Enhancing RESRAD-OFFSITE for Low Level Waste Disposal Facility Performance Assessment

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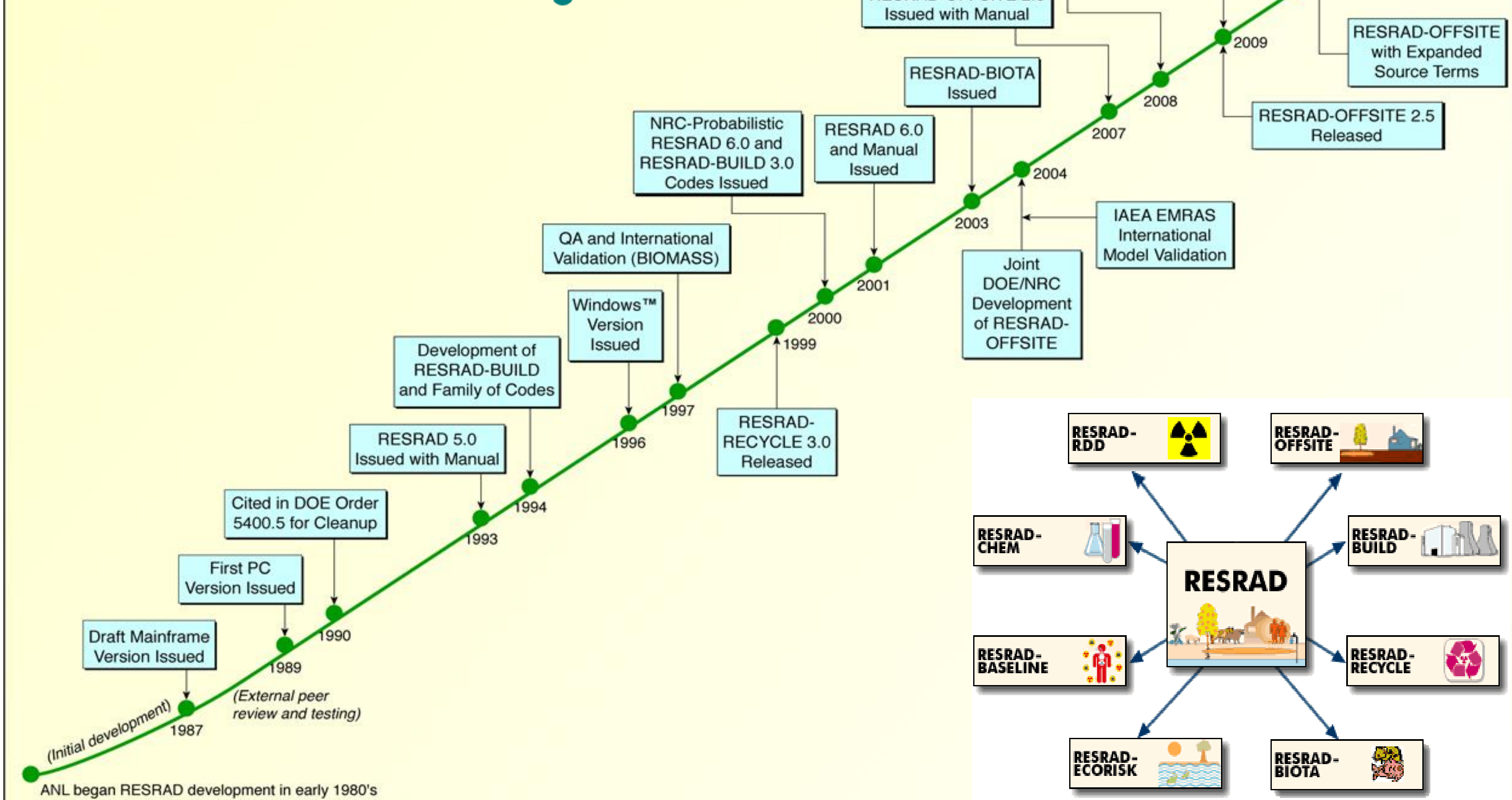
July 16, 2014

HPS 59th Annual Meeting, Baltimore, MD

RESRAD Family of Codes (Since Early1980s)

