SMALL BREAK LOSS OF COOLANT ACCIDENT ANALYSIS
SAN ONOFRE NUCLEAR GENERATING STATION
UNITS 2 AND 3

## INTRODUCTION

This report describes additional small break Loss of Coolant Accident (LOCA) calculations performed by Combustion Engineering, the NSSS supplier, in accordance with 10CFR50.46 for San Onofre Units 2 and 3.

## BACKGROUND

By letter dated July 12, 1979, Southern California Edison Company confirmed verbal notification to the NRC concerning the results of preliminary small break LOCA calculations performed in accordance with 10CFR50.46 and Appendix K. Southern California Edison reported that these preliminary calculations using high pressure safety injection (HPSI) performance characteristics based on recent pump vendor acceptance test results indicate that the peak fuel cladding temperatures will exceed 10CFR50.46 limits for a 0.05 $ft^2$ LOCA. This condition was determined by Southern California Edison Company to be a deviation from expected Safety Injection System performance requiring further evaluation and to be reportable in accordance with 10CFR50.55(e).

An interim report of the preliminary evaluation of the 0.05 $ft^2$ break was submitted by Reference (1). SCE committed in this report to continue evaluation of certain small breaks in order to identify whether the composite conservatism of the assumptions can be reduced or whether any plant modifications are necessary to demonstrate that all criteria of 10CFR50.46 are met. The results of these investigations and a final resolution of the concern were committed to be provided by November 12, 1979. Since the submittal of the interim report to the Office of Inspection and Enforcement, responsibility for review of this analysis has been transferred to the Office of Nuclear Reactor Regulation.

## DISCUSSION

### Description of Deficiency

In October, 1977 Combustion Engineering provided a small break LOCA evaluation for Southern California Edison Company in response to NRC Question 212.21 (see Amendment 5 to the San Onofre Units 2 and 3 FSAR). This evaluation compared several plant designs with respect to power, primary system volume and safety injection system performance, particularly HPSI pump performance. The HPSI delivery curve assumed for San Onofre in this comparison is shown in Figure 212.21-1 of the referenced response. Because of the similarities of design between the different plant types, it was concluded that San Onofre would show small break results similar to other C-E designated plants and that the large break LOCA's reported in the San Onofre FSAR would be more limiting than the small break LOCA's. It was acknowledged in the response that the predicted HPSI pump performance used in the development of the assumed HPSI delivery curve would be verified by final as-built pump performance testing at the pump vendor's shop in 1978. In addition, it was implicitly assumed in the response that HPSI performance would be further verified by preoperational testing in 1980 (see FSAR Section 14.2.12.45).

After completion of the HPSI pump tests in August, 1978 a comparison was made between the assumed HPSI delivery curve (see Figure 212.21-1 of the referenced response) with the revised delivery curve based on the pump performance tests. Although the HPSI pump performance specifications were met, the as-built pump flow rates were less than the previously assumed rates. As a result of both the HPSI performance tests and NRC Question 212.151 SCE requested Combustion Engineering to perform an evaluation of three small breaks, i.e., 1.0, 0.1 and 0.01 $ft^2$ using the revised HPSI delivery curve. These breaks were analyzed using the NRC approved Combustion Engineering small break model defined by References (2) through (6). These analyses assumed the typical conservative assumptions with respect to moderator density coefficient, power distribution, safety injection system performance, etc. The results of these calculations showed that all of the acceptance criteria in 10CFR50.46 are met. These results were submitted to NRC in Amendment 16 to the FSAR in October, 1979 in partial response to Question 212.151.

Based upon further review of the San Onofre Units 2 and 3 HPSI delivery data and following completion of the analysis of the three breaks noted above, a small break calculation of the 0.05 $ft^2$ break was performed. Evaluation of the calculation for this break indicated that the peak fuel cladding temperature exceeded the acceptance criteria in 10CFR50.46.

Analysis of Safety Implications

Analysis of the 0.05 $ft^2$ break showing a peak fuel cladding temperature exceeding 10CFR50.46 acceptance criteria indicates a safety concern. This analysis used as-built pump flow rates, which were recently determined by test and are less than previously assumed rates, and other conservative assumptions such as for the moderator density coefficient, power distributions, etc. If such a break were to occur, it is highly unlikely that all of the values of parameters or assumptions made in the analysis such as single failures in the ECCS, power distributions and moderator density coefficient would be at their conservative extremes.

Corrective Action

Corrective action was initated to investigate further the response of San Onofre Units 2 and 3 to break sizes within the range of 0.01 to 0.1 $ft^2$. This investigation included a survey of the plant parameters and assumptions which have a first order effect on the analysis to reduce unnecessary margins yet, still be consistent with the requirements of 10CFR50, Appendix K.

The results of this investigation demonstrate that the following plant design features can be credited in the small break ECCS analyses.

