US EPA Superfund Radiation Risk Assessment Update: New, Revised, and Upcoming Tools – 16308

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ABSTRACT

The U.S. Environmental Protection Agency (EPA) Superfund remedial program is finishing up a significant number of revisions to its guidance for the risk assessment process at radioactively contaminated Superfund sites. The six Preliminary Remediation Goal (PRG) and Dose Compliance Concentration (DCC) internet based calculators for risk and dose assessment at Superfund sites are being revised to reflect better science, revisions to existing exposure scenarios and new scenarios, and changes to match up more closely with the EPA chemical regional screening level calculator. A comprehensive set of revisions to the PRG calculator was finished in November 2014. Additional revisions to the other 5 calculators were made in 2015 and are discussed in this paper. Further revisions are expected prior to WM and will be presented if finished or discussed in more general terms if still underway.

INTRODUCTION

To help meet the Superfund program's mandate to protect human health and the environment from current and potential threats posed by uncontrolled hazardous substance (both radiological and non-radiological) pollutant or contaminant) releases, the Superfund program has developed a human health evaluation process as part of its remedial response program. The process of gathering and assessing human health risk information is adapted from well-established chemical risk assessment principles and procedures. The Superfund Baseline Risk Assessment provides an estimate of the likelihood and magnitude of health problems occurring if no cleanup action is taken at a site.

Cleanup levels for radioactive contamination at CERCLA sites are generally expressed in terms of risk levels (e.g., 10^{-4}), rather than millirem or millisierverts, as a unit of measure. CERCLA guidance recommends the use of slope factors when estimating cancer risk from radioactive contaminants, rather than converting from millirem. Current slope factors are based on risk coefficients in Federal Guidance Report 13.

The 10^{-4} to 10^{-6} cancer risk range can be interpreted to mean that a highly exposed individual may have a one in 10,000 to one in 1,000,000 increased chance of developing cancer because of exposure to a site-related carcinogen. Once a decision has been made to take an action, the Superfund remedial program prefers

cleanups achieving the more protective end of the range (i.e., 10^{-6}). The Superfund remedial program uses 10-6 as a point of departure and establishes Preliminary Remediation Goals (PRGs) at 1 x 10^{-6}.

Preliminary Remediation Goals (PRGs) are used for site "screening" and as initial cleanup goals if applicable. PRGs are not de facto cleanup standards and should not be applied as such. The PRG's role in site "screening" is to help identify areas, contaminants, and conditions that do not require further federal attention at a particular site.

PRGs not based on ARARs are risk-based concentrations, derived from standardized equations combining exposure information assumptions with EPA toxicity data. PRGs based on cancer risk are established at 1 x 10^{-6}. PRGs are identified early in the CERCLA process. PRGs are modified as needed based on site-specific information.

METHODS

Superfund Risk and Dose Soil and Water Models

EPA has developed a PRG for Radionuclides electronic calculator, known as the Rad PRG calculator. This electronic calculator presents risk-based standardized exposure parameters and equations that should be used for calculating radionuclide PRGs for residential, commercial/industrial, and agricultural land use exposures, tap water and fish ingestion exposures. The calculator also presents PRGs to protect groundwater which are determined by calculating the concentration of radioactively contaminated soil leaching from soil to groundwater that will meet MCLs or risk-based concentrations. The Rad PRG calculator may be found at the EPA website (http://epa-prgs.ornl.gov/radionuclides/).

To address ARARs that are expressed in terms of millirem per year, an approach similar to that taken for calculation of PRGs was also used to calculate soil “compliance concentrations” based upon various methods of dose calculation in another EPA tool, the “Dose Compliance Concentrations”, or DCC calculator. The DCC calculator equations are identical to those in the PRG for Radionuclides, except that the target dose rate (ARAR based) is substituted for the target cancer risk (1 x 10-6), the period of exposure is one year to indicate year of peak dose, and a dose conversion factor (DCF) will be used in place of the slope factor. The DCC calculator may be found at the EPA website(http://epa-dccs.ornl.gov/).

