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INTERIM REPORT

Monthly Highlights

for

September 1979*

Light Water Reactor Thermal Hydraulic Development Division

Budget Activity 60-19-10-01

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1.1 Analytical Modeling (B.J.C. Wu and N. Abuaf)

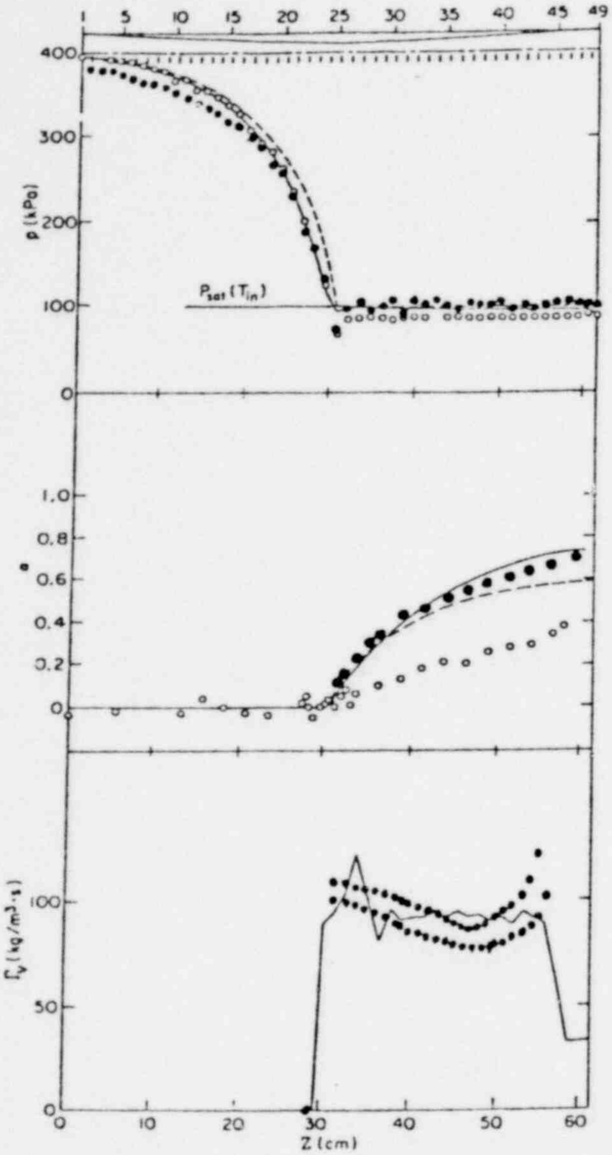
A preliminary evaluation of net vapor generation rate from pressure and area-averaged void fraction distributions measured in the latest series of experiments (see below) has been made. Figure 1 summarizes the results which are compared with data from an earlier experiment done under similar conditions. In addition, the results of TRAC-P1A calculation are shown. In Figure 1 we have also presented pressure distributions and void profiles calculated by a homogeneous equilibrium process. This simple approach seems to predict both the pressure and void fraction profiles close to TRAC-P1A calculations. This observation, together with our finding that flashing inception in our experiments started at the throat, lead us to the thought that we can model our venturi experiments with three regions. One region is solid water upstream of the throat, a transition zone at the throat with single-phase superheated liquid upstream and two-phase downstream, and a third region downstream of the transition zone that can be calculated as two-phase equilibrium flow.

The jump conditions (Rankine-Hugoniot) relating states across a flashing front have been evaluated from some of our experimental data, as well as data of Schrock, Starkman, and Brown's experiments. The maximum mass fluxes through a flashing front, G_{cr} are given as a function of the pressure immediately upstream of the front in Figures 2 and 3 for a BNL experiment and an experiment of Schrock's. The experimental mass fluxes, G_{exp} are also displayed. An intersection of the two curves G_{cr} and G_{exp} would give the location where the flashing front may be maintained. As may be seen in the figure, such an intersection was not found in either of these experiments.