1. Use of safety related borating and charging portions of the chemical and Volume Control Systems (CVCS). The safety-related design features of the CVCS along with a Failure Modes and Effects Analysis (FMEA) of the borating and charging portions of the system are provided in FSAR Section 9.3.4.

2. Improved utilization of the potential for the existing High Pressure Safety Injection subsystem. In order to confirm higher flow rates which could be credited in the ECCS analysis, special considerations would be required during initial field verification and subsequent in-service testing. These considerations include the use of more accurate instrumentation for measurement of HPSI pump performance and more rigorous test requirements and acceptance criteria for flow balancing in the injection piping to the RCS cold legs and the HPSI pump recirculation piping back to the Refueling Water Storage Tank.

Following this investigation, three additional small break sizes, i.e. $0.075ft^2$, $0.05\ ft^2$ and $0.025\ ft^2$ were analyzed taking credit for the design features identified above. The results of the calculations for these breaks, which were analyzed in accordance with the NRC approved C-E Small Break LOCA methodology defined in References (2) through (6), demonstrate compliance with the acceptance criteria of 10CFR50.46. It is our judgement that analyses of these 3 break sizes in combination with other large and small break LOCA analyses provided in the FSAR (i.e. Response to Question 212.151) demonstrate compliance with 10CFR50.46. The detailed results of this analysis will be included in a supplement to the response to FSAR Question 212.151 in Amendment 17 to be submitted in December, 1979.

In order to assure that the assumptions regarding HPSI subsystem performance made in the ECCS analysis are met, the following actions will be taken. First, the HPSI subsystem pre-operational test procedure will be modified to include more rigorous test requirements and acceptance criteria on flow and pressure measurements. (FSAR Section 14.2.12.45 contains the test abstract of this system.) In addition, HPSI subsystem performance will be verified during monthly intervals during plant operation to be proposed in Technical Specifications Section 16.3/4.5.2 in Amendment 17. The inservice testing procedure will include the special requirements and acceptance criteria on flow and pressure measurements.

Implementation of these requirements in the plant pre-operational and inservice testing programs provides assurance of consistency with the ECCS analysis. These actions,coupled with credit for the use of safety related borating and charging portions of the CVCS in the small break ECCS analysis, in combination with other large and small break LOCA analyses provided in the FSAR (i.e. Response to Question 212.151) will demonstrate compliance with 10CFR50.46.

REFERENCES


(1) SCE letter from A. Arenal to R. Engelken (NRC), August 10, 1979.

(2) "CEFLASH-4A, A FORTRAN-IV Digital Computer Program for Reactor Blowdown Analysis, " CENPD-133, April 1974 (Proprietary).

"CEFLASH-4AS, A Computer Program for Reactor Blowdown Analysis of the Small Break Loss of Coolant Accident," CENPD-133, Supplement 1, August 1974 (Proprietary).

"CEFLASH-4A, A FORTRAN-IV Digital Computer Program for Reactor Blowdown Analysis (Modification)," CENPD-133, Supplement 2. December 1974 (Proprietary).

"CEFLASH-4AS, A Computer Program for the Reactor Blowdown Analysis of the Small Break Loss of Coolant Accident", CENPD-133, Supplement 3, January 1977 (Proprietary).

(3) "COMPERC-II, A Program for Emergency Refill-Reflood of the Core," CENPD-134, April 1974 (Proprietary).

"COMPERC-II, A Program for Emergency Refill-Reflood of the Code (Modification)," CENPD-134, Supplement 1, December 1974 (Proprietary).

(4) "STRIKIN-II, A Cylindrical Geometry Fuel Rod Heat Transfer Program," CENPD-135, April 1974 (Proprietary).

"STRIKIN-II, A Cylindrical Geometry Fuel Rod Heat Transfer Program (Modification)," CENPD-135, Supplement 2, December 1974 (Proprietary).

"STRIKIN-II, A Cylindrical Geometry Fuel Rod Heat Transfer Program," CENPD-135, Supplement 4, August 1976 (Proprietary).

(5) "PARCH, A FORTRAN-IV Digital Program to Evaluate Pool Boiling, Axial Rod and Coolant Heatup," CENPD-138, August 1974, (Proprietary).

"PARCH, A FORTRAN-IV Digital Program to Evaluate Pool Boiling, Axial Rod and Coolant Heatup," CENPD-138, Supplement 1, February 1975 (Proprietary).

"PARCH, A FORTRAN-IV Digital Program to Evaluate Pool Boiling, Axial Rod and Coolant Heatup", CENPD-138, Supplement 2, January 1977 (Proprietary).

(6) "Calculative Methods for the C-E Small Break LOCA Evaluation Model," CENPD-137, August 1974 (Proprietary).

"Calculative Methods for the C-E Small Break LOCA Evaluation Model," CENPD-137, Supplement 1, January 1977 (Proprietary).