VARSKIN+ v1.2
Software Release Note

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1.0 Introduction

This document outlines in detail the modifications, additions, and/or removal of features from VARSKIN+ v1.1 to VARSKIN+ v1.2.

All modifications are based on items entered into RCD software issue tracker as a source for the basis of a change.

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2.0 Abbreviations and Definitions

Table 2-1. Abbreviations and definitions.

Term	Definition
CP	change package number (gitlab version identifier)
DLL	dynamic-link library
GUI	graphical user interface

3.0 Base Line Code

The changes identified here have been incorporated into the baseline of VARSKIN+ v1.2.

Table 3-1. GIT attributes.

Git Location	Revision ID (Commit SHA)
https://gitlab.com/RCD-1/varskin/-/tags/varskin+v1.1	d2f7c94e0b144f9830f151307078c27f68d63a6e
https://gitlab.com/RCD-1/varskin/-/tags/varskin+v1.2	

Table 3-2. Executable attributes.

Executable Name	VARSKIN+1.2.exe
MD5sum	(not yet compiled)
SHA256	(not yet compiled)
SHA512	(not yet compiled)

VARSKIN+ has the following project dependency as noted in Table 3-3

Table 3-3. Dependency attributes.

Software	Version	Git Location	Revision ID (Commit SHA)
NRC-Graphing	0.0	https://gitlab.com/RCD-1/nrc-graphing	46904227
Intel Fortran	19.1.0057.15	n/a	n/a
JDK	17	n/a	n/a

4.0 Changes

The following sub-sections outline the changes made from VARSKIN+ version 1.1 to VARSKIN+ version 1.2. A summary of changes is provided in Table 4-1.

Table 4-1. Summary of versions and resolved issues.

Version	Issue #	Description	Section(s)
1.1 (CP12)	-	Major Release.	-
1.1.1 (CP13)	21	Expansion of maximum beta spectrum energy to ensure entire range of nuclides' beta decays can be represented. Java version was switched to jdk17.	4.1
1.1.2 (CP15)	17	The descriptor to print in a dose report for the syringe has been changed from thickness to 'DY,' which is the syringe's length. The density for the syringe geometry is now visible.	4.2
1.1.3 (CP14)	28, 34	Zr-97 from ICRP-107 and Tl-208 from ICRP-38 (last nuclides in the database files) can now be added to the database.	4.3, 4.4
1.1.4 (CP16)	27, 29	Results table can now display more than 80 nuclides. The "calculate" button may now be clicked only once during an active calculation.	4.5, 4.6
1.1.5 (CP18)	36	Updated write precision to the nuclide XML database file to 15 digits to ensure consistent results are obtained during loading and re-executing scenarios.	4.7
1.1.6 (CP17)	20	Treatment of exponents for non-English users was corrected to account for the proper machine regional settings. Writing of country, language, and decimal separator was also added to the XML scenario file.	4.8

Version	Issue #	Description	Section(s)
1.1.7 (CP20)	32	Constant-radius annuli are implemented instead of constant-area for calculating the alpha dose. The number of dose rings is also increased ensuring proper resolution of the solution methods.	4.9
1.1.8 (CP21)	30, 35	Addition of Doppler broadening to ENDF tape parsing ensuring that cross sections of low-mass nuclides included for neutron dosimetry are more accurate. Addition of a first-principles neutron energy degradation model, currently applicable only to water.	4.10, 4.11
1.1.9 (CP22)	38,39	Results from more than 8 nuclides can now be saved with proper activities stored and loaded.	4.13, 4.12
1.1.10 (CP24)	5	Complete remodel of the system used to incorporate radioactive progeny in calculations involving decay-enabled (“D”) databases for SkinDose. Calculations now account for in-growth and decay of daughters up to and through exposure period.	4.14
1.1.11 (CP23)	40	Graphs of discrete emission spectra have been changed to use the Spectrum type instead of Histogram.	4.15
1.1.12 (CP25)	41	Daughter calculations were improved with v1.1.10 for SkinDose. The inclusion of daughters in the previous and new framework is not yet available for WoundDose. Additional checks and limitations are incorporated to ensure proper use.	4.16

Version	Issue #	Description	Section(s)
1.1.13 (CP26)	43	Neutron flux degradation through tissue has been improved using the framework of the added neutron shielding model in v1.1.8. The previous neutron dosimetry model attenuated neutrons from the skin's surface to the selected dose depth only by use of the total cross section; no energy degradation is performed. Energy degradation is now accounted for.	4.17
1.1.14 (CP27)	9	Graphing project name changes, no technical changes.	4.18
1.1.15 (CP28)	45	Update to about information.	4.19
1.2 (CP29)	-	Major Release.	-

4.1. Issue 21: Expansion of Max Beta Range

For SkinDose and WoundDose, incorrect calculation of the electron dose occurred whenever an electron energy was larger than the nuclide max beta spectrum energy. This was resolved by ensuring the array of energies used for electron and beta calculations encompass the max beta or electron energy.

