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# INDEPENDENT ASSESSMENT OF TRAC-P1A WITH SUPER-CANON BLOWDOWN TESTS*

by

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As a part of the independent assessment of TRAC-P1A code[1], calculations were performed for some of the Super-CANON tests[2]. The purpose of these calculations was to assess the code's capability to predict the transient discharge rate from a horizontal pipe, initially pressurized with subcooled water at high pressure.

The tests were similar to the Edwards' blowdown[3] and the CANON[4] tests. However, for all the Super-CANON tests, the initial pressure inside the pipe was much higher, i.e., 150 bar, which is approximately the operating pressure of a PWR. The pipe inside diameter was 0.1 m and the length was 4.389 m. One end of the pipe remained closed, whereas the other end was ruptured to initiate the blowdown. The diameter of the open end was varied from full-open (0.1 m) to 0.03m, and the initial water temperature was varied from 280° C to 320° C. As the transient progressed, the pressure and temperature at several axial positions, and the area-averaged void fraction at a distance of 1.5 m from the closed end were recorded.

For TRAC predictions, the test section was simulated by a PIPE component with a zero-velocity FILL at the closed end and a BREAK with ambient pressure at the discharge end. After a nodalization study[5], 104 non-uniform cells (with smaller cells near the break) were used to represent the test section. This nodalization was comprised of 84 cells each 0.05 m in length, 18 cells each 0.01 m in length, and two 0.0045 m long cells nearest to the break. The implicit numerical option and the annular flow friction factor option were used, although the results were not sensitive to the other choices available in TRAC-P1A.

Four Super-CANON tests with two different break diameters (0.1 m and 0.03 m) and two different initial water temperatures (280° C and 320° C) were calculated with TRAC-P1A. Figure 1 shows typical results for the run with the full open break of 0.1 m diameter, and the initial water temperature of 280° C. Since the pressure tap P3 was located near the void fraction measurement station, the pressure trace obtained at this location is shown along with the void data. It can be seen that up to about 0.05 second, TRAC-P1A overpredicts the experimental value of pressure by as much as 10 bars. Thereafter, the calculated pressure decreases rather sharply, and beyond 0.1 second, the code underpredicts the experimental pressure. This behavior of calculated pressure is consistent with the predicted void fraction which is somewhat higher than the measured values during the period in which the calculated pressure drops rather sharply. From the pressure predictions, it can be inferred that TRAC-P1A overpredicts the discharge flow rate, and empties the pipe earlier than the experiment. Similar results were obtained for the run with full open break and an initial temperature of 320° C.

For the runs with smaller break diameter, i.e. 0.03 m, the sudden area change model of TRAC-P1A was employed through input specification. However, the results were similar to that obtained for the full-open breaks. Typical comparisons between the TRAC-P1A prediction of pressure and the measured values are shown in Figure 2. It can be inferred that even for these cases with smaller break sizes, TRAC-P1A overpredicts the discharge flow rates.

In order to resolve the above discrepancies between the TRAC-P1A calculations and the experiments, two specific changes were made in the code separately, and the test with full-open break and the initial temperature of 280° C was rerun. First, the relative velocity in the calculation was reduced by decreasing the value of void distribution parameter, $C_0$, from the built-in value of 1.1 to 1.01. Thus the flow approached a homogeneous condition. This reduction in relative velocity did not affect the short-term ($t < 0.1$ sec) pressure history. However, the discharge flow rate was somewhat reduced, and the long-term (t > 0.1 sec) pressure prediction was in closer agreement with the data.

Secondly, the correlation of Alamgir and Lienhard[6] for flashing delay was incorporated in the code. This change delayed the onset of vapor generation until the pressure dropped below the saturation pressure by a certain amount. However, the calculations showed that although a pressure undershoot was obtained, the calculated pressure recovered to the original TRAC-P1A prediction within a millisecond. Thereafter, two predictions were almost identical. Therefore, the inclusion of the flashing delay model alone cannot improve the code prediction for these experiments. Further examination of the vapor generation and relative velocity models is required to resolve the discrepancy between the code predictions and the experimental data.

