

**New Science and Newer Risk Assessment Policy: Updates to the
U.S. EPA Superfund Risk and Dose Assessment Models - 11570**

Stuart Walker

U.S. Environmental Protection Agency (EPA)
Office of Superfund Remediation and Technology Innovation (OSRTI)
Science and Policy Branch
1200 Pennsylvania Avenue, NW. (5204P), Washington, DC 20460

ABSTRACT

This paper describes how the EPA Superfund 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. This presentation would go over those changes that have been incorporated recently and those that should be finished in the coming months. The presentation will help users know when and how to utilize default or site-specific aspects of these new features.

SUPERFUND RISK-BASED CLEANUP LEVELS

Cleanup levels for radioactive contamination at CERCLA sites are generally expressed in terms of risk levels, rather than millirem or millisieverts, as a unit of measure. CERCLA guidance recommends the use of slope factors in the EPA Health Effects Assessment Summary Tables (HEAST) when estimating cancer risk from radioactive contaminants. HEAST is based on risk coefficients in Federal Guidance Report 13.

Compliance with the requirements of other Federal environmental laws, more stringent State environmental laws, or State facility-siting laws is often the determining factor in establishing cleanup levels at CERCLA sites. These requirements are known as Applicable or Relevant and Appropriate Requirements (ARARs). However, where ARARs are not available or are not sufficiently protective, EPA generally sets site-specific remediation levels for: 1) carcinogens at a level that represents an upper-bound lifetime cancer risk to an individual of between 10^{-4} to 10^{-6} ; and for 2) non-carcinogens such that the cumulative risks from exposure will not result in adverse effects to human populations (including sensitive sub-populations) that may be exposed during a lifetime or part of a lifetime, incorporating an adequate margin of safety. The specified cleanup levels account for exposures from all potential pathways, and through all media (e.g., soil, ground water, surface water, sediment, air, structures and biota).

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

To assess the potential for cumulative noncarcinogenic effects posed by multiple contaminants, EPA has developed a hazard index (HI). The HI is derived by adding the noncancer risks for site contaminants with the same target organ or mechanism of toxicity. When the HI exceeds 1.0, there may be concern for adverse health effects due to exposure to multiple contaminants. Radioisotopes of uranium are generally the only radionuclides for which EPA will evaluate the HI.

PRGs

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 1×10^{-6} . PRGs are identified early in the CERCLA process. PRGs are modified as needed, based on site-specific information.

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 PRG calculator may be found at:

<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 (1×10^{-6}), the period of exposure is one year to indicate year of peak dose, and a DCF will be used in place of the slope factor. The DCC calculator may be found at:

<http://epa-dccs.ornl.gov/>

EPA has developed with the state-led consortium Interstate Technology Regulatory Council (ITRC) training on both the PRG and DCC calculators in the online training course entitled “Radiation Risk Assessment: Updates and Tools.” This training may be found here: http://www.clu-in.org/conf/itrc/rads_051507/.

SUPERFUND DECOMMISSIONING MODELS

EPA has also completed four risk assessment tools that are particularly relevant to decommissioning activities conducted under CERCLA authority. These are the:

1. Building Preliminary Remediation Goals for Radionuclides (BPRG) electronic calculator, which may be found at:
<http://epa-bprg.ornl.gov/>
2. Radionuclide Outdoor Surfaces Preliminary Remediation Goals (SPRG) electronic calculator, which may be found at:
<http://epa-sprg.ornl.gov/>
3. ARAR Dose Compliance Concentrations for Radionuclides (BDCC) electronic calculator, which may be found at:
<http://epa-bdcc.ornl.gov/>
4. ARAR Radionuclide Outdoor Surfaces Dose Compliance Concentrations for Radionuclides (SDCC) electronic calculator, which may be found at:
<http://epa-sdcc.ornl.gov/>

EPA developed the BPRG calculator 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 intent of SPRG calculator is to address 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 BDCC and SDCC calculators were developed to determine concentrations that would comply with dose based standards that site-specifically are determined to be ARARs.

EPA and ITRC have developed training on all four of these calculators in the online course entitled “Decontamination and Decommissioning of Radiologically-Contaminated Facilities” which may be found at:
http://www.clu-in.org/conf/itrc/radsdd_040308/

INITIAL AREA CORRECTION FACTORS (ACFs) FOR SOIL

In Part 5 of the “Soil Screening Guidance for Radionuclides: Technical Background Document” issued on November 21, 2000, EPA developed Area Correction Factors (ACFs) for adjusting slope factors for eight site sizes. In this guidance EPA provided recommended ACFs for radionuclides as a function of source area calculated using MicroShield V5.01.1. Since the default source size is 0.5-acre (i.e.,

2,000 m²), the default ACF for default soil screening level risk assessment equations were set at 0.9 for all isotopes. The calculations assumed a uniform layer of contamination 15 cm deep with a soil density of 1.6 g/cm³. A single recommended value was considered suitable for all radionuclides over the range of source areas since EPA's initial analysis shows that ACFs vary little from one radionuclide to another.

