CENPD - 279
SUPPLEMENT 2

ANNUAL REPORT
ON
C-E ECCS CODES AND METHODS
FOR 10CFR50.46

LOCA ANALYSIS AND METHODS
NUCLEAR FUEL ENGINEERING

APRIL, 1991

Abstract

This report describes changes and errors in the ABB Combustion Engineering codes and analysis methodology for ECCS analysis in 1990 per the requirements of 10CFR50.46. For this reporting period only one computer code had reportable changes or errors. The corrections and changes did not affect the peak cladding temperature. The cumulative temperature change for large break LOCA is a reduction of less than $1^{o}F$. No changes or errors that affect the peak cladding temperature for small break LOCA have occured. Per the criteria of 10CFR50.46, no action beyond this annual report is required.

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1.0 Introduction

This report addresses the NRC requirement to report changes or errors in licensed codes for ECCS analysis. The revision to the ECCS Acceptance Criteria[1] spells out reporting requirements and actions required when errors are corrected or changes are made in an evaluation model or in the application of a model for an operating licensee or construction permittee of a nuclear power plant.

The action requirements in § 50.46(a)(3) are:

1. Each applicant for or holder of an operating license or construction permit shall estimate the effect of any change to or error in an acceptable evaluation model or in the application of such a model to determine if the change or error is significant. For this purpose, a significant change or error is one which results in a calculated peak fuel cladding temperature (PCT) different by more than $50^{o}F$ from the temperature calculated for the limiting transient using the last acceptable model, or is a cumulation of changes and errors such that the sum of the absolute magnitudes of the respective temperature changes is greater than $50^{o}F$.

2. For each change to or error discovered in an acceptable evaluation model or in the application of such a model that affects the temperature calculation, the applicant or licensee shall report the nature of the change or error and its estimated effect on the limiting ECCS analysis to the Commission at least annually as specified in § 50.4.

3. If the change or error is significant, the applicant or licensee shall provide this report within 30 days and include with the report a proposed schedule for providing a reanalysis or taking other action as may be needed to show compliance with § 50.46 requirements. This schedule may be developed using an integrated scheduling system previously approved for the facility by the NRC. For those facilities not using an NRC approved integrated scheduling

system, a schedule will be established by the NRC staff within 60 days of receipt of the proposed schedule.

4. Any change or error correction that results in a calculated ECCS performance that does not conform to the criteria set forth in paragraph (b) of § 50.46 is a reportable event as described in §§ 50.55(e), 50.72 and 50.73. The affected applicant or licensee shall propose immediate steps to demonstrate compliance or bring plant design or operation into compliance with § 50.46 requirements.

This report documents all the changes, made in the year covered by this report, to the presently licensed ABB C-E LOCA analysis models and methodology which have not been reviewed by the NRC staff. This document is provided to satisfy the reporting requirements of the second item above.

2.0 Codes for ECCS Evaluation

ABB C-E uses several digital computer codes for ECCS analysis that are described in topical reports, are licensed by the NRC, and are covered by the provisions of 10CFR50.46. Those for large break LOCA calculations are CEFLASH-4A, COMPERC-II, PARCH, STRIKIN-II, and COMZIRC. CEFLASH-4AS is used in conjunction with COMPERC-II, STRIKIN-II, and PARCH for small break LOCA calculations. The codes for post-LOCA long term cooling analysis are BORON, CEPAC, NATFLOW, and CELDA.

3.0 Error Corrections and Model Changes in Computer Codes

This section discusses all error corrrections or model changes to the licensed codes which may affect the calculated PCT. Only the BORON code for long term cooling analysis of large break LOCAs has been changed in 1990. This change was made to correct an error. No changes to analysis procedures have been made since the last approved submittal to the NRC.

3.1. BORON

A. Code Description

BORON is a FORTRAN digital computer program which is used by Combustion Engineering, Inc. to calculate the boric acid concentration in the reactor core after a LOCA. This information is used to determine the point in time, if ever, at which boric acid concentration will reach the solubility limit before core flushing is initiated by starting combined hotside/coldside safety injection. A detailed code description is presented in Reference 2.

B. Coding Error in BORON

The coding that calculates the total boric acid content of the system was found to have the variable VRCS mistyped as VCRS, where VRCS is the mass of solution in the reactor coolant system (RCS). Correct coding is used if there is a boric acid storage tank (BAST) in the system, if it empties after the refueling water tank (RWT), and if the BAST can't supply as much water as is being boiled-off in the core. Normally the BAST can't supply as much water as is being boiled off in the core under these conditions. Otherwise, the incorrect coding is used.

The correct and erroneous equations are described below.

<u>Correct Equation</u> (Page C-9 of Reference 2)

```
BTOTL1 = VRCS*BRCS/100.0+0.9*VRWT*BRWT/100.0+VSIT*BSIT/100.0   (1)

BTOTAL = BTOT1 + BBAST*VBAST/100.0                             (2)
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where BTOTAL : Total boric acid mass in system (lbm),
BBAST : Boric acid concentration in BAST (w/o),
BRCS : Boric acid concentration in RCS (w/o),

BRWT : Boric acid concentration in RWT (w/o),
BSIT : Boric acid concentration in safety injection tank (SIT) (w/o),
VBAST : Mass of solution in BAST (lbm),
VRCS : Mass of solution in RCS (lbm),
VRWT : Mass of solution in RWT (lbm),
VSIT : Mass of solution in SIT (lbm),

Incorrect Equation

BTOTL1 = VCRS*BRCS/100.0+0.9*VRWT*BRWT/100.0+VSIT*BSIT/100.0 (3)

The difference between Equations (1) and (3) is the first term on the right hand side of the equations. The error was introduced in 1983 and was detected and corrected in 1990.

C. Impact of RCS Mass Error on PCT

The coding error in BORON caused the code to use undefined input for the RCS solution mass for some transients under the conditions described above. This error could affect the PCT by over-predicting the time available before core flushing must be initiated to prevent precipitation of boric acid and possible blockage of the coolant channels in the fuel. However, an evaluation of the effect of this error for those analyses that were performed with the code version with the erroneous coding shows that precipitation does not occur before flushing is started. Since cooling water circulation is not impeded by boric acid precipitation throughout the post-LOCA period, the coding error has no effect on PCT for a large break LOCA.

4.0 Conclusions

The error in BORON had the potential to affect the PCT by over-predicting the time until core flushing must be initiated. However, it is the case that precipitation will not occur before flushing is initiated by

starting combined hotside/coldside safety injection. Consequently, there is no change in PCT for a large break LOCA due to the code error.

The cumulative change in PCT for large break LOCA including that from the previous annual reports, References 3 and 4, is a reduction of less than $1^{o}F$. There have been no changes in the small break LOCA results to date. Therefore, there was no significant change in the sense of 10CFR50.46 in 1990 and no action beyond the submission of this report is needed.

5.0 References

1. "Emergency Core Cooling System; Revisions to Acceptance Criteria," 10CFR50, Federal Register, Vol. 53, No. 180, September 16, 1988.

2. CENPD-254-P-A, "Post-LOCA Long Term Cooling Evaluation Model," June, 1980.

3. CENPD-279, "Annual Report on C-E ECCS Codes and Methods for 10CFR50.46," April, 1989.

4. CENPD-279, Supplement 1, "Annual Report on C-E ECCS Codes and Methods for 10CFR50.46," February, 1990.