Level Tracking

- 12 years ago a substantial improvement was introduced to the level tracking models in TRAC-B, TRAC-P and RELAP5 based on work at Penn State University.
  [Aktas, B. and J. H. Mahaffy, "A Two-Phase Level Tracking Method," Nuclear Engineering and Design, Vol. 162, pp. 271-280 (1996)]

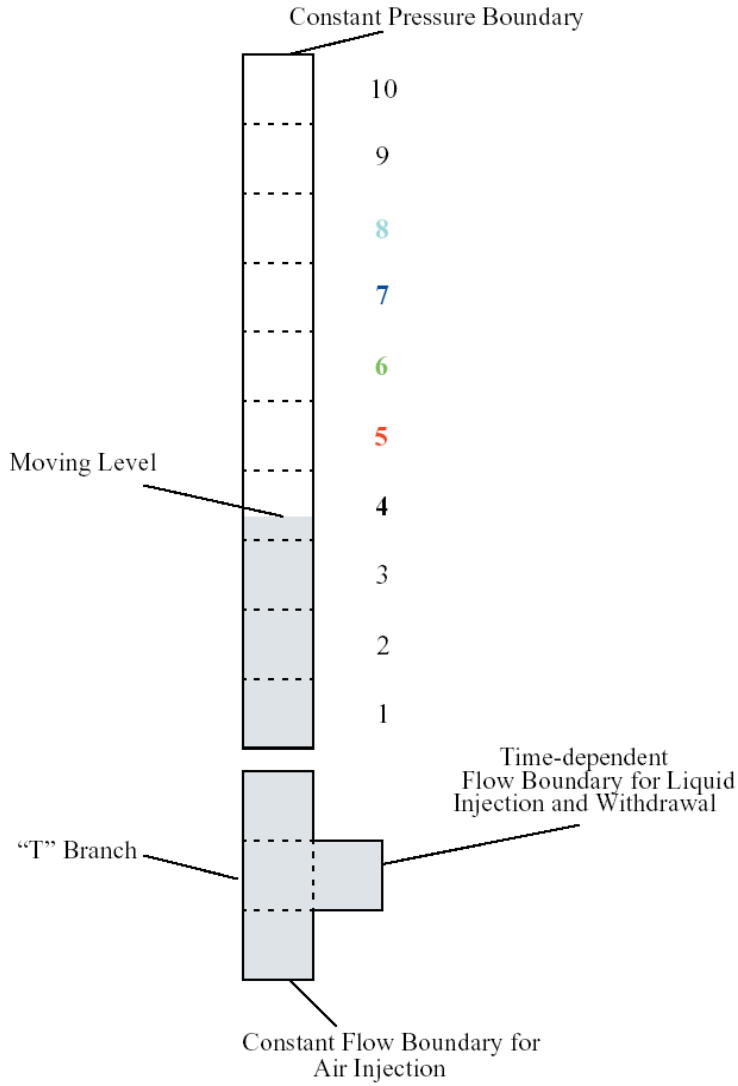
- This methodology has been substantially improved by Birol Atkas, and totally rewritten to fit in the modernized structure of TRACE. [Aktas, B. "Tracking Interfaces In Vertical Two-phase Flows,"ICONE 10, (April 2002)]

- Modifications have been introduced that substantially reduce the tendency of the original implementation to force small time steps when a level crosses a cell edge. Results when levels cross cell boundaries are in general much cleaner with very little smearing of void fraction profiles.

- For vertical flow this model has eliminated the need for the old water packing model.

- A very large suite of test problems has been introduced to verify the functionality of the model, and assure that it is not damaged by future code modifications. In addition to normal operation, level tracking has been verified for restart, levels crossing component boundaries, and levels crossing between components modeled on separate processes in an ECI driven parallel calculation.