The basic equations of mass, momentum, and energy conservation across the transition zone implies an adiabatic, frictionless, constant area process and the equation of state applied after the transition zone assumes a complete relaxation to the equilibrium conditions. The lack of the intersection mentioned above may imply that either some of the basic assumptions in the equations is not valid or that the liquid undergoes a partial relaxation and is not yet at complete equilibrium. The assumptions underlying this treatment are currently being reexamined in an effort to resolve this problem.

1.2 Flashing Experiments (G. A. Zimmer, J. H. Klein, B.J.C. Wu, and N. Abuaf)

The room temperature full and empty calibrations of the test section were performed with the multibeam gamma densitometer. The single-phase hydrodynamic calibrations of the nozzle effective area were completed with the new turbine meters and the recently installed automatic computer-controlled scanivalve system. Flashing experiments at inlet temperatures of 100 ^{o}C and 125 ^{o}C were completed for various inlet mass fluxes. In all these runs, the static pressure distributions were recorded, as well as the transverse distribution of the chordal averaged void fractions at every axial location. One of the experiments (RUN 130) was analyzed in detail and the pressure distributions, area-averaged void profiles and vapor generation rates were compared with TRAC-P1A predictions (Figure 1). The static pressure distributions presented in Figure 1 shows the accurate repeatability of the experimental data run under similar conditions with a time period of more than six months between them. The area-averaged void profiles depicted at each axial location in the same figure were obtained from detailed transverse profiles of chordal averaged void fractions measured with the five beam gamma densitometer. These detailed radial profiles are presented in Figure 4 for various axial locations upstream of the test section exit (Top Home). The open circles, (in Figure 1), which depict the results of a previous experiment (RUN 76), show that the axial distribution of the diametrical averaged void fractions is not representative of the area-averaged values for this flow regime configuration. This finding implies that under some experimental conditions and specific flow regimes, the diametrical averaged void fractions measured experimentally will not provide a true picture of the area-averaged void fractions (difference between open circles and dark circles in Fig. 1) and any comparison of these diametrical averaged void fraction to area-averaged void fraction predictions by various models can lead to inaccurate conclusions.



Pressure Distribution

Measured: ● Run 130

○ Run 761

Calculated: —— TRAC

---- Equilibrium

Void Fraction Distribution

Measured: ● Run 130 Area Average

○ Run 762 Diametrical Average

Calculated: —— TRAC

---- Equilibrium

Net Vapor Generation Rate

Deduced from Run 130: ●
(Upper trace for $C_o = 1.1$,
lower trace for $C_o = 1.0$)

Calculated: —— TRAC

Figure 1 - Comparison of TRAC predictions and homogeneous equilibrium calculations with BNL experiments. All experimental data displayed were obtained under the same run conditions: $G_{in} \simeq 6040\ kg/m^2s$, $p_{in} \simeq 395$ kPa, $T_{in} = 99.3\ ^oC$. Runs 76, 761, and 762 were made previously, and details are discussed in BNL-NUREG-26003; Run 130 is the new experiment where chordal averaged void fractions were recorded as a function of transverse location and axial location.