4.2. Issue 17: Syringe Geometry Parameters

For SkinDose, a user reported that, when using syringe geometry, the “source length” as reported in the plain-text report was always the same, regardless of inputs. It was found that the “length” reported in the plain-text report was the length of the syringe’s equivalent slab, not the cylinder length as entered by the user. This has been modified to report the user input value.

In addition, when loading a scenario file with syringe geometry specified, SkinDose would not load the syringe’s parameters (length and diameter). Because the geometry type is set after reading values from the scenario XML, these defaults overrode the values read from the scenario file. This has been rectified by ensuring that the default syringe dimensions are applied only if the user has changed the geometry type, not if the geometry has been loaded from a scenario file.

It was also requested that the user be able to input the syringe’s density; the appropriate variable entry box has been enabled for syringe geometry.

4.3. Issue 28: Error Reading ^{97}Zr

When ^{97}Zr was selected to be added to the user’s nuclide library, the program would idle, spinning the trefoil at the bottom of the Add Nuclides screen, endlessly. This was noted only for ICRP 107; ^{97}Zr is not available in ICRP 38.

This was caused by an exception thrown during the DAT file read routine (on Java’s side) caused by the iterator used to hold the file’s contents attempting to read beyond the size of the file. This has been rectified by adding a check to ensure that the file’s iterator indeed has more lines to read before the routine attempts to read another line; this fix has been applied to both the DAT and BET read routines in Java. Note that this error did not appear when reading the last nuclide in the ICRP 38 database (^{95}Zr) because the last entry in ICRP 38 is the “XX-MeV” placeholder.

4.4. Issue 34: Error Reading ^{208}Tl

An error was noted when adding ^{208}Tl from the ICRP 38 database to the user's nuclide library. This was caused by the nuclide addition routine attempting to read past the end of the BET file. The same problem was noted when trying to add ^{97}Zr from ICRP 107 (Section 4.3); both nuclides are the last entry in the BET file for their respective database.

4.5. Issue 27: Results Table Unable to Display More Than 80 Nuclides

The results table in SkinDose and WoundDose had a "preferred height" of 2000 pixels, which was only enough to display 80 entries (25 pixels each). The table would display properly when fewer than 80 nuclides were selected, but would not resize when more than 80 nuclides were selected, thus entries number 81 and beyond were not displayed. The data was still present and could be accessed by printing the dose report.

This has been rectified by calculating the correct table height (the number of selected nuclides, multiplied by 25) and setting the table's preferred size after each update to the table's contents. Any number of results can now be displayed properly.

4.6. Issue 29: "Calculate" Button Not Disabled When Calculating

Clicking the "calculate" button in SkinDose or WoundDose multiple times would cause several calculation threads to start. This resulted in various issues including the program crashing or freezing.

This has been rectified by disabling the "calculate" button at the beginning of the calculation thread such that it can only be triggered once. Appropriate checks to ensure new threads are not started are already in place, since the "calculate" button is already disabled if there are no nuclides selected.

4.7. Issue 36: Scenario Save File Resolution

For SkinDose or WoundDose, there is a change in the calculated electron dose between a "fresh" loading of the nuclide data versus using an already loaded nuclide in the available list.

This was caused by a precision difference when loading the user saved scenario file. To correct the issue the write precision to nuclide XML scenario file was increased to 15 digits.

4.8. Issue 20: Decimal Separator Handling for International Number Format

A Danish user has reported that when selecting and de-selecting values, the exponents increase incrementally each time selected.

There was extraneous coding that was manipulating the output incorrectly when accounting for the use of commas versus periods as the decimal separator. This coding was removed and tested. Writing of country, language, and decimal separator was also added to the XML scenario file.

4.9. Issue 32: Alpha Dose Various Problems

For SkinDose, the alpha dose was noted to have abnormal (non-Bragg curve) behavior as the depth of the averaging area was increased. This was discovered to be a result of the way dose annuli are discretized (with constant area versus constant radii).

