Idaho National Engineering and Environmental Laboratory

RELAP5-3D Development & Application Status

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Outline

- *Improvements in Version 2.0*
- *Ongoing and future work*
- *Current applications at the INEEL*

RELAP5-3D Version 2.0

New models and improvements to existing models

- ***DETECTOR MODEL*** **-** Simulates the response of an in-core detection device that senses the radiation field and generates a signal based on the strength of the field
- ***PRIZER MODEL*** **-** The PRIZER model now permits the user to specify a multiplier to be applied to the interfacial heat transfer coefficients (gas and liquid sides)
- ***CRITICAL FLOW MODEL*** **-** Discontinuities in the default critical flow model would occasionally be reported during the transition from single- to two-phase conditions. Modifying transition logic corrected the problem

RELAP5-3D Version 2.0

New models and improvements to existing models (cont'd)

- ***INTERFACIAL DRAG MODEL -*** The interfacial drag model was modified to overcome non-physical void oscillations that were exhibited in a model of the GE 1-ft. Level Swell Experiment 1004-3. "Widening" the transition region between the churn-turbulent bubbly correlation and that of Kataoka-Ishii fixed the problem.
- ***BPLU -*** Two outstanding problems with the Border-Profile-Lower-Upper (BPLU) matrix solver were resolved. It is the fastest solver for virtually all RELAP5-3D problems. Users are encouraged to try BPLU and report back to the INEEL what improvements in run time they are able to attain.

RELAP5-3D Version 2.0

New models and improvements to existing models (cont'd)

- ***RBMK CROSS-SECTION LIBRARIES -*** Two sets of RBMK-specific cross section libraries were developed, one for Kursk and one for Ignalina. The two versions were combined into one, adding options in the input file for specifying problem-dependent information, adding the capability for accessing pointwise kinetics output data, and other miscellaneous changes.
- ***LARGER MODELS ACCOMMODATED -*** To accommodate larger RELAP5-3D models being developed the size of the main storage array in the code was increased. Whereas Version 1.3 required at least 28 MB of RAM to load, Version 2.0 requires at least 72 MB.

RELAP5-3D Version 2.0

New models and improvements to existing models (cont'd)

- ***SEPARATOR MODEL -*** The model was extended to allow some liquid to exit the vapor/gas outlet junction and some vapor/gas to exit liquid fall back junction

RELAP5-3D Version 2.0

New User Options

- ***New volume initial condition option -*** Allows the user to specify the initial composition and thermodynamic state by inputting pressure, liquid temperature, vapor/gas temperature, vapor/gas void fraction, and noncondensable quality.
- ***Allow heat structures to be "decoupled" from the hydrodynamic model -*** This new capability retains the normal response of a heat slab to the model's hydraulic conditions, but does not include the energy convected to/from the heat structure and the fluid. [IRUG funded]

RELAP5-3D Version 2.0

New User Options (cont'd)

- Allow specification of a sink temperature as a control variable in the wall heat transfer
- Added variables representing parts of the pressure drop term to the list of junction quantities available for plots/minor edits
- Allow restart without inputting the restart number
- Permit turning off interfacial drag

RELAP5-3D Version 2.0

- SCDAP/RELAP5-3D is included on the CD-ROM for trial use
- RGUI is included with Version 2.0 for all IRUG members

RGUI Improvements

- Heat Structure Screen
- SCDAP Vessel Screen
- PYGI GUI
- THUMB Deck Builder (Begun)