A Simple Level Tracking Test

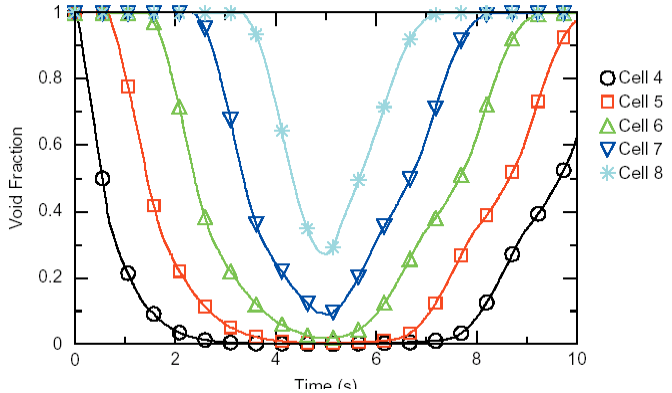


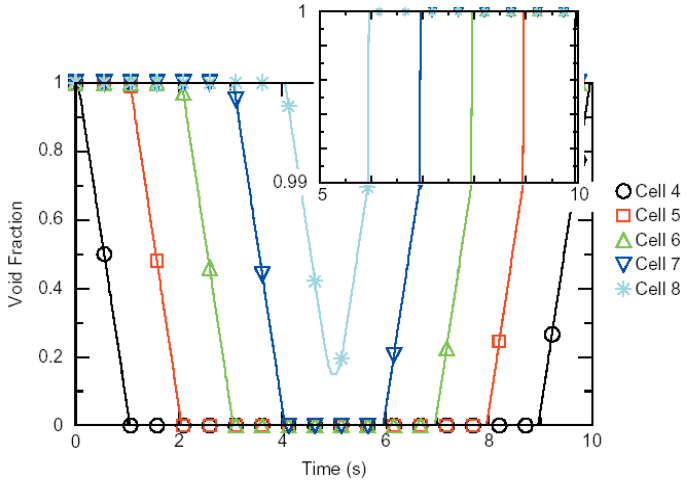
Results for Rising and Falling Level

Without Level Tracking

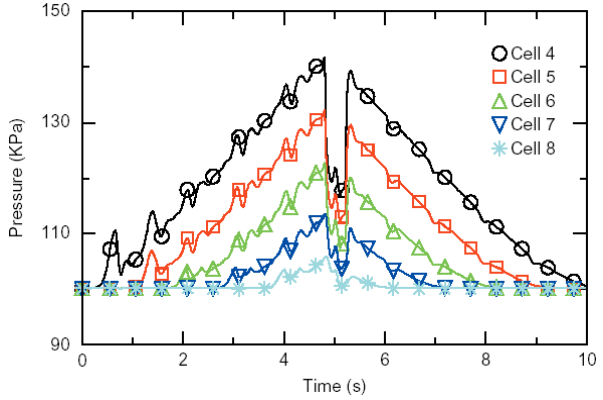
With Level Tracking

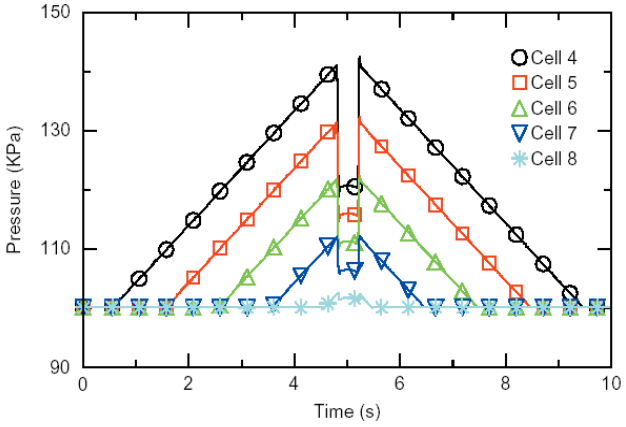
Void Fraction





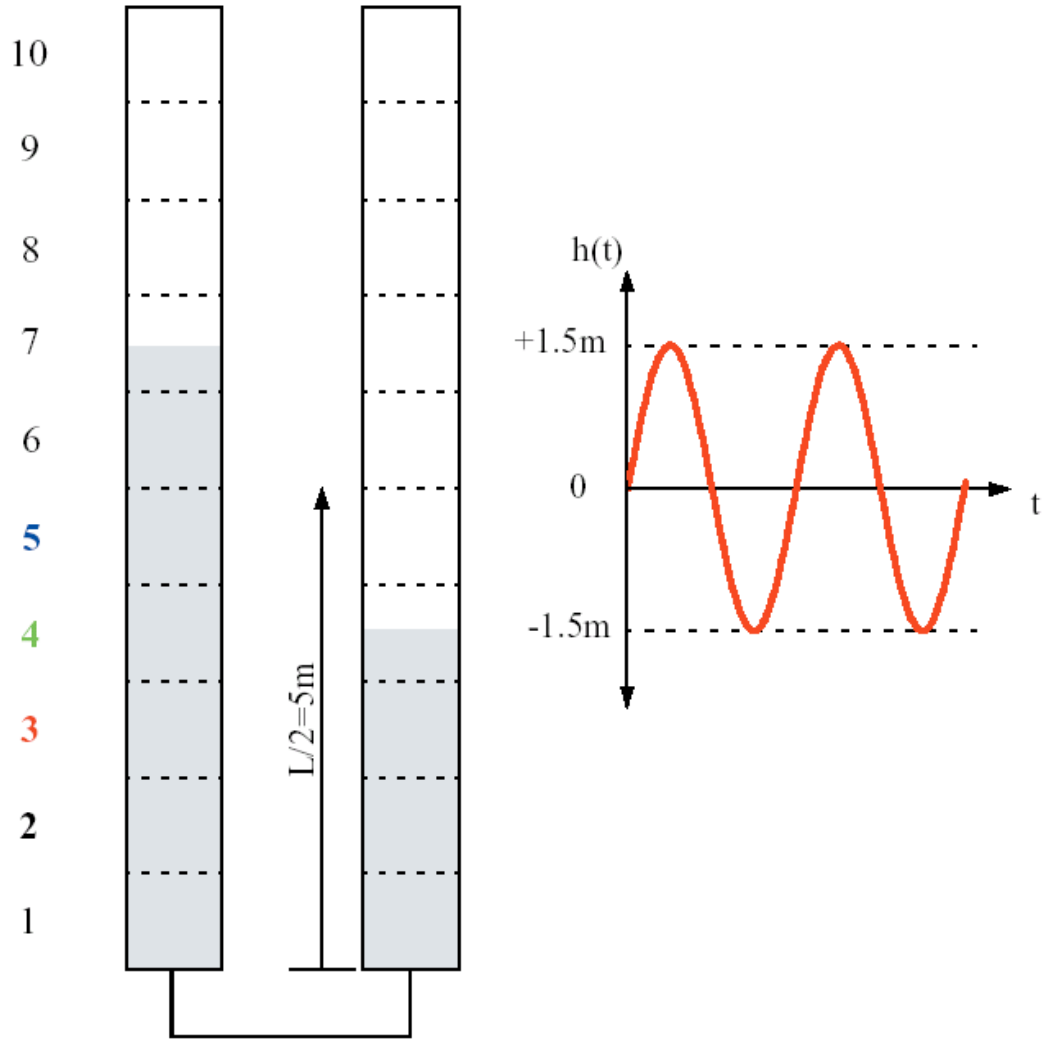
Pressure





Void fraction traces have much sharper transitions to pure air or pure water than previous implementations. Pressure behavior near 5 seconds in both cases is associated with a large flow acceleration, as boundary conditions switch abruptly from inflow to outflow of liquid at the bottom.