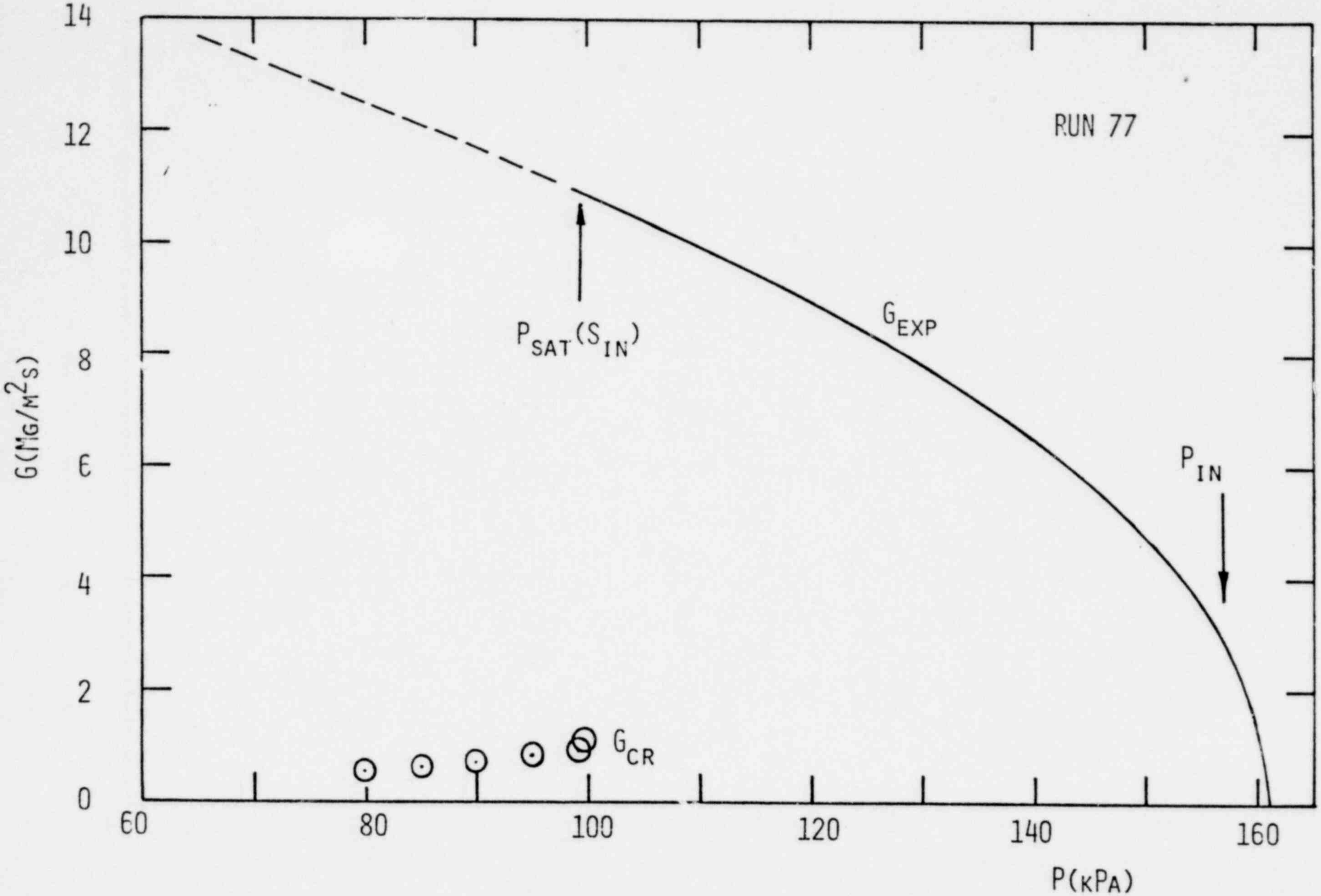


Figure 2 - Comparison of experimental mass flux G_{exp} and the maximum mass flux G_{cr} predicted by a "jump model" of flashing region for BNL experiment 77.

