Release Notes for RELAP5-3D Version 3.0

Code Improvements from Version 2.4

The following is a brief description of improvements and new features in version 3.0. The associated material in the User Manuals shown as an underline.

Turbine Specification Cards Modified

Modified Card CCC0400, Turbine Performance Data. Two new words were added (W7 and W8).

W7(R) User-specified control variable number for the multiplier on the user-specified form loss for the junction identified in W8.

W8(I) Junction number.

Modified Card CCC0401, Type-3 Turbine Performance Data. One new word added (W9).

W9(I) User-specified control variable number for the multiplier on the calculated efficiency.

See Vol. 2, Appendix A, Section 7.

Pump Specification Cards Modified

Modified Card CCC0301, Pump Index and Option. Two formats are now allowed. Previous code version only allowed 7 word format.

a) 7 word format – two-phase pump degradation multipliers as a function of void fraction only.

b) 9 word format – two-phase pump degradation multipliers as a function of void fraction and pressure.

Modified Cards CCCXX00 – CCCXX99, Pump Two-Phase Multiplier Tables.

a) Format for two-phase multiplier as a function of void fraction only. W1, W2, W3, repeat W2 and W3 up to 100 pairs.

b) Format for two-phase multiplier as a function of void fraction and pressure.

See Vol. 2, Appendix A, Section 7.

FORTRAN 90 Conversion

- Machine independence via F90/95 intrinsics
- Machine independent plot, strip, fluids files
    - Separation of restart from plot files
    - Multiple formats for plot files
- Elimination of many memory restrictions
- Modernize code for longevity considerations
    - Modern language for current-day developers
    - Code easier to read and understand

ANS2005 Decay Heat Standard Added

The ANSI/ANS decay heat standard was revised in 2005. This decay heat standard is now incorporated in RELAP5-3D.

Modified Card 30000002, Fission Product Decay Information

W1(A) Fission product type now allows ANS05-1 and ANS05-4 as acceptable options.

See Vol. 2, Appendix A, Section 15.

Nodal Kinetics Upgrades

Krylov solver is recommended over LSOR

Card 30000003, Nodal Kinetics Control Information

W17(I) Set to 1 for Krylov solver

New features include

- Full steady-state and transient solution (with restart)
- 4 Energy group representation (up- and down-scatter)
- TPEN nodal solution
    - Slower, but higher accuracy over NEM
    - Useful for problems with steep flux gradients
- GMRES solver added as compliment to BiCGSTAB
    - Better performance for poorly-conditioned linear systems
- Rod Decusping Logic (TPEN only)
- Reactivity feedback edits

See Vol. 2, Appendix A, Section 15.

Time-step Inconsistency Correction

A new integer time-stepping algorithm was implemented in the RELAP5-3D code. This corrected many time-step inconsistencies in calculations.

Sound Speed Calculation Correction

RELAP5-3D code now has junction sound speed calculation method with noncondensables present consistent with volume sound speed calculation method with noncondensables present. The old calculation method is available with Card 1 Option 3.

See Vol. 2, Appendix A, Section 2.

Implementation of Viscous Effects

Some turbulent effects can be modeled using the MULTID component.

Controlled by Card 1 Option 31

PVM Coupling Junction

Created to eliminate the unused “from-volume” in PVM coupling problems and to reduce input.

See Vol. 2, Appendix A, Section 7.

New Fluids DowThermA and r134a

Fluids DowThermA and r134a were added to the list of available fluids.

See Vol. 2, Appendix A, Section 2.

MetaStable Extrapolation at Constant Temperature

Mass error can result in a bad liquid density extrapolation at constant pressure. Capability to extrapolate at constant temperature was added.

This capability is accessed with Card 1 Option 71.

See Vol. 2, Appendix A, Section 2.

Mass Error Edits

Mass error edits were added for

- Total (liquid plus vapor)
- Liquid
- Vapor (includes the noncondensables)
- Noncondensables
- Boron

Groeneveld CHF table fix

The Groeneveld CHF table was found to have erroneous values entered when compared with the original document. These errors were corrected in this version of the code.

Alternate Heat Structure – Fluid Coupling Model

Uses estimate of average temperature in the volume for heat flux computation. It is restricted to single phase vapor/gas conditions.

Card 1CCCG501 – 1CCCG599 and/or 1CCCG601 – 1CCCG699, Left and Right Boundary Condition.

W3(I) 5xxx

Allowed values of xxx are 001 and 1nn where values of 1nn are shown in Table 8.12-1 See Vol. 2, Appendix A, Section 8.

2D Conduction Model

The 2D conduction model is part of the reflood model – uses the ADI technique. The model uses fixed fine mesh model with 2 subdivisions per heat structure.

Card 1CCCG000, General Heat Structure Data

W6(I) Set to 3 for the 2D conduction model

See Vol. 2, Appendix A, Section 8.

Updates for Low Speed Flow

The current solution to the momentum equation is not accurate at low fluid velocities. Specifically, the code currently limits the Reynolds number to 50 for the calculation of wall drag and the user-input form loss coefficient. The pressure drop associated with the input loss coefficient is not accurate when the junction velocity approaches 0.01 m/s. Also, the code limits the absolute value of the total pressure drop to 0.00004 Pa to limit spin up problems, which is not accurate for low flows in horizontal pipes. Updates were added to allow the user to obtain a more accurate solution to the momentum equation at low flows. With these updates, the minimum Reynolds number is set to 0.01, the minimum junction velocity used in the form loss pressure drop calculation is 1.0e-8 m/s, and no minimum is used for the absolute value of the pressure drop.

This capability is accessed with Card 1 Option 29.

See Vol. 2, Appendix A, Section 2.

Elimination of Volume Upper Limit for 3D Component

3D components were previously limited to 999 volumes for size concerns. This upper limit has been removed allowing for the possibility of using 88,209 volumes in 3D components.