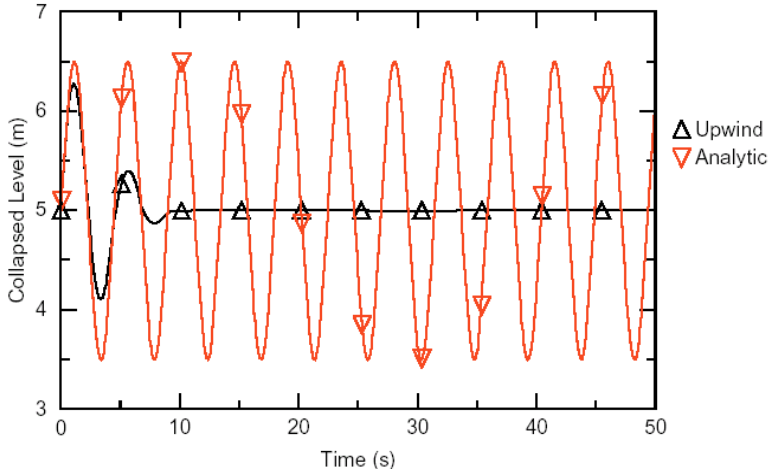
Standard Manometer Test



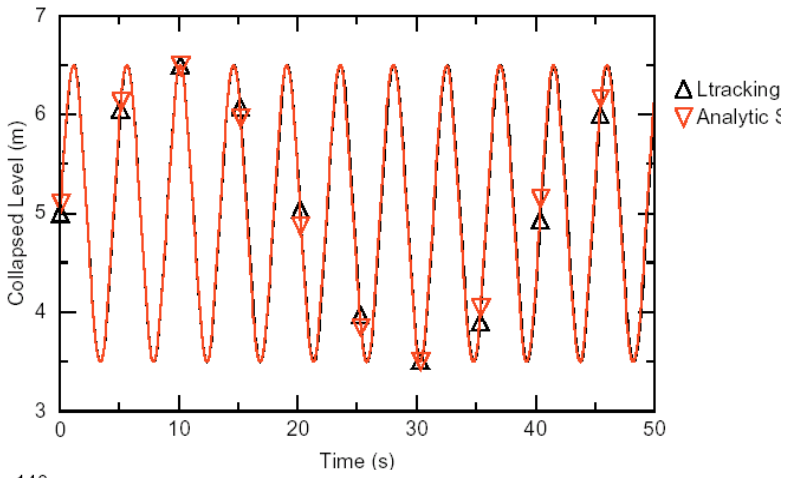
Manometer Results

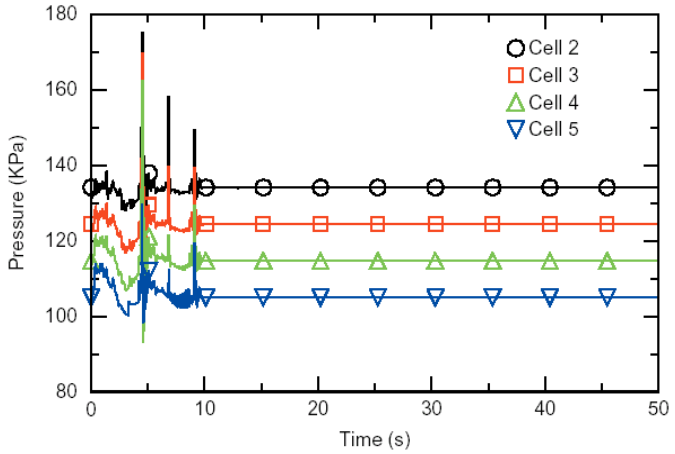
Without Level Tracking

With Level Tracking

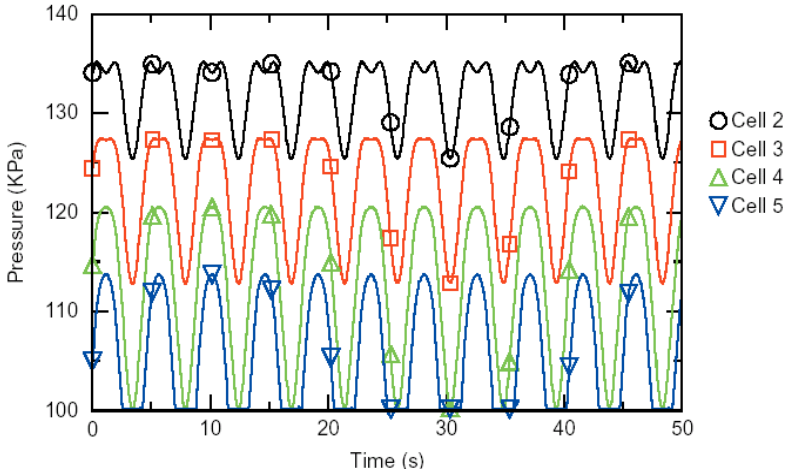


Level



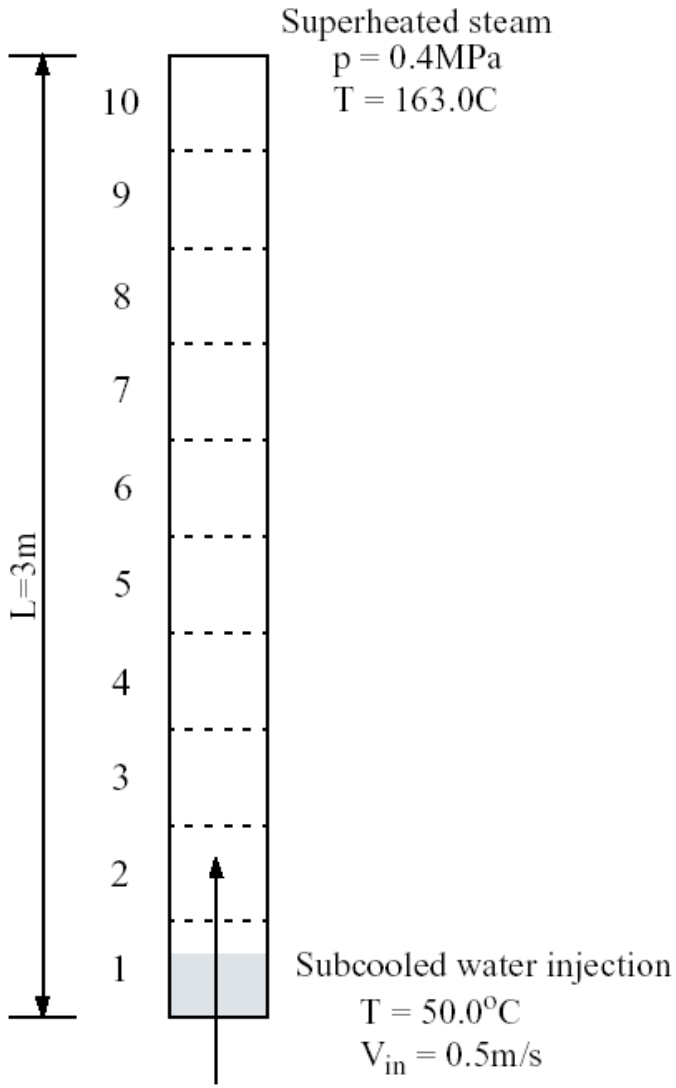


