CONF-831047--44

BNL-NUREG-33280

Peach Bottom Turbine-Trip Test 3 Analysis With RELAP5 Code *

M. S. Lu
Brookhaven National Laboratory
Department of Nuclear Energy
Upton, New York 11973

BNL-NUREG--33280

DE83 015151

Submitted to the 1983 ANS Winter Meeting
San Francisco, California

The Peach Bottom turbine trip tests[1] provide excellent benchmark problems for transient analysis of a boiling water reactor (BWR). Analyses of the three turbine trip tests with the RELAP3B/BNL-TWIGL, RETRAN and other codes have been documented.[2,3] The non-equilibrium, two fluid thermal-hydraulic code-RELAP5/MOD1 was recently used to analyze the test at low power, Test 1.[4] This paper presents the analysis of the more severe transient, Test 3, with the RELAP5 code and provides a comparison of the calculated water level with the measurement. (Reference 4 did not provide level comparison for Test 1). In addition, a method has been developed to expedite the establishment of a steady state condition via the plant control system and simple computer code modifications. Using the results of this analysis, the capability of the RELAP5 code will be assessed and the areas requiring further improvement will be shown.

The steady state condition for Test 3 (at 69% rated power) was developed from a BWR/4 deck at rated power[5,6] in the following manner: The computer code was first modified so that the power was ramped to the desired level (69%); the reactivity was set to zero during this period. In the input data, the feedwater and the steam load were also ramped to 69% at the same time. The control system that modeled the pressure regulator and recirculation flow

*This work was performed under the auspices of the U.S.Nuclear Regulatory Commission.

controller per plant design automatically adjusted the turbine control valve and the recirculation pump speed to obtain the desired steady state without further user intervention.

The model has in total 120 volumes and 126 junctions, including 10 nodes for the reactor core and 8 nodes for the steamline.

The calculated reactor power (Fig. 1), steam dome pressure (Fig. 2), core exit plenum pressure and the steamline pressures at the main steam isolation valve and the turbine stop valve agreed very well with the test data. The water level, calculated by accounting for fluid inventory in the vessel above the level probe, taking into consideration the wide variation of flow areas near the separators was in better agreement with the data than the result in Reference 3 in which a bubble rise model was used. Yet, the result remains unsatisfactory. Since the level measurement is an important parameter for the plant safety system, better models for the separator, dryer and their surrounding regions are required for the level calculation.

In order to test the automatic time step feature in the RELAP5 code, a maximum time step (0.02 sec) four times as large as the reference case was used in a sensitivity study. With the large time step, the calculated result did not agree well with the data, and the code did not provide any warning to the user. An automatic time step logic where the time step is determined based on user selected key parameters for the transients has been used successfully in RELAP3B, and could be implemented here to improve the RELAP5 capability.

In summary, RELAP5/MOD1 has been used to analyze the most severe of the three turbine trip tests, Test 3. The code calculated very well the reactor power and the pressure transients throughout the system. The level calculated based on inventory and detailed geometry did not agree as well, although it was in better agreement than a previous analysis.[3] Improved models for the separator, dryer and their surrounding regions as well as a better automatic time step logic based on user selected variables could improve the code.

Reference

1. L. Carmichael et al., "Transient and Stability Tests at Peach Bottom Atomic Power Station Unit 2 at End of Cycle 2", EPRI-NP-564, Electric Power Research Institute, June 1978.

2. M. S. Lu et al., "Thermal Hydraulic Analysis of Peach Bottom II Turbine Trip Tests," BNL-NUREG 25526; H. S. Cheng et al., "Core Analysis of Peach Bottom Turbine Trip Tests," BNL-NUREG 24903, Brookhaven National Laboratory, September 1978.

3. J. Naser et al., "RETRAN Analysis of the Turbine Trip Tests at the Peach Bottom Atomic Power Station Unit 2 at the End of Cycle 2," EPRI NP-1076-SR, Electric Power Research Institute, April 1979.

4. J. C. Wells et al., "RELAP5/MOD1 Analysis of Turbine Trip Test 1 at Peach Bottom Unit 2" proceeding on Nuclear Reactor Thermal Hydraulics 556, Intermountain Technoligies, Inc., January 1983.

5. M. S. Lu et al., "BWR/4 Loss of Feedwater Transient Analysis", BNL-NUREG 32396, Brookhaven National Laboratory, July 1982.

6. W. G. Shier et al., "A Generic BWR/4 Plant Model for Plant Transient Analyses With the RELAP Code," BNL-NUREG report in progress, Brookhaven National Laboratory, 1983.