Using constant area annuli results in the annuli farthest from the center of the averaging area having smaller “widths” (difference between inner and outer radii) than those in the center. This, in turn, requires a great many more annuli toward the edge of the averaging disk than at the center, producing a greater effective weight (more dose calculations occurring) for the annuli at the edges.

However, because of the extremely short range of alphas in skin, the annuli at the edge of the disk are almost always calculating zero dose, usually leaving only the three innermost annuli to calculate the alpha dose over the entire averaging area. Changing to a constant radius method allows for many more annuli to be calculated in the dose region of interest (usually 80+ annuli). In addition to using a constant radial increment method, a minimum number of 1,000 radial increments are used with a maximum increment size of 1.0E-4 cm. This ensures that there is sufficient resolution in the problem calculation.

The number of depth intervals used when calculating volume-averaged dose has also been increased, from 10 to 100. This was included to ensure there was sufficient depth resolution with little computational cost; there is no evidence that using 10 intervals made previous calculations inaccurate.

Impact of changes are depicted in Figure 4-1.

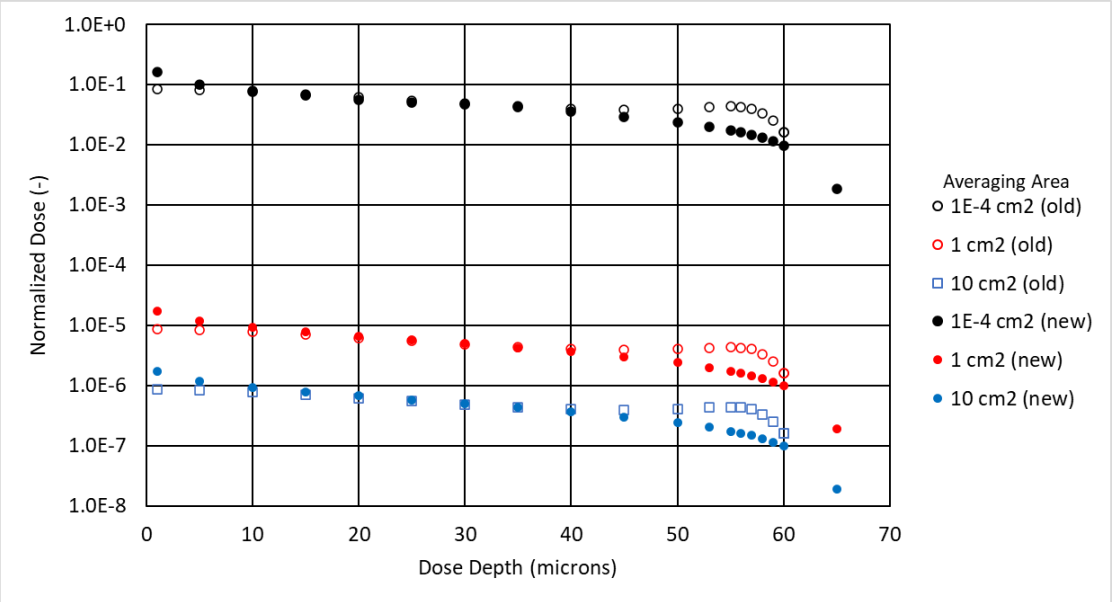

Figure 4-1. Alpha dose results.

4.10. Issue 30: Addition of Doppler Broadening to ENDF Parsing

The changes described here have no impact on the calculational results of this release for NDose. The changes described here are for planned future model development and improvements.

Erroneous cross section information was returned from the currently unused ENDF parsing routines implemented during the original implementation of the neutron dosimetry model, repair of which was postponed due to the presence of a lookup table for the same information in the neutron model's module.

The errors in this data processing were found to be caused by the lack of Doppler broadening considerations in the ENDF parsing routine. Total and elastic scattering cross sections for incident neutrons are provided in the ENDF tapes for materials at a temperature of absolute zero, and must be broadened to room temperature for use. The difference caused by this broadening can be several percent.

This issue has been rectified by accounting for Doppler broadening from 0 K up to 293.15 K. All broadening is currently evaluated at 293.15K. Cross sections returned by the ENDF parsing routine for the four nuclides of interest to the neutron dosimetry model (hydrogen, carbon, nitrogen, and oxygen) are now correct to several decimal places.

Despite this error in the ENDF parsing routine being rectified, the lookup tables in the neutron dosimetry model have not yet been replaced by direct ENDF calculation. Removal of the lookup tables is planned for a future release.