Web Site: www.evs.anl.gov/resrad



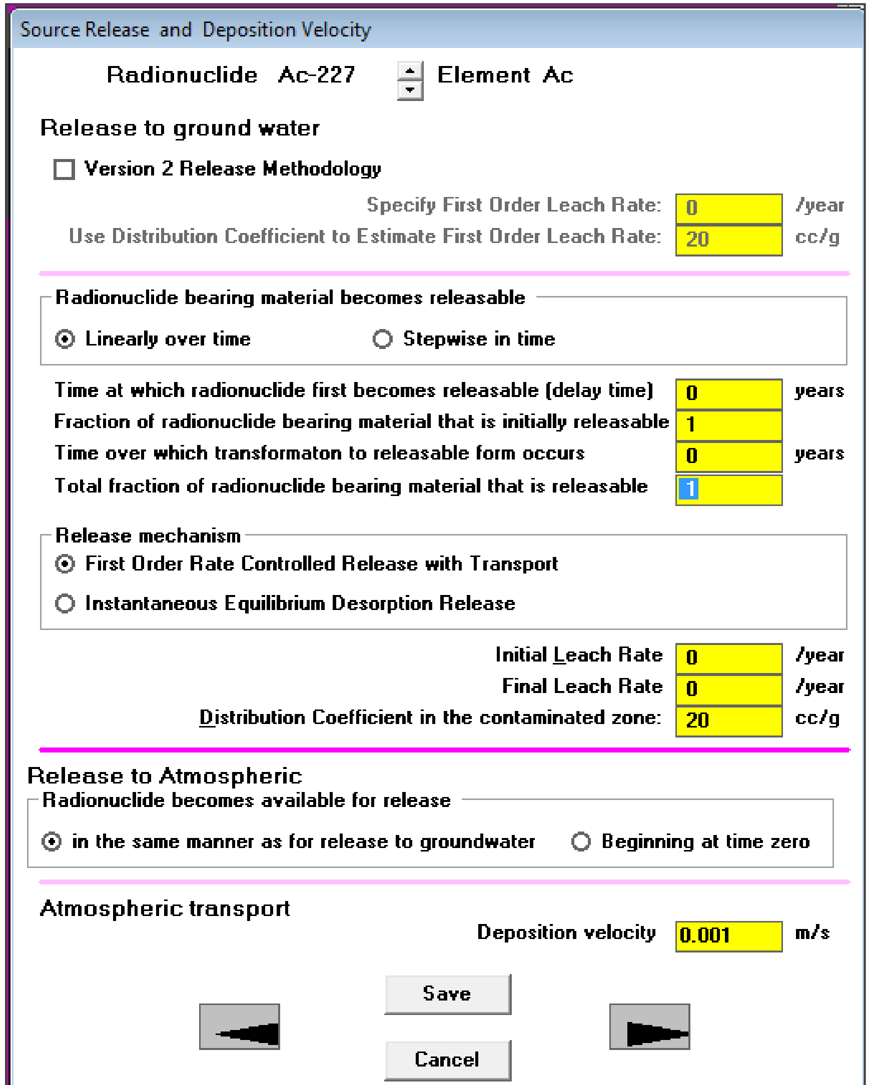
Recent Improvements to RESRAD-OFFSITE

- Made Help files compatible with Windows 7 and 8
- Improved installation package
- Allowed specification of relationships between variables in RESRAD-OFFSITE for probabilistic analysis
- Modified RESRAD-OFFSITE external dose model to include dose from primary contamination to all offsite locations/fields
- Allowing partially or fully submerged source term
- Adding Representative Person DCFs for DECDATA (ICRP 107) radionuclides
- Updating Data Collection Handbook for RESRAD (onsite) and RESRAD-OFFSITE codes
- Updating transfer factors based on IAEA TRS-472