FIGURE 1
PEACH BOTTOM 2 TURBINE TRIP TEST 3
REACTOR POWER

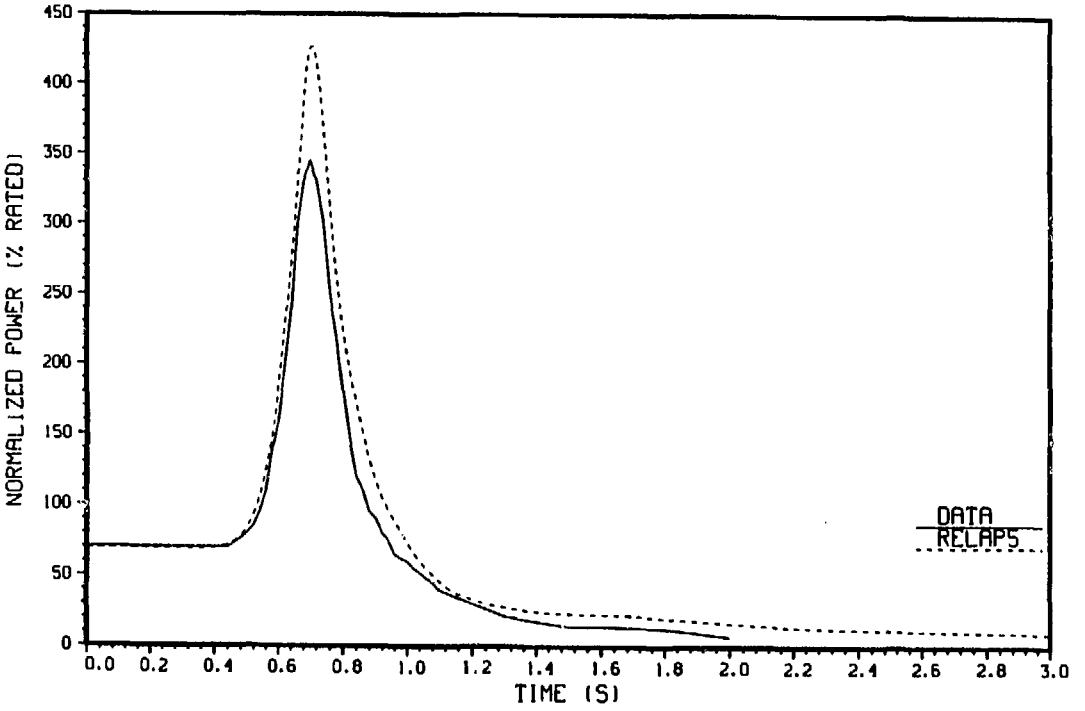
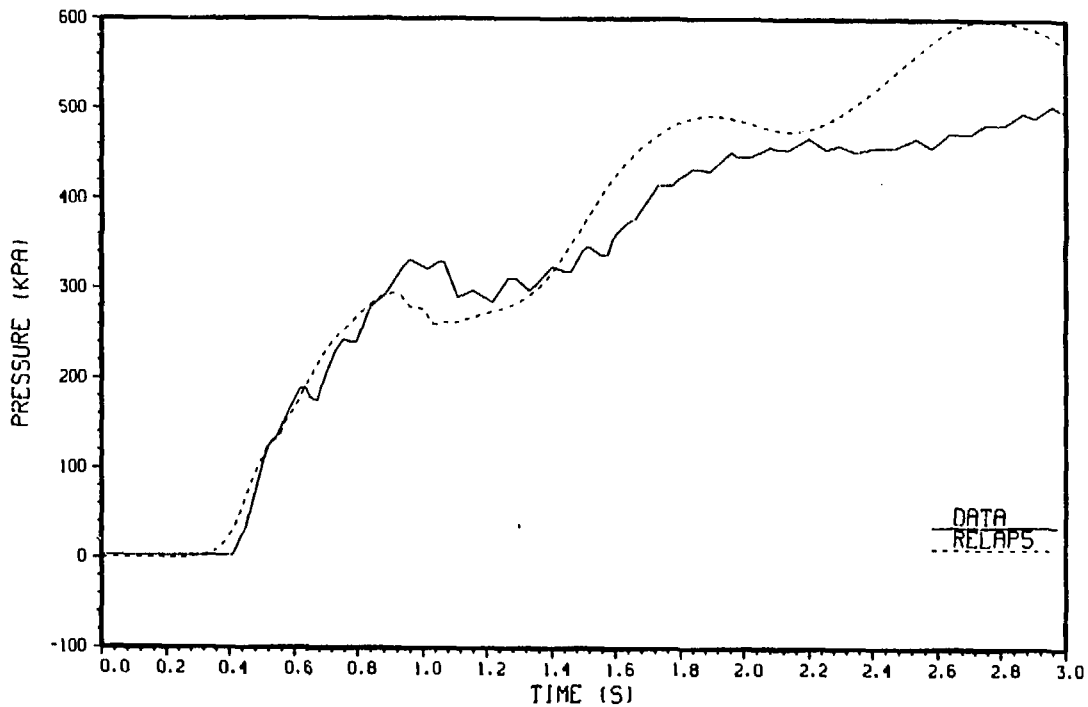


FIGURE 2
PEACH BOTTOM 2 TURBINE TRIP TEST 3
STEAM DOME PRESSURE RISE



DISCLAIMER