CENPD - 279
SUPPLEMENT 1

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

FEBRUARY 1990

COMBUSTION ENGINEERING

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TRANSIENT METHODS AND LOCA
NUCLEAR FUEL ENGINEERING

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Abstract

This report describes changes and errors in the Combustion Engineering codes and analysis methodology for ECCS analysis in 1989 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 cummulative 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°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°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. This report is to be filed within one year of discovery of the error and must be reported each year thereafter until a revised evaluation model or a revised evaluation correcting minor errors is approved by the NRC staff.

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 to the presently licensed C-E LOCA analysis models and methodology which have not been reviewed by the NRC staff. This is specifically to satisfy the requirements described in the second item above.

2.0 Codes for ECCS Evaluation

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 CFR 50.46. 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.

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 COMPERC-II for a large break has been changed in 1989. No changes to analysis procedures have been made since the last approved submittal to the NRC.

3.1. COMPERC-II

A. Code Description

COMPERC-II is a FORTRAN digital computer program which is used by Combustion Engineering, Inc. to calculate the core refill and reflood transient portion of a PWR loss of coolant accident (LOCA). A detailed code description is presented in References 2 through 4.

B. Model Change in COMPERC-II for SI Spillage

The model for the spillage calculation in COMPERC-II has been changed to reflect a more realistic physical representation. The change is as described below:

Present Model (Page 10 of Reference 2)

If $Z_{A,MAX} < Z_A \leq Z_{A,MAXI}$

$$W_{spill} = \left[\frac{(Z_{A,MAXI} - Z_{A,MAX})\ 2\ g_c\ \rho_A^2\ A_{B,F}^2}{K_{spill}} \right]^{1/2} \qquad (1)$$

where W_{spill} : Rate of water spillage out of the break,
K_{spill} : Loss coefficient for the spillage of water out of the break,
$A_{B,F}$: Flow area in the core,
Z_A : Height of the water in the downcomer,
$Z_{A,MAX}$: Distance between bottom of core and bottom of inlet pipe,
$Z_{A,MAXI}$: Distance between bottom of core and top of inlet pipe,
ρ_A : Density of water in the downcomer/lower plenum,
g_c : Conversion constant.

Modification

Equation (1) was modified as

$$W_{spill} = \left[\frac{(Z_A - Z_{A,MAX})\ 2\ g_c\ \rho_A^2\ A_{B,F}^2}{K_{spill}} \right]^{1/2} \qquad (2)$$

The difference between Equations (1) and (2) is the first term of the numerator on the right hand side of the equations. This change uses the real head term instead of the fixed head term while the mixture level is in the span of the cold leg.

C. Reasons for the Modification

As indicated in the previous section, this change reflects a better physical representation than the model described in Reference 1. However, a more important reason for this modification is to remove low-amplitude flow oscillations introduced by the discontinuity of the fixed head in the old model.

D. Impact of the Spillage Model Change on PCT

The change in downcomer spillage head term has the possibility to affect PCT through two effects -- reflood rate and two-phase level. Comparison of the reflood rates for cases without and with the change in head term shows that the small oscillations in the reflood rate are removed. However, the reflood rate selected for subsequent use is not changed; therefore, there is no change in PCT from this effect. The change in the head term for downcomer spillage also eliminates oscillations in the two phase-level but does not change the base two-phase level. Elimination of the oscillations reduces the uncertainty in the two-phase level selected for the next step in the analysis. However, due to the small sensitivity of the C-E methodology to two-phase level changes, the change in the two-phase

level due to the change in the head term for spillage has no effect on PCT.

4.0 Conclusions

The change to COMPERC-II has the potential to affect the PCT by changing the reflood rate or the two-phase level. However, an evaluation of the reflood rates and effect of the two-phase level for cases before and after the change in head term for the downcomer spillage shows that there is no change in PCT.

The cummulative change in PCT for large break LOCA including that from the previous annual report, Reference 5, 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 CFR 50.46 in 1989 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-134P, "COMPERC-II, A Program for Emergency-Refill-Reflood of the Core," August, 1974.

3. CENPD-134P, Supplement 1, "COMPERC-II, A Program for Emergency Refill-Reflood of the Core (Modifications)," February, 1975.

4. CENPD-134, Supplement 2, "COMPERC-II, A Program for Emergency Refill-Reflood of the Core," June, 1985.

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