RELAP5-3D/4.0.3 Product Line

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On July 20, RELAP5-3D version 4.0.3 was officially released to the international community. A number of different client-group products make up the product line. An article was published in Innovation Magazine to herald the release of the Version 4.0 at: http://www.innovation-america.org/toward-safer-nuclear-reactors. The new version has many new features, has been developmentally assessed, and compared against a benchmark version, RELAP5-3D version 2.4.2.

The products created from RELAP5-3D version 4.0.3 include that International RELAP5 User Group (IRUG) executable and source code products, the Department of Energy (DOE) source and executable products, and the Real Time (RT) source code product. The executable products come with a README file, executable program, input files, sample output, and manuals. The executable products require a time-sensitive license key, created at INL, to operate. Source code products have greater security requirements and the licenses cost more, but include everything in an executable product except the executable program and all the source and auxiliary code needed to build the RELAP5-3D executable. The advantage of source code is the ability to modify it.

The principal change between 2.4.3 and 4.0.3 is the conversion of code architecture from FORTRAN 77 to FORTRAN 95. This conversion allowed a great many advancements and user conveniences to be developed in the code. Some other improvements were made to: 3D modeling, fluid properties, kinetics, heat flux boundary condition, integer-based time stepping, and the plotting/stripping capabilities.

Since the three-dimensional component inspired the name RELAP5-3D, it is important. Viscous terms were added to the liquid and gas momentum equations, including a rudimentary turbulence term for the liquid equation and a compressibility term for the gas. The artificial size limitation was increased from 999 control volumes to over 99,000. The linear equation solver was improved to run faster with larger 3D systems.

Greater accuracy in the steam tables generated via NIST formulas for water and sodium was achieved via mesh refinement, there are more mesh points with better placement. Transport properties are now available with the property tables, accessible through Card 1 option 46. New properties including lead, refrigerant r134a, and vertrel, were added. The property files are now machine independent, thus the same files can be used on Macintosh, Windows, and Linux platforms.

Improvements to the kinetics include read and write of TPEN variables to the restart file and logic to compute hex areas on a per-node basis rather than use one hex area for all nodes. A new capability to model a heat flux boundary condition with a control variable was added.

Time stepping was made improved by using integers to track time. This was an issue for coupled computations coordinating RELAP5-3D and other codes to model complex systems. The user's

minimum and maximum timestep (DTMAX) determine the smallest step RELAP5-3D can take, DTSMALL. Every timestep RELAP5 has ever taken, except at a timecard endtime or coupling exchange time, can be written as DTSMALL×2^K. So, using 1 to represent DTSMALL and 2^K for other steps, integer arithmetic can replace floating point, and all floating round-off error is eliminated. This is important when large numbers of steps are taken as it prevents overshooting plot, edit, restart, coupling-exchange and timecard-end times.

Restart and plot files are now split. This allows for smaller restart files and numerous formats for the plot files including: machine dependent, machine independent, and ASCII. The strip mode can read these formats and produce strip files in many formats as well.

Of course, many other changes have been made. These are reported annually at the RELAP5 International User Seminar (RIUS). Information on this year's meeting may be found at: http://www.inl.gov/relap5/news/2012_2q_r5_3d_rius_info.pdf.