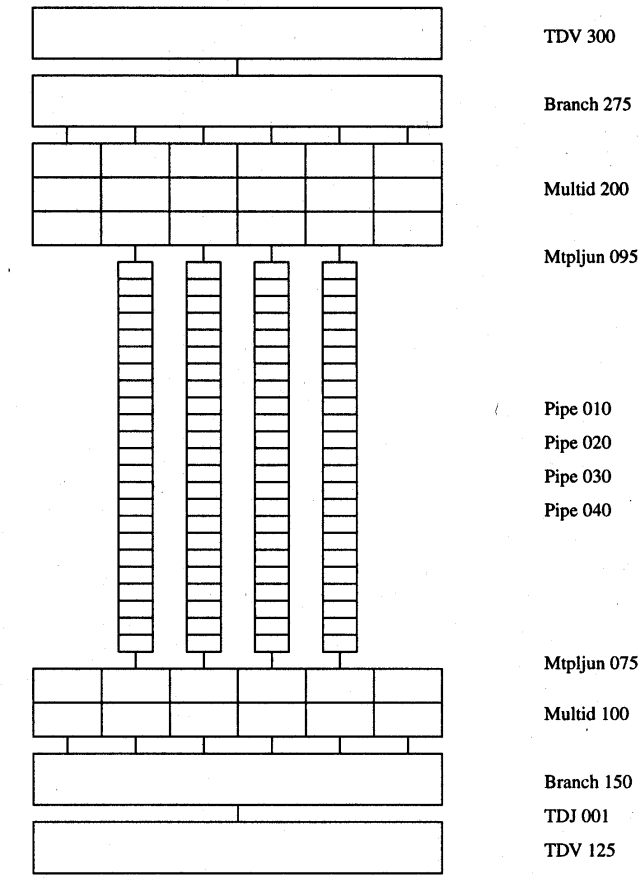
Ongoing and Future Work

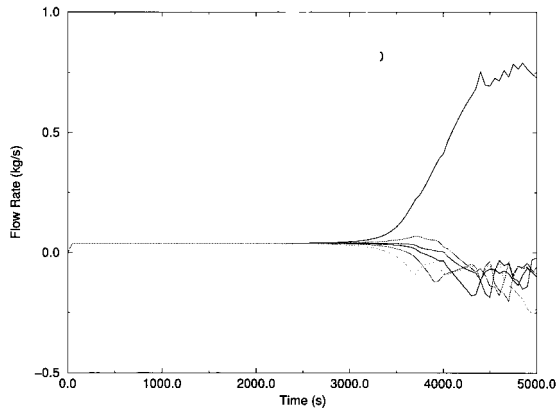
- **MULTI-THREADED -** *permit execution of RELAP5-3D in parallel when coupled to another code using the PVM methodology*
- **AIR APPEARANCE -** *Improve air appearance logic so that a time step backup is not necessary since this wastes CPU time*
- **REFLOOD ON LEFT -** *Allow reflood model to be applied to left side of heat structures*
- **FORTRAN 90 -** *Continue implementing FORTRAN 90 constructs*

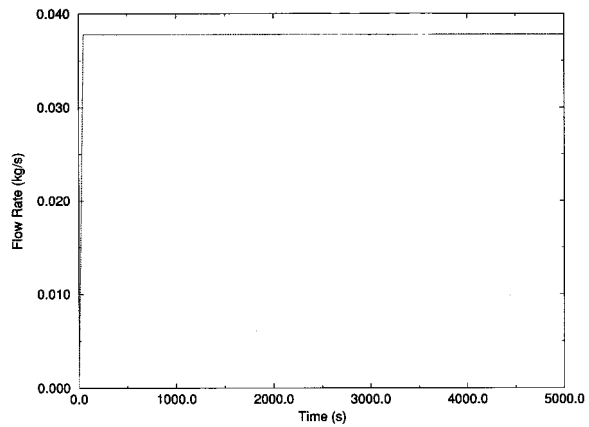
Ongoing and Future Work (cont'd)

- **TURBINE MODEL -** *Make model more mechanistic*
- **FEEDWATER HEATER MODEL -** *Allow horizontal feedwater heaters with variable heating based on water level*
- **COUPLING -** *Enable explicit coupling methodology to preserve mass and energy*
- **3D ASYMMETRY -** *Resolve cause of asymmetrical result in a 3D flow problem*

Anomalous asymmetry in a simple flow problem was mitigated by truncating spurious ΔP's arising from machine round-off







Current Validation/Applications

- ***International Nuclear Safety Program***
  - *Validation for VVER modeling using data from the PSB facility*
  - *VVER CHF tests*
  - *IRUG-East meeting in Kiev*
  - *RBMK modeling workstation*
- ***Generation IV reactor studies***
  - *MASLWR*
  - *Pb-Bi*