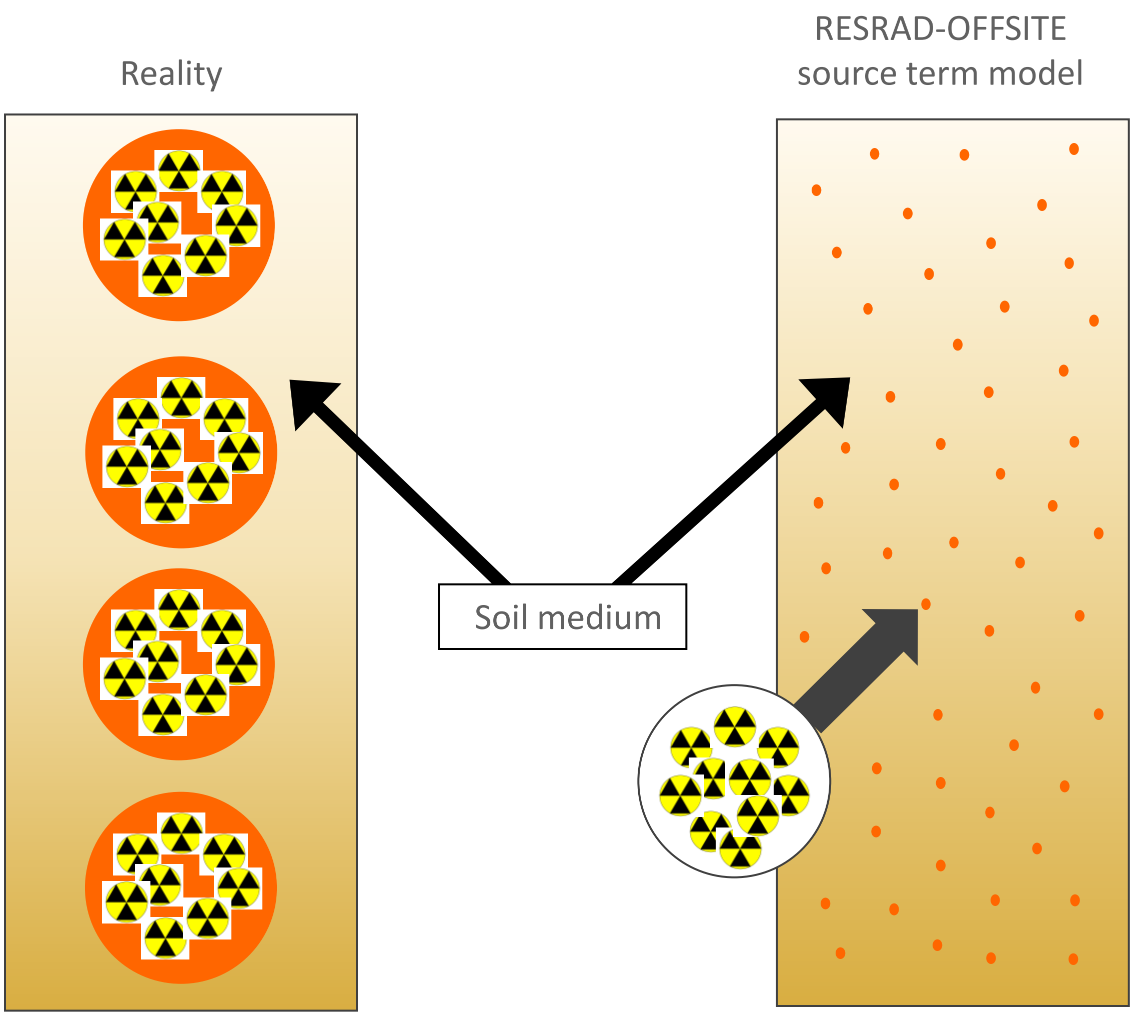
Recent Developments in RESRAD-OFFSITE

- Added a new source term model (for LLW Performance Assessment)
  - Derivation of analytical formulations based on the DUST-MS code for the releases to three media (air, runoff, and infiltration) and the vertical profile within the contaminated zone for release to groundwater
  - Mass balance
  - Radionuclide database: ICRP 38 and ICRP 107 and cut-off half-life
  - Backward compatibility (older versions compatibility)
  - Uncontained (soil) and containerized (waste) contamination
  - Sensitivity and probabilistic analyses
- Added delay times in the source release options
  - Two delay times
  - Stepwise or linearly increase in time
- Output area factors (for MARSSIM applications)
  - Using probabilistic analysis feature
  - For multiple radionuclides

Input Screen for Selection of Source Release Models



Conceptualization of Buried Sources Within the Contaminated Zone for Transport Modeling



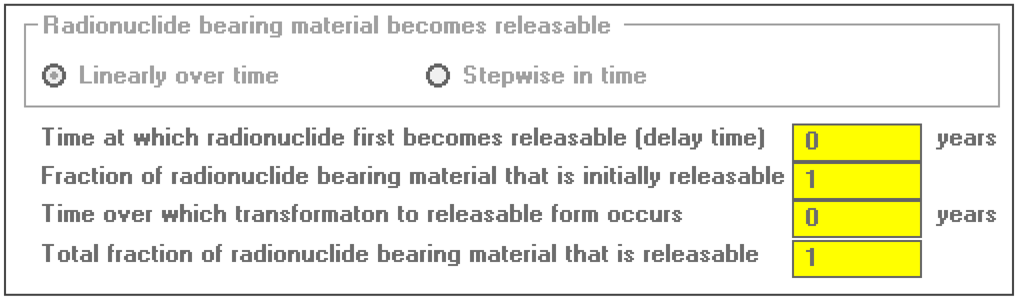
Conceptualization of the Physical States of Waste/host Materials

- The waste/host materials that contain the radionuclides are conceptualized to be in two different states
  - A state that is susceptible to releasing radionuclides
    - Radionuclides contained within are releasable (to water)
  - A state that is immune to releasing radionuclides
    - Radionuclides contained within are not releasable

