

RADTRAD Change Log: Version 5.0.1

Released June 2020

- **Updates:**

- An error in the implementation of the L_∞ (local) error norm was fixed, making this a suitable error norm to use in addition to the L_2 (global) norm. The L_∞ norm determines the nuclide with the largest error and minimizes this error. This minimizes error, even for nuclides that have negligible impact. The L_2 norm calculates a root mean square error for dose which is then minimized. The practical result is that the L_2 norm minimizes the error of those nuclides which contribute the most to dose.
- A source term initialization error that occurs when adaptive time stepping is used was fixed. This bug was introduced with adaptive time stepping in RADTRAD 4.5.0. Impacts vary among test cases, with test results showing many cases with negligible impact, and other cases showing error as large as 20% in the cumulative dose. Cloudshine dose appears to be more heavily impacted than TDED and Thyroid dose.

RADTRAD Change Log: Version 5.0.0

Released February 2020

- **Updates:**

- RADTRAD 4.x was converted from Fortran to java. While java is a modern language, many of the paradigms of Fortran were maintained in the code. RADTRAD 5.0.0 involved significant changes to modernize the structure of the code, remove limitations, and make the code more maintainable.
- There is no longer a limit on the number of components allowed or size of tables in a RADTRAD model.
- The code has been optimized to make the adaptive time stepping algorithm much faster.
- In previous versions, the adaptive time stepping algorithm calculated error only at the dose locations. Because of this, there was often a time delay between the event that caused the error (e.g., a gap release to containment) and the algorithm's measurement of that error (e.g., in a dose location many compartments downstream of containment). In such a scenario, the algorithm would attempt to decrease time steps to correct for a mechanism that had already passed, as it occurred many time steps before the error was measured. In order to address this, RADTRAD 5.0.0 calculates phantom doses in each compartment (doses that are not used or output in the formal calculation) and estimates error using these doses. This allows for error to be measured closer to the point of occurrence, improving the algorithm's ability to adapt the time step accordingly.
- In addition to the L_2 (global) error norm, and L_∞ (local) error norm was added. The L_2 norm minimizes error in nuclides that contribute the most to dose. The L_∞ seeks to minimize error in all

nuclides whether they contribute significantly to dose or not. The L^∞ error norm is expected to cause more timesteps to occur in general. However, in the RADTRAD 5.0.0 release, there is an implementation error in the L^∞ algorithm, and the L_2 norm is recommended. This is fixed in RADTRAD 5.0.1.

- The command line option '-M' or '--useMAXerror' was added, which causes the calculated error to be based on the maximum error over all dose values rather than using an averaged error that is weighted toward nuclides with larger dose concentrations.
 - The 'r' or '--rgtest' (regression testing) command line option causes the plot and output file to remove markers that might differ in different versions of the code to simplify comparison. In RADTRAD 4.5.x, this option did not cause the cpu time plot variable to be removed from the plot file, so the command line option '-T' or '--cpu_time_off' had to be used as well for regression tests. In RADTRAD 5.0.0, the cpu time variable is removed when the '--rgtest' command line option is used.
 - Legacy code to process RADTRAD 3.x input files was removed.
 - The command line option '--addNucliPlots' was added. This causes the nuclide quantity in each compartment to be included in the plot file.
 - The command line option '--addTransPlots' was added. This causes the quantity in each compartment of each transport group to be included in the plot file.
- **Code Fixes:**
 - SNAP allowed RADTRAD component numbers to be specified manually. However, RADTRAD would fail or get incorrect results if the components were not ordered sequentially. This was corrected so that the user can customize the component numbering and get correct results.
 - The adaptive time step algorithm would sometimes get into cycles where the timestep is doubled and then cut in half repeatedly, suggesting that the error calculation was not stable. Code was added that causes RADTRAD to wait 10 time steps after the time step size has been cut to increase the time step in order to improve stability.

RADTRAD Change Log: Version 4.5.8

Released June 2018

- **Code Fixes:**
 - Added a command line option '--aerosol_24_hr_limit' that causes aerosol natural deposition filter to cease removing nuclide after 24 hours if no deposition rates are included in the table after 24 hours.

- A command line option ‘`--2hr_limitB4_24hrs`’ was added that causes the time step size from 12.5 hours to 24 hours to be limited to a maximum of 2 hours in the default time step algorithm. After 24 hours, the time step size can grow to a maximum of 4 hours.
- A divide by zero error was fixed that occurred when a compartment with spray removal contained no nuclide to remove.
- The NRC output file had some mislabeled columns in the DOSE CONVERSION FACTORS AND DECAY CONSTANTS table. The column labels were corrected.
- The filter table in the output file now displays time to 1/100th of a second.

