CENPD-134
Supplement 2

# COMPERC-II

## A PROGRAM FOR EMERGENCY REFILL-REFLOOD OF THE CORE

TRANSIENT METHODS AND LOCA
NUCLEAR FUEL ENGINEERING

JUNE 1985

COMBUSTION ENGINEERING

Power Systems

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## A Program for Emergency Refill-Reflood of the Core

Transient Methods and LOCA

April, 1985

## ABSTRACT

This report describes a change made to the Combustion Engineering post-LOCA refill/reflood hydraulics computer code, COMPERC-II. The change is an option which has been added to the computer code which allows the user to specify, via input, the time the safety injection pumps begin to inject into the reactor coolant system.

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## 1.0 INTRODUCTION

The COMPERC-II computer code (References 1 and 2) analyzes the thermal-hydraulic response of a pressurized water reactor (PWR) during the refill and reflood periods of a loss-of-coolant accident (LOCA). It is one of the computer codes which is used in the Combustion Engineering large break LOCA emergency core cooling system (ECCS) evaluation model (Reference 3). COMPERC-II calculates FLECHT-based reflood heat transfer coefficients which are used in the STRIKIN-II hot rod heatup computer code (Reference 4) and the core steam flow rate which is used in the PARCH computer code (Reference 5) to calculate steam cooling heat transfer coefficients. COMPERC-II has component models which calculate the containment back pressure, the resistance to steam flow in the reactor coolant system (RCS), the effect of steam-water and steam-water-nitrogen interaction in the injection section of the reactor coolant pump discharge leg, and the safety injection system flow rate.

This supplement to the COMPERC-II topical report describes one change to the COMPERC-II computer code. An option has been added to COMPERC-II which allows the user to specify, via input, the time the safety injection pumps begin to inject into the RCS. Previously, the COMPERC-II safety injection system flow rate model assumed that the safety injection pumps begin to inject when the safety injection tanks (SIT) empty.

## 2.0 DESCRIPTION OF MODEL CHANGE

The COMPERC-II safety injection system flow rate model is described in Appendix A of Reference 1 and Section II.A of Reference 2. The model calculates the flow rate into the RCS from the SIT and the safety injection pumps for cold leg safety injection systems.

As described in Appendix A of Reference 1, the model had assumed that the safety injection pumps begin to inject when the SIT empty. An option has been added to the safety injection system flow rate model which now allows the user to specify, via input, the time the safety injection pumps begin to inject into the RCS, $t_{pump}$.

The mass and energy balances performed in the intact reactor coolant pump discharge legs to calculate the flow rate and enthalpy of the fluid entering the downcomer/lower plenum (Reference 1, page A-3) have been modified as follows to account for this new option. When $t > t_{pump}$ and the SIT are not empty, the mass and energy balances are, respectively:

$$W_{SI} = (N)(\dot{m}_L) + \sum_{j=1}^{N} W_{pump,j} + (F)\,(W_{S,OP}) \qquad (2\text{-}1)$$

and

$$h_{SI} = [(N)(\dot{m}_L)(h_{SIW}) + (\sum_{j=1}^{N} W_{pump,j})(h_{pump}) + (F)(W_{S,OP})(h_{SS})]/W_{SI} \qquad (2\text{-}2)$$

Where the second term on the right side of both Equation 2-1 and 2-2 has been added to account for the safety injection pump flow rate. When $t < t_{pump}$, the safety injection pump flow rate, $W_{pump,\,j}$, in Equation 2-1 and 2-2 is zero.

When the SIT are empty and only the safety injection pumps are injecting, the mass and energy balances are the same as described in Reference 2, namely:

$$W_{SI} = \sum_{j=1}^{N} W_{pump,j} \tag{2-3}$$

$$h_{SI} = h_{pump} \tag{2-4}$$

The original COMPERC-II model which assumed that the safety injection pumps begin to inject when the SIT empty is still available as a user option.

## 3.0 NOMENCLATURE

| Name | Description |
|---|---|
| $F$ | fraction of steam flow that is condensed |
| $h_{pump}$ | enthalpy of safety injection pump water, BTU/lbm |
| $h_{SI}$ | enthalpy of water entering the downcomer/lower plenum, BTU/lbm |
| $h_{SIW}$ | enthalpy of safety injection tank water, BTU/lbm |
| $h_{SS}$ | enthalpy of superheated steam, BTU/lbm |
| $m_L$ | flow rate from one safety injection tank, lbm/sec |
| $N$ | number of intact reactor coolant pump discharge legs |
| $t$ | time, sec |
| $t_{pump}$ | time safety injection pumps begin to inject, sec |
| $W_{pump,j}$ | safety injection pump flow rate into the $j^{th}$ intact reactor coolant pump discharge leg, lbm/sec |
| $W_{SI}$ | flow rate entering the downcomer/lower plenum, lbm/sec |
| $W_{S,OP}$ | total steam flow rate in the RCS coolant loops, lbm/sec |

## 4.0 REFERENCES


1. CENPD-134P, "COMPERC-II, A Program for Emergency Refill-Reflood of the Core", August 1974.

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

3. CENPD-132P, "Calculative Methods for the C-E Large Break LOCA Evaluation Model", August 1974.

   CENPD-132P, Supplement 1, "Calculational Methods for the C-E Large Break LOCA Evaluation Model", February 1975.

   CENPD-132P, Supplement 2-P, "Calculational Methods for the C-E Large Break LOCA Evaluation Model", July 1975.

   CENPD-132, Supplement 3-P, "Calculative Methods for the C-E Large Break LOCA Evaluation Model for the Analysis of C-E and W Designed NSSS," June 1985.

4. CENPD-135P, "STRIKIN-II, A Cylindrical Geometry Fuel Rod Heat Transfer Program", August 1974.

   CENPD-135P, Supplement 2, "STRIKIN-II, A Cylindrical Geometry Fuel Rod Heat Transfer Program (Modifications)", February 1975.

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   CENPD-135P, Supplement 5, "STRIKIN-II, A Cylindrical Geometry Fuel Rod Heat Transfer Program", April 1977.

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

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

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

# APPENDIX A

## Description of Input Change

# APPENDIX A

## Description of Input Change

Floating Point Data Cards:

| Rel. Add. | COMPERC-II FORTRAN | |
|---|---|---|
| 165 | TPUMP | Time after start of refill that the safety injection pumps start injecting into the RCS, sec (If TPUMP < 0.0, the safety injection pumps start injecting when the safety injection tanks have emptied). |

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