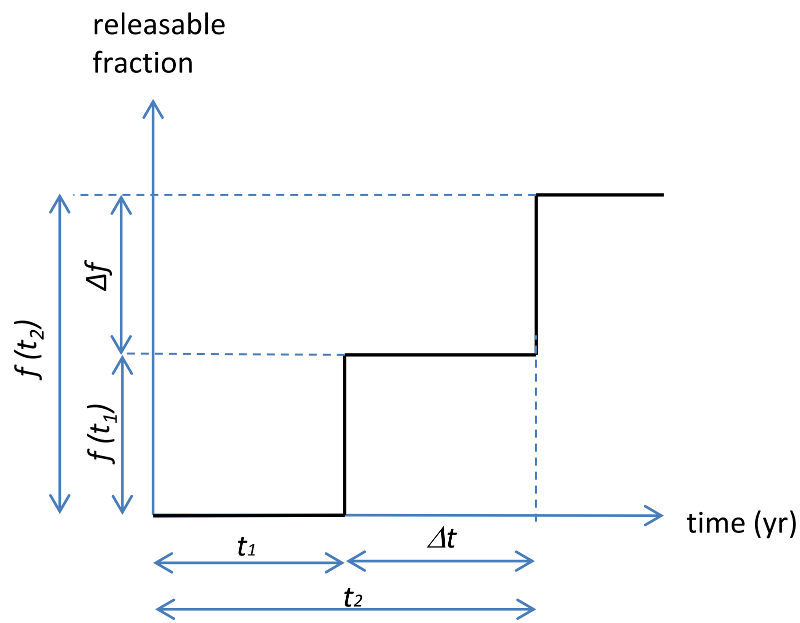
- At any particular time
  - All the waste/host materials can be in one state or the other
  - Some of the waste/host materials can be in one state and the rest can be in the other state
  - The fraction of waste/host materials susceptible to releasing radionuclides can change (increase) with time
    - So can the releasable fraction of radionuclides

- Waste/host materials in each state are distributed homogeneously over the primary contamination

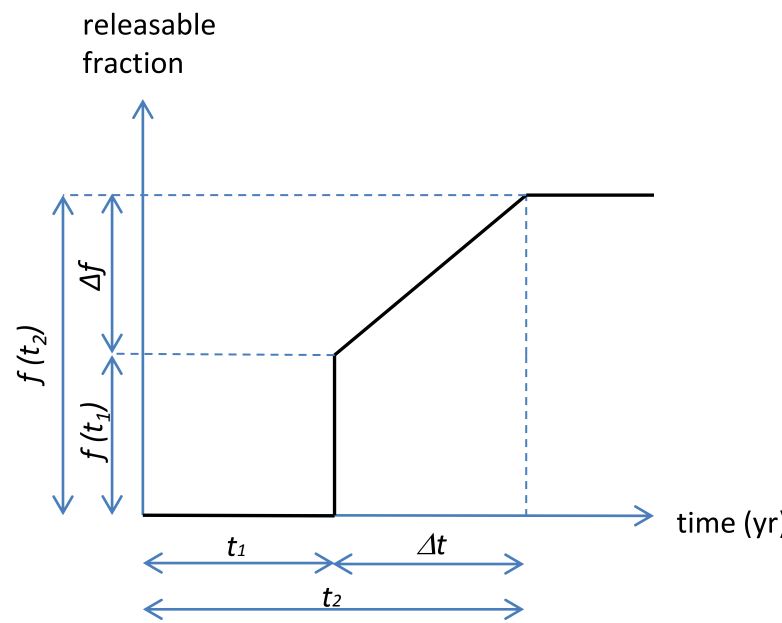
Specification of the Physical States of Waste/host Materials



- Radionuclides that become releasable at a certain time can be released at or after that time



Change of releasable fraction in a stepwise manner



Change of releasable fraction in a linear manner

NUREG/CR-7127 on the New Source Term Model

- Describes three source release options
  - First order release (with transport)
  - Equilibrium desorption (rinse) release
  - Uniform release (constant dissolution)
- Documents verification testing and benchmarking
- Describes the new source term model with delay times
- Sensitivity analysis to identify influential inputs
- Output area factors (for MARSSIM application)

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NUREG/CR-7127
ANL/EVS/TM/11-5

New Source Term Model for the RESRAD-OFFSITE Code Version 3

Manuscript First Draft: September 2011
Manuscript Revision Completed: May 2013
Date Published: June 2013