Pressure



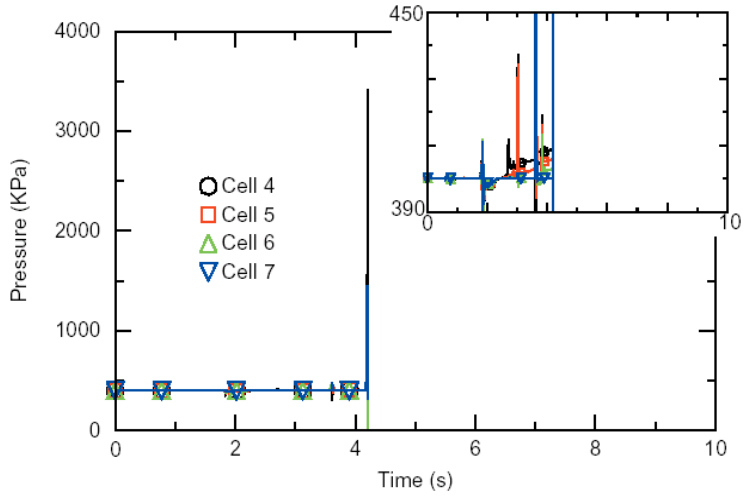
Results with level tracking overlap analytic results. Pressure plots are very important. If Brand X level tracker does not show you pressure plots, they are either not paying attention to details, or are hiding flaws in their model.