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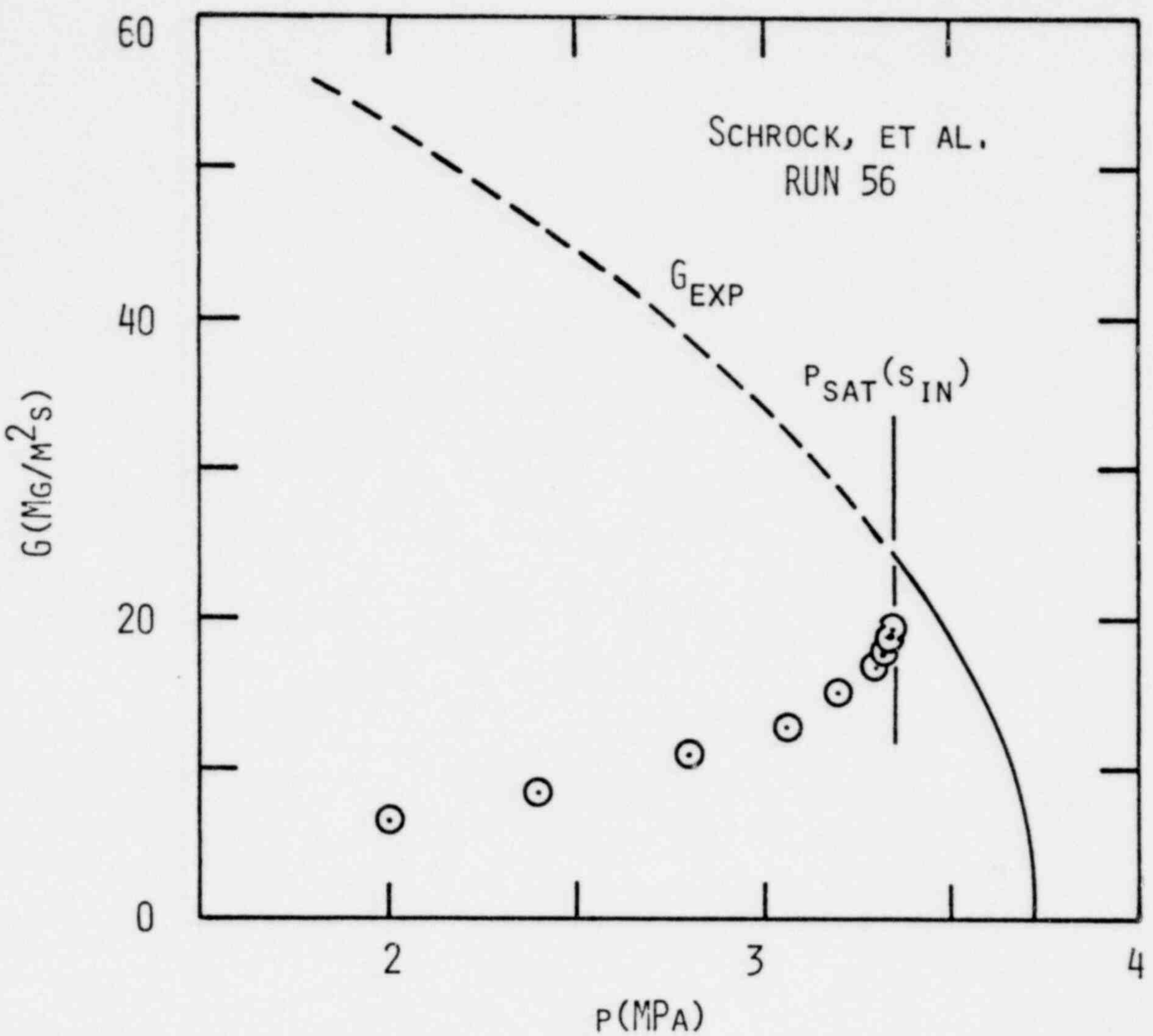

Figure 3 - Comparison of experimental mass flux G_{exp} and the maximum mass flux G_{cr} predicted by a "jump model" of flashing region for Run 56 of Schrock, Starkman, and Brown (1977).