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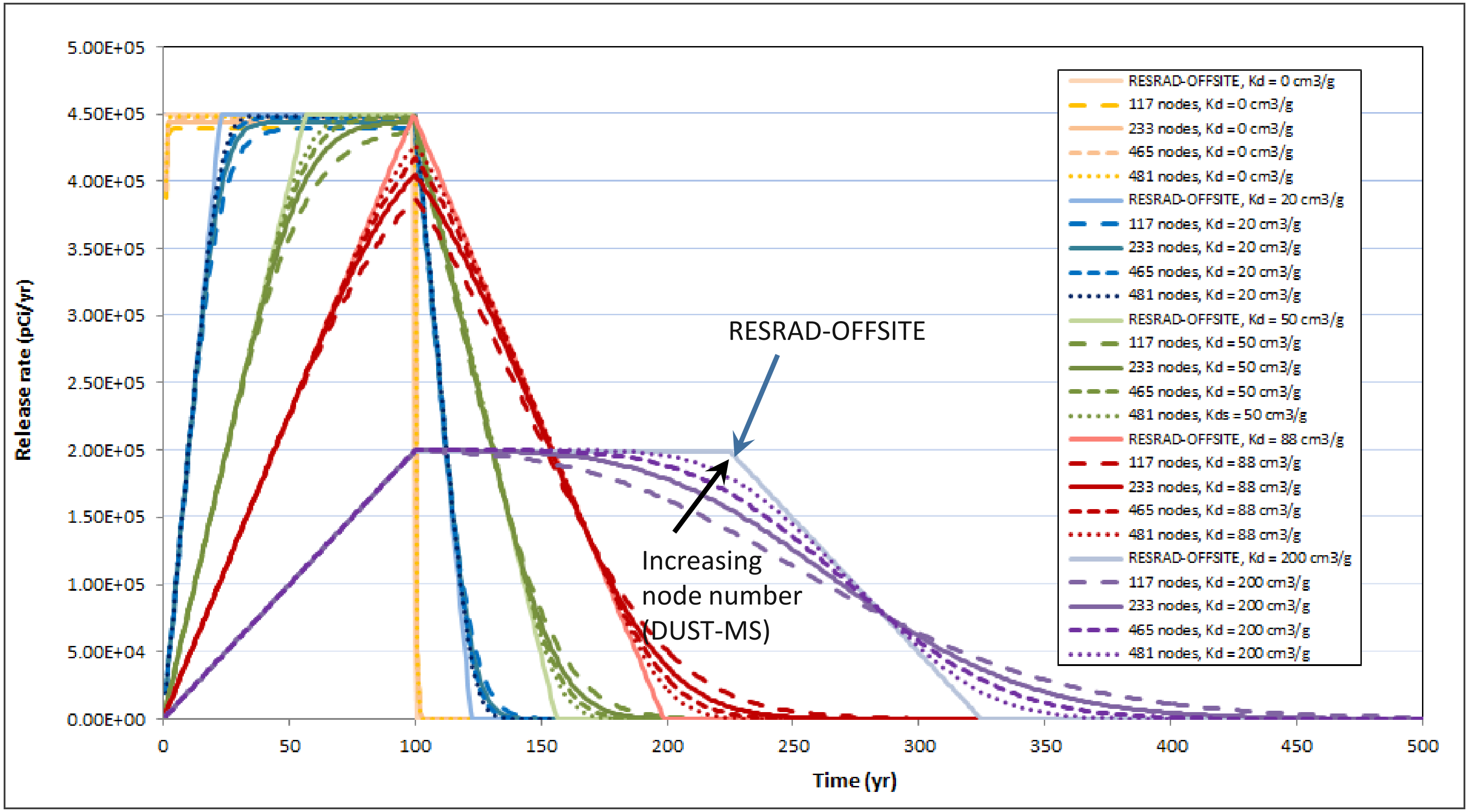
NRC Job Code N6731 (First Draft) & V6360 (Revision)