Rising Cold Liquid in Steam

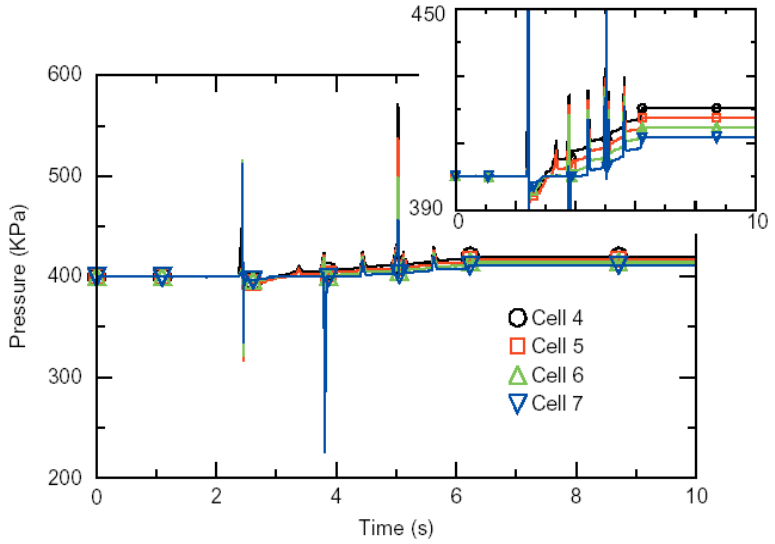


Rising Cold Liquid in Steam

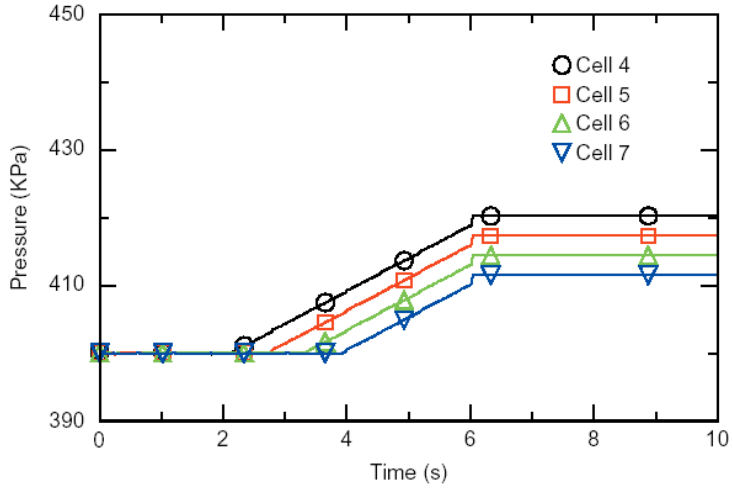
Pressure for Base Code



Pressure with Water Packing Model



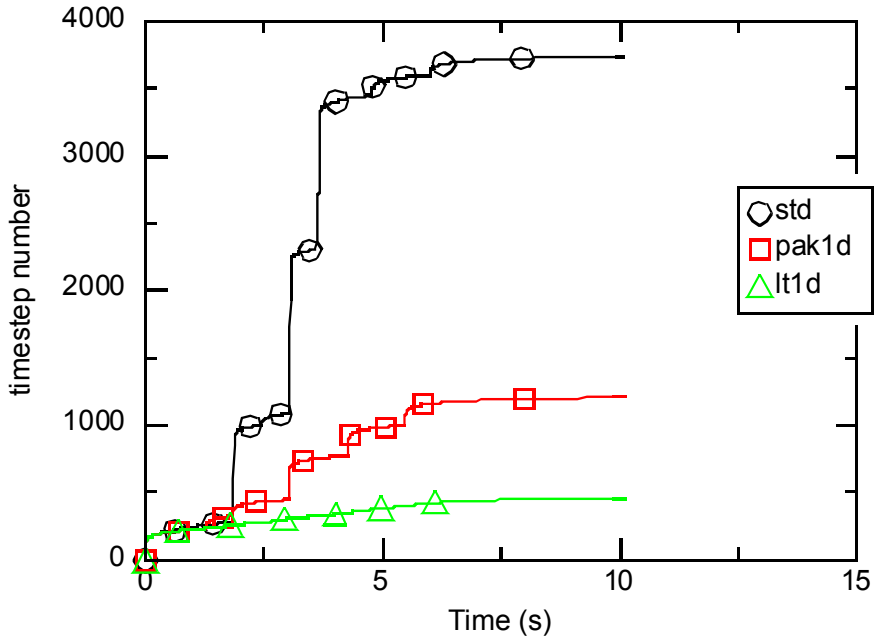
Level Tracking Model Engaged



The model currently accounts for level location in computation of interfacial drag and interfacial area. However, work is still needed to link the level tracking model to a sub-grid energy equation that accounts for a buildup of saturated liquid at the water/steam interface.

Run Time Improvements with Level Tracking

Level rising into steam using the semi-implicit numerical method with no special models (std), with water packing (pak1d), and with level tracking (lt1d).



Level rising into steam using the SETS numerical method