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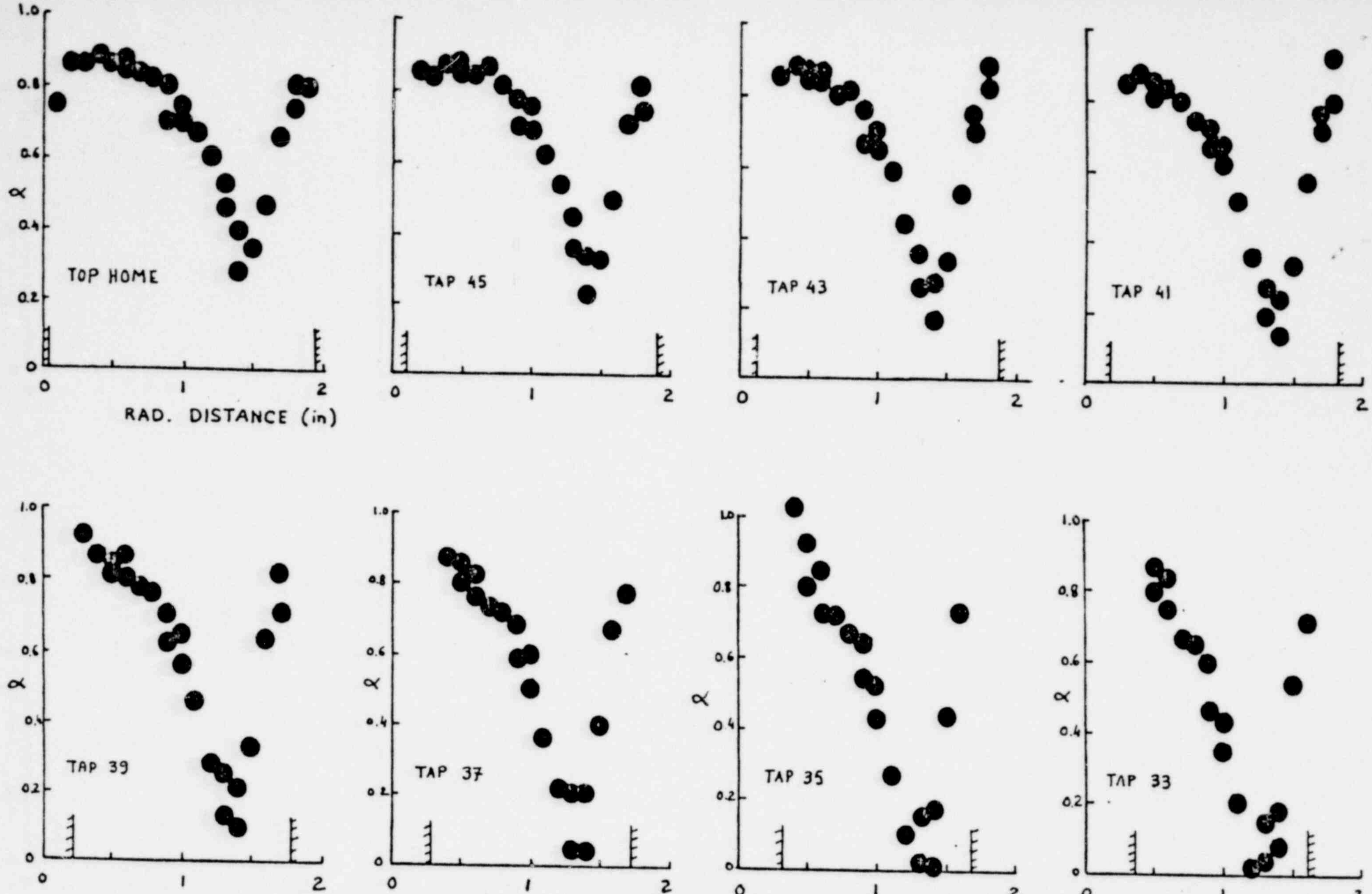

Figure 4 - Transverse distributions of the chordal averaged void fractions at several axial locations, corresponding to various static pressure tap positions. Run 130, $G_{in} \approx 6040\ kg/m^2s$, $p_{in} \simeq 395$ kPa, $T_{in} = 99.3\ ^oC$.