Office of Nuclear Regulatory Research

Comparison of Release Rates for Case I

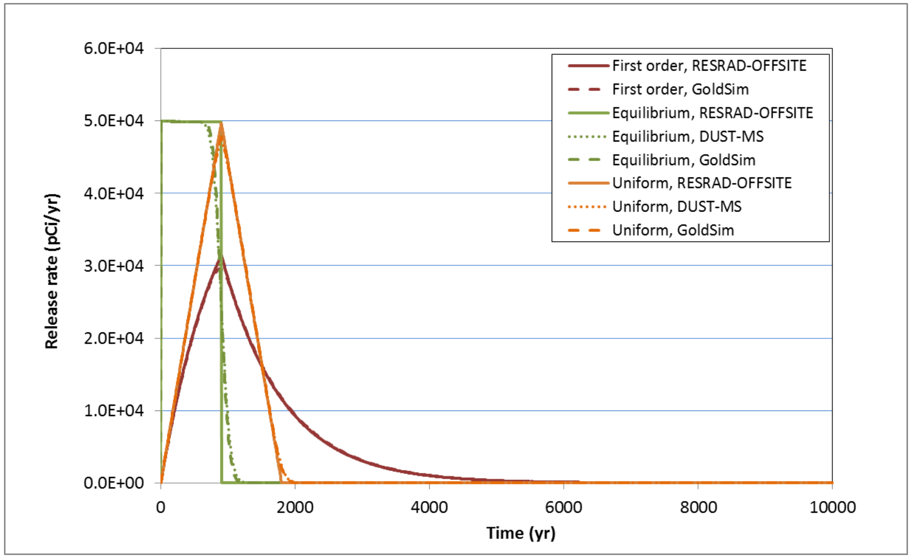
- *No dispersion – uniform release 0.01/yr for 100 years – 0.3-m Tc-99 source*



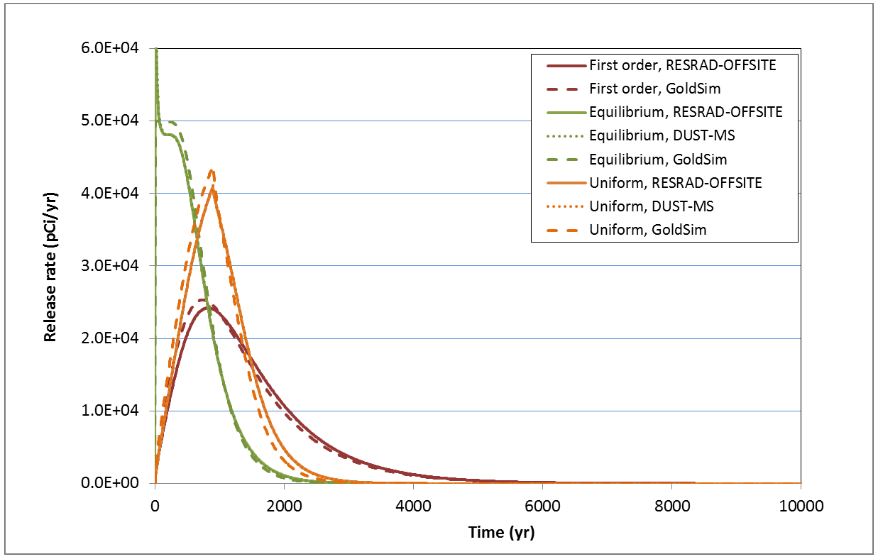
Comparison of Release Rates for Case III