4.11. Issue 35: Addition of Neutron Energy Degradation Model for Shielding

A first-principles, deterministic model for calculating the degradation in energy fluence of a beam of neutrons traversing a one-dimensional infinite (i.e., leakage-free) shield has been added. This model is based on Fermi age theory (an extension of age-diffusion theory) to compute the probability of energy losses due to scattering events, combined with neutron attenuation using the Beer-Lambert law.

The user can specify the composition of a shield via a new dialog, accessible from the neutron model window, which provides a table to specify individual “segments” of a shield based on material and depth. At the moment, only water is allowed for shielding material. The model is generally applicable to any material whose isotopic composition can be specified, and the ENDF files for which are available.

Several changes to the neutron spectrum graph have also been implemented, to allow the user to view the modified (degraded) neutron spectrum after having passed through the specified shield. These changes take the form of a menu bar, added to the graph’s dialog, that allow the shielded or unshielded spectrum to be selected. The graph can also be saved as an image file from this menu.

4.12. Issue 39: Unable to Modify Nuclide Activities

This error does not impact a released version of VARSKIN+ and only occurs within an intermediate developmental release.

Setting activities to something other than 1.0 (units do not matter) for nuclides after the first one listed does not actually update the activity. Changing focus from the Activity column merely results in the entered value resetting to 1.0. Activity for the first nuclide in the list can be set and modified normally.

This has been corrected by modifying the implemented for loops in the save function.

4.13. Issue 38: Not Able to Save Activities of More Than 8 Nuclides

An error was noted when saving the scenario file where it was only possible to save the activities of 8 different isotopes. If the user attempted more; it would save incorrect activities.

This has been corrected by modifying the implemented for loops in the save function.

4.14. Issue 5: Radioactive Progeny Activity Calculation

Previous versions of VARSKIN incorporated radioactive progeny by assuming that a secular equilibrium was established between the parent and all its progeny. This amounts to assuming that all progeny have the same activity as the parent, accounting for branching ratios, at all times.

This assumption does not hold for progeny with half-lives longer than their parents (no equilibrium will ever be established). The previous method also makes no account of ingrowth times which are shorter than that required to establish secular equilibrium.

A complete remodel has been implemented to incorporate radioactive progeny in calculations involving decay-enabled (“D”) databases for SkinDose. Calculations now account for in-growth and decay of daughters up to and through the exposure period. This model is currently only available for SkinDose.

When first adding a nuclide, additional inputs are prompted for that define the time since purity (i.e., time at which only the parent nuclide is present). To allow for backwards compatibility with previous versions of VARSKIN+ the user can select the secular equilibrium box, for nuclides that can establish a secular equilibrium, to obtain equivalent treatment of previous versions.

The yield tables and spectrum plots for a parent and associated daughters include the effects of in-growth periods and branching ratios. These are available by hitting Nuclide Info on the main screen for the selected nuclide. Here the time since purity may also be modified.

4.15. Issue 40: Graph Type Change from Histogram to Spectrum

Graphs of discrete emission spectra (i.e., all except the beta spectrum) in the Nuclide Information window are currently histograms. These graphs depict each emission as a "block," which spans the entire area between the emission being depicted and the one to its left. This can be somewhat misleading, as emissions spaced far apart can appear to be a continuum of emissions spanning the entire area.

The spectrum-type graphs deal with this problem by making each "block" have unity width regardless of the spacing of emission yields. These plots have been changed to spectrum plots.

4.16. Issue 41: Preventing Daughter Calculations within WoundDose

At present, WoundDose does not properly handle progeny calculation; the local and shallow dose models will require modifications to account for progenies. Systemic dose is currently based on lookup tables, and so cannot have progeny accounted for until the tables are updated. As such, progeny-enabled nuclides are to be excluded from WoundDose calculations. When running from WoundDose, the Add Nuclides window already prohibits the user from selecting the "-D" databases to add a new nuclide, but "-D" nuclides that have already been added could still be activated when loading the program.

Extra checks are implemented to ensure that nuclides with progeny cannot be loaded with WoundDose.

4.17. Issue 43: Accounting for Neutron Energy Degradation in Skin for nDose

The simple Beer-Lambert attenuation model used in the neutron dosimetry model previously (using only the total macroscopic cross section) has been removed completely and replaced with degradation model implemented for the neutron shielding model (Section 4.11). Attenuation now accounts for neutron energy degradation based on the shielding degradation model.

4.18. Issue 9: Graphing Project Name Changes

Internal graphing project name changes, no technical changes.

4.19. Issue 45: Update of About Information

Update to about and contact information, no technical changes.