## REFERENCES

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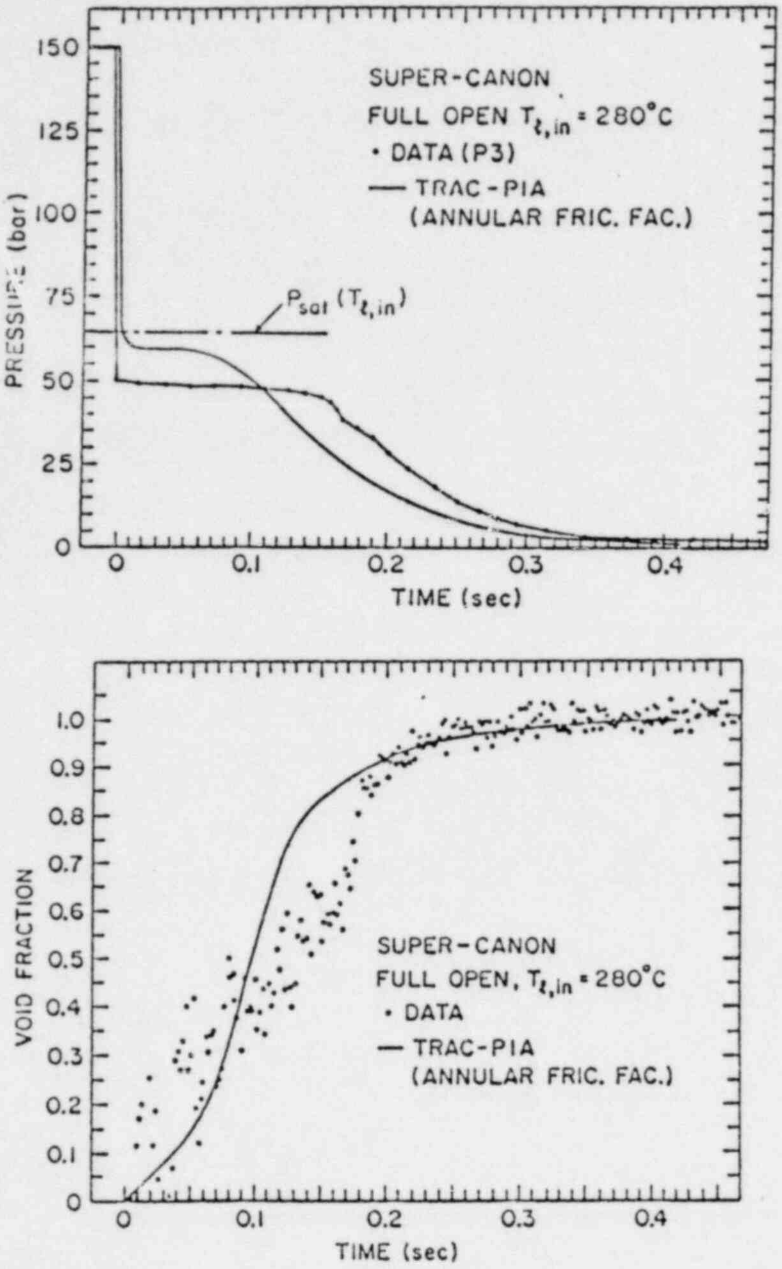

Figure 1. Comparison of TRAC-P1A Prediction of the Pressure and Void Fraction with the Experimental Data of a Super-CANON Test with Full Open Break and Initial Water Temperature of 280° C.

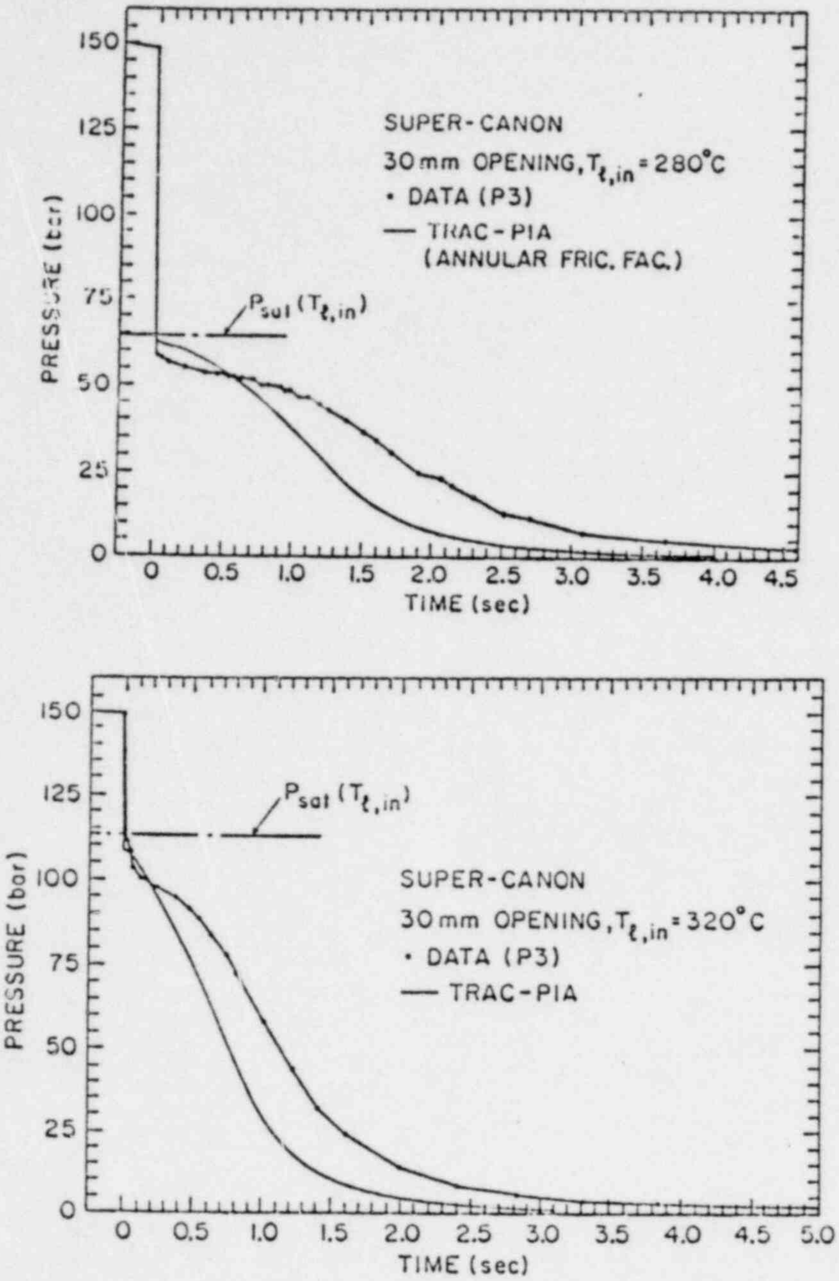

Figure 2. Comparison of TRAC-P1A Prediction of the Pressure with the Experimental Data of Super-CANON Tests with 0.03 m Break Diameter.