- *0.3-m U-234 source – Kd = 200 cm^3/g for U-234*
- *Release rate of U-234*

No dispersion



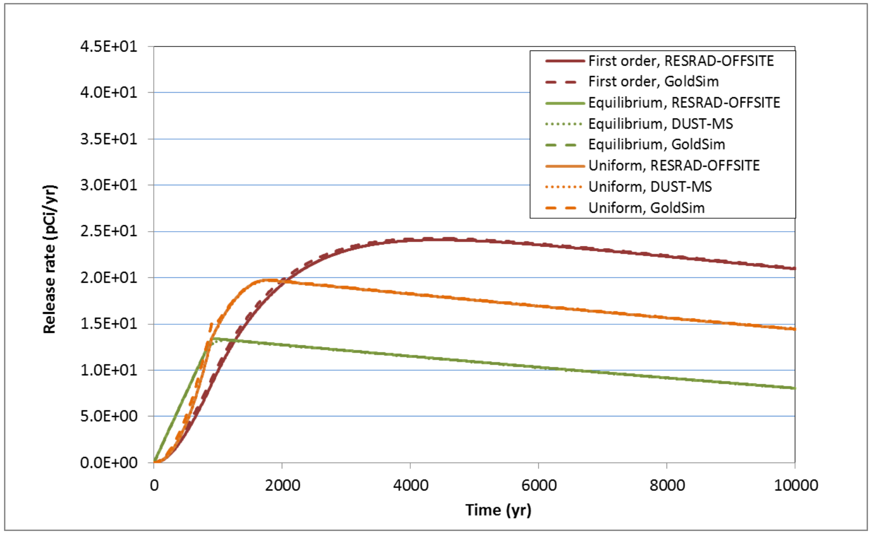
Dispersivity = 0.03 m



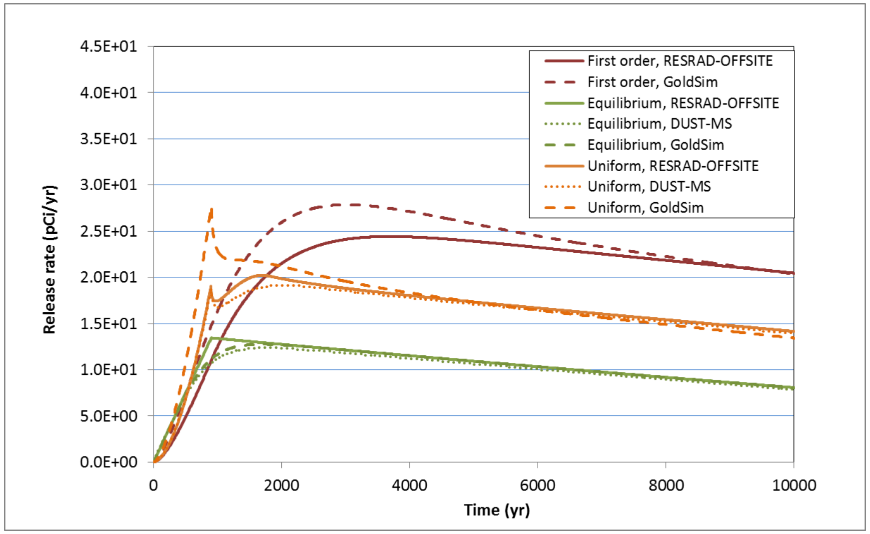
Comparison of Release Rates for Case III (Cont.)