Superfund Decommissioning Models

The EPA Superfund remedial program has two risk assessment tools that are particularly relevant to decommissioning activities conducted under CERCLA authority. The Preliminary Remediation Goals for Radionuclides in Buildings (BPRG) electronic calculator was developed to help standardize the evaluation and cleanup of radiologically contaminated buildings at which risk is being assessed for

occupancy. BPRGs are radionuclide concentrations in dust, air and building materials that correspond to a specified level of human cancer risk. The BPRG calculator may be found at the EPA website (http://epa-bprg.ornl.gov/).

The Preliminary Remediation Goals for Radionuclides in Outside Surface SPRG calculator addresses hard outside surfaces such as building slabs, outside building walls, sidewalks and roads. SPRGs are radionuclide concentrations in dust and hard outside surface materials. The BPRG and SPRG calculators include both residential and industrial/commercial exposure scenarios. The SPRG calculator may be found at the EPA website (http://epa-sprg.ornl.gov/).

To facilitate compliance with dose-based ARARs while conducting decommissioning activities under CERCLA, EPA developed two electronic calculators. These are the Radionuclide Building Dose Cleanup Concentrations (BDCC) and the Radionuclide Outside Hard Surfaces Dose Cleanup Concentrations (SDCC) electronic calculators. Both of these ARAR dose calculators are set up in a similar manner to the BPRG and SPRG calculators. They include the same exposure scenarios. Also, the equations in the scenarios are essentially the same except the ARAR dose calculators use: dose conversion factors instead of slope factors, and a year of peak dose instead of risk over a period of exposure such as 30 years. The BDCC calculator may be found at: http://epa-bdcc.ornl.gov/. The SDCC calculator may be found at the EPA website (http://epa-sdcc.ornl.gov/).

Superfund Ecological Risk Model

The EPA Superfund remedial program is also developing the “Radionuclide Ecological Benchmark” calculator. This calculator provides biota concentration guides (BCGs), also known as ecological screening benchmarks, for use in ecological risk assessments at CERCLA sites. This calculator is intended to develop ecological benchmarks as part of the Superfund remedial guidance "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments." The calculator will develop ecological benchmarks for ionizing radiation based on cell death only.

DISCUSSIONS

Revisions to Risk and Dose Models

All three DCC calculators and the BPRG and SPRG now include a baseline risk or dose assessment feature. When developing risk based PRG or dose based DCC concentrations, the user is nowable to input the existing contamination levels at the same time to get isotope specific and overall risk and dose estimates.

New dose conversion factors in the 3 DCC calculators is now based on information in ICRP 107.

There are a number of revisions that will apply only to DCC calculator, that were made to the PRG calculator the previous year. A recreator scenario has been added

that includes a swimmer, park user, and a game eater. In the tap water scenario, the external route of exposure from bathing and showering is added to the existing ingestion and volitization exposure routes. The farmer scenario is now broken into separate soil and water subscenarios which assume all of the contamination is solely within that media. There is a new feature for accounting for clean soil on top of contaminated soil. Also new transfer factors have been adopted from the IAEA for addressing uptake into plants and animals.

In the PRG calculator additional source depth-specific soil gamma shielding factors (GSF) are now given for cover depths of 2 to 10 meters.

In the BPRG and BDCC calculators updated F_{SURF} values were added that account for multiple source depths (ground plane, 1cm, 5cm, 15cm and infinite depth) and multiple building materials (wood, glass, concrete, drywall and adobe mud brick were analyzed as well as 2 composite scenarios). Composite 1 is a drywall room with a glass window, wooden doors and drywall walls. The floors for composite 1 are concrete and the ceiling is drywall. Composite 2 is a concrete room with wooden doors, a drywall ceiling and a concrete floor. Both composite cases used a homogeneous mix of material for the walls to represent the window and door mixed in with the wall.

It is expected that by WM EPA will have updated the produce portions of the farmer and residential scenarios in the PRG and DCC calculators with revised intake information from the RCRA program and transfer factors from IAEA; the construction worker with adjustments for external exposure for construction workers in different size ditches, and gamma shielding factors from contamination in soil based on different housing materials.

CONCLUSIONS

The changes to the Superfund PRG and DCC models will facilitate the risk assessment process at radioactively contaminated Superfund sites by improving the scientific basis for the model runs while not increasing complexity for the users.