RADTRAD Change Log: Version 4.5.7

Release May 2018

- **Code Changes:**

- Removed extra space from output file header

RADTRAD Change Log: Version 4.5.6

Released May 2017

- **Code Fixes:**

- RADTRAD fails with an ‘array out of bounds’ exception if the filter table contains more than 12 entries. This limit has been increased to 50 entries.

RADTRAD Change Log: Version 4.5.5

Released April 2017

- **Code Fixes:**

- The copyright notice was being printed at the start of each logical page in the output and NRC output files. The copyright is now just printed at the start and end of the output files.
- The plot variable type ‘body’ was changed to ‘cloudshine’.
- The plot variable type ‘cloudshine’ was mislabeled in earlier versions of RADTRAD. The correct label of ‘inhalation’ is now used.
- The ‘skin’ dose is printed at all dose locations.
- When the ‘level doses’ diagnostic flag is set to 3 or higher, extra dose information is printed that specifies the organ type the dose is applied to. In previous version, the organ type string was not set, so the organ was listed as ‘null’. The organ name is now printed.

RADTRAD Change Log: Version 4.5.4

Released June 2016

- **Code Fixes:**

- The maximum number of sources allowed in a model is 10. However an error would occur if more than 5 sources were included in a model because a maximum of 5 release fraction and timing tables was allowed. The maximum number of release fraction timing table was increased to be equal to the number of sources allowed.

RADTRAD Change Log: Version 4.5.3

Released April 2016

- **Code Fixes:**

- The nuclide file information table now prints “Specific Inventory” for each nuclide in units of Ci/MWt and MBq/MWt (in separate columns).
- “Iodine Units” was renamed to “Release Units”. The options “Curies and REM based” or “SI Units” are supported. Units in the output and NRC output files are printed in the associated units.
- The plot file now includes both British units of REM as well as SI units of mSv. The units can be selected by the user in AptPlot.

RADTRAD Change Log: Version 4.5.2

Released October 2015

- **Code Fixes:**

- The interim “skin dose” value that was printed to the NRC output file was the deposition skin dose. The deposition velocity used in the code is zero and thus the interim skin dose was zero. However in the final “skin dose” result, cloudshine skin dose was printed. This value is nonzero. For consistency, the interim value that is printed is now cloudshine skin dose.
- When printing interim accumulated dose data, which is recorded per dose location, info was printed based on the number of compartments, not based on the number of dose locations. This was causing the code to fail on index errors in a few cases. This has now been corrected.

RADTRAD Change Log: Version 4.5.1

Released August 2015

- **Updates:**

- Added copyright information to the RADTRAD output files.

RADTRAD Change Log: Version 4.5.0

Released May 2015

• Updates:

- Added the option for user to select an adaptive time step algorithm which dynamically adjusts time step size in order to keep the estimated solution error within a user specified limit. Estimated solution error is included as a plot variable.
- Added the option for user to select the default time step option with error calculation. This option does not use adaptive time stepping, but does calculate error, and includes the estimated error plot variable to determine whether an adaptive time step solution is advisable.
- Added a reactor coolant system (RCS) activity calculator to the SNAP model editor to permit the calculation of radionuclide concentration in the reactor coolant based on the ANS 18.1 Standard and the GALE-BWR and GALE-PWR computer codes. Pre-incident and co-incident iodine spiking is included in the model. The ability to consider dose equivalent I-131 and Xe-133 is also included.
- Added the ability for the user to model alternative source term (AST) non-LOCA DBAs described in Regulatory Guide 1.183 (RG 1.183). Accident scenarios include the fuel handling accident and a rod ejection (PWR) or control rod drop (BWR) accident. The design basis accident models based on the TID-14844 and the alternate source term in RG 1.183 is retained. The ability to consider a gap release from either RG 1.25 or RG 1.183 is also available.

• Code Fixes:

- Update the dose conversion factors (DCFs) to those provided in the Radiological Toolbox which are based on the DCFs compiled in FGR-11 and FGR-12. A total of 748 dose conversion factors is available.
- Updated and added larger radionuclide database from ICRP-38 (838 available nuclides). Note that FGR11 and 12 DCFs are not available for all nuclides. A warning is provided in the SNAP model editor if the user selects a nuclide for which no DCF is available. Users can input DCF data as needed.
- Plot variables were previously named based on the dose location number (e.g., dose1.body). They are now named based on the dose location name with spaces removed (e.g. ExclusionAreaBoundary.body).
- Changes to the output files:
 - Previously the model description was printed to the output and NRC output file in the header to sections or at page divisions. Now the description is only printed at the start of the output file and the model 'title' is printed in the header to sections or at page divisions.
 - Worst two hour dose is printed as a time range rather than a single time value.

- Worst two hour dose was removed from final doses since this information is already provided in the section just above final doses.