- *0.3-m U-234 source – Kd = 6,000 cm³/g for Th-230*
- *Release rate of Th-230*

No dispersion



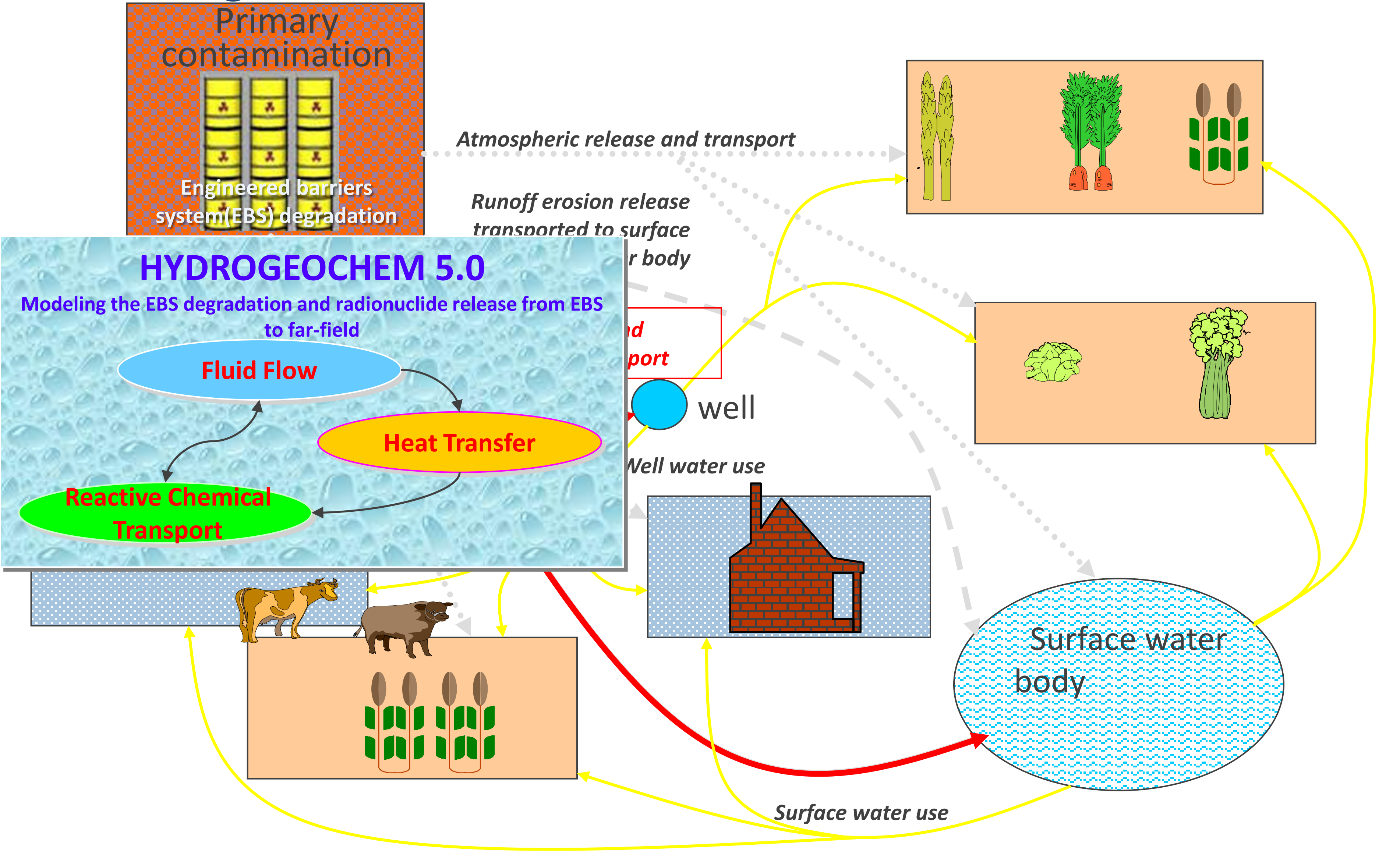
Dispersivity = 0.03 m



Upcoming Developments in RESRAD-OFFSITE

- Add delay time in the source release options
- Output area factors (for MARSSIM applications)
- Improve the RESRAD-OFFSITE flux and concentration input options:
  - Flux to ground water
  - Flux to atmosphere
  - Flux to surface water
  - Concentrations in surface water and well water
  - Inventory remaining in the primary contamination and mixing layers
- Link to other codes

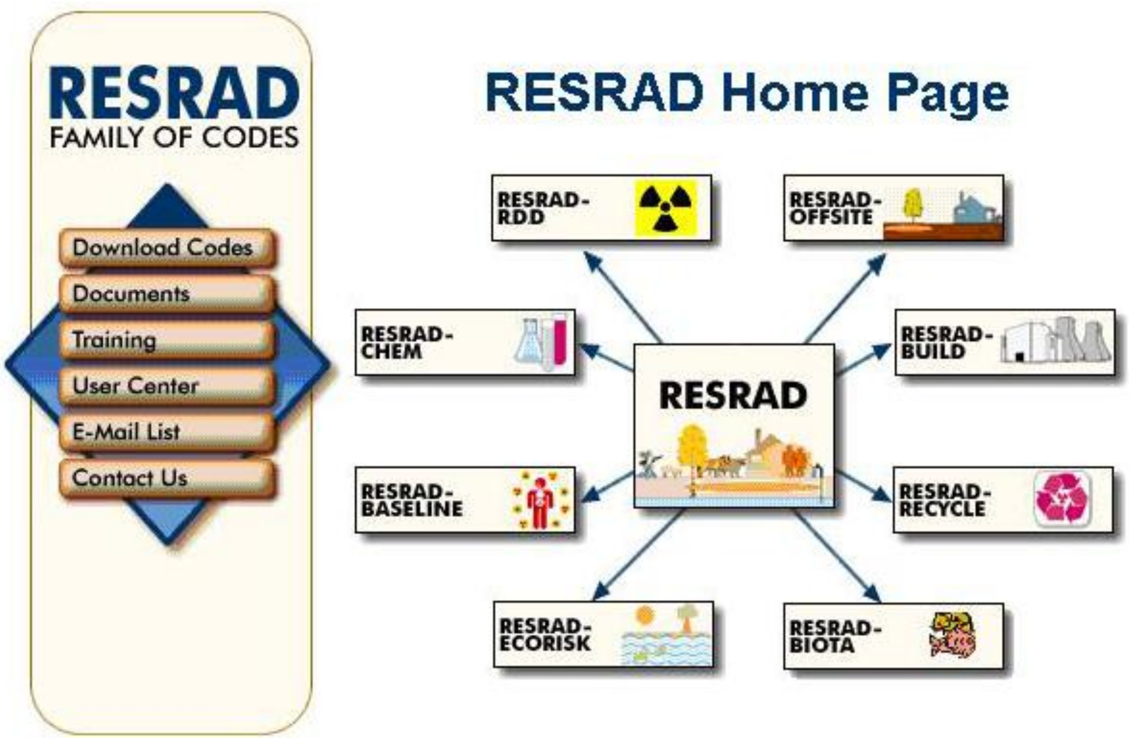
Linking RESRAD-OFFSITE and HYDROGEOCHEM



Applications of RESRAD-OFFSITE to LLW Disposal

- Draft Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste (DOE/EIS-0375-D) (http://energy.gov/sites/prod/files/EIS-0375-DEIS_Volume02-2011.pdf).
- IAEA EMRAS II NORM and Legacy Sites Working Group used RESRAD-OFFSITE for several scenarios by many countries/participants (http://www-ns.iaea.org/projects/emras/emras2/working-groups/working-group-two.asp?s=8).

Thank you!



The next RESRAD training Course: Sept. 15-26, 2014 at Argonne National Lab

More Info at RESRAD Web Site:

http://www.evs.anl.gov/resrad

Email: resrad@anl.gov