RELAP5-3D Reported Problems and Requested Improvements

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Introduction

• Reported problems usually fall into the categories of installation problem, input processing failure, code execution failure, restart/renodalization failure, and unphysical result.

• Requested improvements are new capabilities.

• This presentation will discuss some of the more recent generic code problems and improvements for RELAP5-3D.
INEEL Contact for User Problems

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Partial Backups Replaced With Full Backups

- Previously, code had 3 partial backups: velocity flip-flop, noncondensable appearance, water packing.
- Partial backups had added much complexity to the code; thus, replaced with full backups for both semi-implicit scheme and nearly-implicit scheme.
- Since PVM coupled computation had full backups in semi-implicit scheme, extended this to include full backups for uncoupled computation.
- Full backups were incorporated in nearly-implicit scheme for uncoupled computation.
Partial Backups Replaced With Full Backups (Continued)

- Semi-implicit scheme full-backups: velocity flip-flop (also added major edit junction printout), noncondensable appearance, water packing.
- Nearly-implicit scheme full-backups: velocity flip-flop, noncondensable appearance, no water packing since currently not in nearly-implicit scheme.
- Verification: development input decks, Zion-1 PWR small break input decks (typpwr, typ1200, etc.).
Cladding Deformation Model Corrections

- Previously, when cladding ruptured, change in the hydrodynamic flow area was incorrect for more than 1 heat structure segment connected to the flow area.
- Now, flow area change was corrected by weighting it by a factor (the heat structure segment length divided by the flow length); this was then normalized by the sum of all such factors for this hydrodynamic volume.
- Previously, when cladding ruptured, heat structure geometry’s internal gap pressure was set to external hydrodynamic volume pressure when the number 1 heat structure segment ruptured (could be top or bottom depending on the numbering).
Now, this was corrected by resetting the internal gap pressure when any of the heat structure segments ruptured.

This will now occur at the same segment for any numbering; can occur at the top, bottom, or any of the middle segments.

Limits were also placed on the hydrodynamic flow area so that it does not go the zero (similar to what was done when SCDAP was linked with RELAP5-3D).
Level Model Corrections

- Previously, level stack input processor incorrectly found 4 level stacks in pressurizer deck with 3 abrupt area junctions.
  - Now, fixed; found missing line in subroutine LEVSKT.
  - Previously, calculation failed with segmentation fault in subroutine LEVEL.
  - Now, fixed; variable not set in subroutine LEVEL.
  - Previously, calculation failed with divide by zero in subroutine LEVEL.
  - Now, fixed; modified level velocity calculation and protected against divide by zero.
Level Model Corrections (Continued)

- Previously, calculation showed oscillations when compared to calculation on earlier code version.
- Now, fixed; bottom and top connecting u-tube junctions were made horizontal and kept above volumes in stack if bottom volume is made not vertical.
- Previously, calculation failed with thermodynamic property error at minimum time step in volume with level model on.
- Now, fixed; ramped off pancake model and ramped on non-pancake model at low void fraction.
Pump Model Input

- Previously, pump model did not allow the user to input the exponent, as well as the coefficients in the friction torque model (the turbine model already does this).
- Previously, pump model also did not allow a user supplied lower limit and critical speed ratio on the friction torque.
- Now, optional input words 13-17 of data cards CCC0302-CCC0304 were added to include the exponent, lower limit, and critical speed ratio.
Metal-water Reaction Model Output

• Previously, metal-water reaction model output variables (outside oxide thickness, inside oxide thickness, hydrogen generated) for each heat structure were only available in major edits.

• Now, metal-water reaction model output variables are available in minor edits/plots.

• The outside oxide thickness variable is OXTO, the inside oxide thickness variable is OXTI, and the hydrogen generated variable is H2GEN.
CCFL Model Output

- Previously, junction ccfl flag (0 if flow is not ccfl-limited, 1 if flow is ccfl-limited) was only available in major edits.
- Now, junction ccfl flag is available in minor edits/plots.
- The junction ccfl flag variable is CCFLF.
- This is similar to junction choking flag (variable is CHOKEF).
Summary

• Full backups are now used instead of partial backups (semi-implicit scheme and nearly-implicit scheme).
• Cladding deformation model corrected (more than 1 heat structure and resetting internal gap pressure).
• Level model problems (stacks, failures, oscillations) have been fixed.
• User-friendly changes have been implemented:
  - Pump model input
  - Metal-water reaction model output
  - CCFL model output