EPA's also provided examples of ACFs for seven radionuclides as a function of source area calculated using MicroShield V5.01. The calculations again assumed a uniform layer of contamination 15 cm deep with a soil density of 1.6 g/cm³. The guidance recommended that users that have one of the radionuclides from the analysis as a contaminant at their site may use the radionuclide specific ACF that is appropriate for their source area rather than the general value otherwise used for all radionuclides.

ADJUSTMENTS FOR BUILDINGS

For the Preliminary Remediation Goals for Radionuclides in Buildings (BPRG) electronic calculator issued on August 29, 2007, EPA made two sets of further enhancements. First, EPA issued external ground plane SFs for 800 radionuclides for assessing contamination that existed only on the surface of walls, floors, or ceiling. This was in addition to the traditional external SFs that assumed an infinite depth. These ground plane slope factors were developed by converting the ground plane external DCFs in Federal Guidance 13.

Second, EPA issued surfaces factors (F_{SURF}) to account for the varying radiation fields inside a contaminated room within a structure. The surfaces factor, in the recommended default and site-specific equations, is based on exposure to 4 walls, the floor and the ceiling in a room. This calculator uses the relationship between the dose rate coefficients for exposures in a contaminated room and dose rate coefficients for an infinite source to calculate a surfaces factor (F_{SURF}). The dose quantity evaluated is the air kerma rate one meter above the floor. The floor, walls and ceiling of the rooms are assumed to be contaminated to the same level. 81 locations in 5 room sizes, ranging from 10 by 10 by 10 to 400 by 400 by 40 feet, were modeled to account for the dose contribution from multiple surfaces. The F_{SURF} for the default option is set to the most protective value across the 5 room sizes and 4 receptor positions. In the site-specific option the user can select from the 5 room sizes and 4 receptor positions: average, center, center wall and corner for each of 800 radionuclides. Further, photon energies of each radioisotope were incorporated into the modeling. The methodology for developing isotope-specific dose rates and the results are discussed in the report "Dose Rates in Contaminated Rooms of Various Sizes." [1] The results show that only at very low photon energies is the position of the receptor in the room likely to be relevant. Also shown is that only at very low photon levels is the size of the room likely to be relevant. The report contains a table of the 16,000 F_{SURF} values used in the BPRG calculator for each radioisotope, room size and receptor position.

ADJUSTMENTS FOR OUTSIDE HARD SURFACES

For the Preliminary Remediation Goals for Radionuclides in Outdoor Surfaces (SPRG) electronic calculator issued on January 16, 2009, EPA made three sets of further enhancements, each of which were made for 800 radionuclides. First, EPA issued external 1 centimeter, 5 centimeter, and 15 centimeter SFs for contamination that had been only as thick as each of those respective amounts. These external SFs were in addition to the ground plane SF first used in the BPRG calculator and the traditional infinite depth SF. These differing centimeter slope factors were developed by converting the centimeter DCFs in Federal Guidance 13.

Second, in the SPRG calculator EPA issued new F_{SURF} values based on exposure to 2 vertical surfaces (outside building surfaces on either side of a street) and a horizontal surface (road and sidewalk). The SPRG calculator uses the relationship between the dose rate coefficients for exposures in a contaminated outdoor setting and dose rate coefficients for an infinite source to calculate a surfaces factor (F_{SURF}). The dose quantity evaluated is the air kerma rate one meter above the sidewalk. The outdoor surfaces are assumed to be contaminated to the same level. Locations in the midpoint of the sidewalk, next to the buildings and in the middle of the street for building heights of 12.5, 30, 59 and 150 and 200 feet, were modeled to account for the dose contribution from multiple surfaces. Further, photon energies of each radioisotope were incorporated into the modeling. The report "Dose Rate in Contaminated Street" [2] contains a detailed explanation of the process. Side Walk Dose Rate shows that building height doesn't effect the dose rate significantly after 150 feet. The report also shows a table of the F_{SURF} values used in this calculator for each radioisotope. F_{SURF} values were calculated for each position-specific and building-height specific combination.

Third, for the 2-D exposure models addressing building slabs, a new ACF was developed which is made variable by isotope and area for site-specific analysis. The SPRG calculator allows the user to select from 8 different slab area sizes. If no size is selected for the finite slab analysis, the ACF from the most protective slab size is selected. For further information on the derivation of the isotope-specific/area-specific ACF values for 2-D slabs see the report "Ratios of Dose Rates for Contaminated Slabs." [3] This report also includes a table of each of these new isotope-specific ACFs for each radionuclide and eight slab sizes.

CONCLUSIONS

In most instances, the more accurate modeling results derived from these gamma adjustments are less conservative. The notable exception are for some radionuclides in rooms with contaminated walls, ceiling, and floors, and the receptor is in location of the room with the highest amount of radiation exposure, usually the corner of small rooms and the center of large conference rooms.

REFERENCES

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