicated that the effects of voiding (as calculated by SHADRAC) were relatively small. Since the 1975 calculation contained a number of conservatisms, it was believed that new calculations would confirm the continued applicability of the ERFs incorporated in the ABB-CE ECCS performance evaluation models, even in the presence of voiding. Calculations were consequently initiated in early July, 1997 using ABB-CE's current Monte Carlo computer code for photon transport, MCNP. The MCNP calculations indicate that the effect of voids is larger than had been calculated in Reference 1 using SHADRAC. As a result, the calculations have failed to confirm the continued applicability of the ERFs used in ABB-CE's ECCS evaluations. Specifically, the MCNP calculations indicate that the energy deposition in the hot rod is underpredicted by 0.5 to 1.5%.

A 0.5 to 1.5% underprediction of the ERF corresponds to an underestimate of approximately 20 to 60 °F in PCT in the large break ECCS evaluation. Depending on the value of PCT calculated and the magnitude of compensating conservatisms present in the AOR, the corrected PCT could exceed the ECCS acceptance criterion of 2200 °F.

ABB-CE recommended actions (described in the Attachment) to assure the validity of the current LOCA AOR. Those recommendations continue to be applicable.

Very truly yours, COMBUSTION ENGINEERING, Inc.

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Ian C. Riekard, Director Operations Licensing

cc: M. F. Barnoski (ABB-CE)

### ABB Combustion Engineering Nuclear Operations 10 CFR 21 Report of a Defect or Failure to Comply

The following information is provided pursuant to 10 CFR 21.21 (c)(4):

(i) Name and address of the individual informing the Commission:

Ian C. R<sup>1</sup>Jkaro, Director Operations Licensing Combustion Engineering 2000 Day Hill Road Windsor, CT 06095-0500

(ii) Identification of the facility, the activity, or the basic component supplied for such facility or such activity within the United States which fails to comply or contains a defect:

The energy redistribution factors (ERF) used in the LOCA analysis for all plants for which ABB-CE performed the analysis of record (AOR) did not properly consider the effects of significant moderator voiding which may occur at various times during a LOCA.

(iii) Identification of the firm constructing the facility or supplying the basic component which fails to comply or contains a defect:

Combustion Engineering, Inc. 2000 Day Hill Road Windsor, CT 06095-0500

## (iv) Nature of defect or failure to comply and the safety hazard which is created or could be created by such defect or failure to comply:

The defect identified is that the energy redistribution factors (ERF) used in the LOCA analysis for all plants for which ABB-CE performed the AOR did not properly consider the effects of significant moderator voiding which may occur at various times during a LOCA. Specifically, calculations indicate that the energy deposition in the hot rod is underpredicted by 0.5 to 1.5%.

(v) The date on which the information of such defect or failure to comply was obtained:

Information indicating that the ERF's may not have considered the effect of voids was obtained on July 9, 1997.

(vi) In the case of a basic component which contains a defect or fails to comply, the number and location of all such components in use at, supplied for, or being supplied for one or more facilities or activities subject to the regulations of this part:

This issue affects the following plants for which ABB-CE has provided the LOCA AOR:

- Palo Verde Units 1, 2, and 3
- San Onofre Nuclear Generating Station Units 2 and 3
- Waterford Unit 3
- Arkansas Nuclear One-Unit 2
- Calvert Cliffs Units 1 and 2
- Saint Lucie Unit 2

## (vii) The corrective action which has been, is being, or will be taken; the name of the individual responsible for the action; and the length of time that has been or will be taken to complete the action:

For plants for which ABB-CE has performed the LOCA AOR, ABB-CE has provided the following recommendations via Infobulletin 97-04:

For the ABB-CE Digital Plants, assure that one of the following conditions is met:

- Assure that there is at least 0.2 kw/ft margin between the COLSS PLHGR and the PLHGR LCO value
- Reduce the COLSS PLHGR LCO by 0.2 kw/ft
- Assure that there is at least 2% margin between the measured all-rods-out Fxy peaking value and the ARO Fxy value installed into COLSS

For the ABB-CE Analog Plants, assure that one of the following conditions is met:

- Assure that does is at least 2% margin to the Tech Spec Fxy limit, if monitoring linear heat rate using ex-core detectors, or
- Assure that there is at least 0.2 kw/ft margin between the measured PLHGR and the PLHGR LCO, if monitoring linear heat rate using in-core detector signals.

# (viii) Any advice related to the defect or failure to comply about the facility, activity, or basic component that has been, is being, or will be given to purchasers or licensees:

ABB-CE issued Infobulletin 97-04 on July 11, 1997 to notify licensees of this issue. The Infobulletin provided the recommendations identified in item (vii) above.

The above recommendations constituted interim advice. Licensees are further advised to either:

- Confirm that sufficient PCT margin or other conservatisms exist in the AOR to accommodate the defect in the ERF, or
- Reduce the PLHR LCO by 0.2 kw/ft to compensate for the defect in the ERF.