"Carl Gogolak"
<cvg@verizon.net>

02/15/2008 08:29 AM

To <Jay.Bassin@emsus.com>

cc

bcc

Subject RE: U.S. EPA Peer Review of Superfund PRG Calculator

History:

Jay,
I have attached my comments as annotations to both the user's guide (yellow balloons) and the charge (blue insertion marks).

I looked at the references, but did not examine the parameters in detail. Generally, the User's Manual is not. It does not explain how to use the calculator, and does not describe the screen and input options. Without more info, tutorial or guidance, I would be reluctant to use anything but the defaults. As with many of these models, the interaction amongst the parameters is not spelled out, viz., if I change parameter A, should that imply a corresponding change to parameter B? Should certain parameters be restricted to a reasonable range? Should there be error checking on the input to prevent gross errors in their values?

There are MANY broken links: some crucial, like the equations in the calculator. Like many of the models out there, this one tries to include everything. There is no real discrimination between which factors are the biggest contributors and should be paid most attention to. There are sensitivity analyses that can be done to assess such things.

It may not simple or easy to make some of the changes/additions I suggest. I feel that most folks who are not experts in these particular models will just use the defaults.
Otherwise the learning curve may be too high.

I hope this is sufficient for the task at hand. If you need something else, I guess we have till COB today.

Regards

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From: Jay.Bassin@emsus.com [mailto:Jay.Bassin@emsus.com]
Sent: Wednesday, January 16, 2008 12:58 PM
To: carl@gogolak.org
Subject: U.S. EPA Peer Review of Superfund PRG Calculator

On behalf of EPA, I appreciate your willingness to conduct an external peer review of an on-line calculator of "Preliminary Remediation Goals for Radionuclides in Outdoor Surfaces."

We are requesting that you complete the peer review and provide me with your comments by February 15, 2008.

I am attaching a purchase order, the statement of work/"Charge" to the peer reviewers, a conflict of interest certification, and an IRS Form W-9 (the IRS form need not be used if your check will be issued to a corporation; if it will be issued to you as an individual, we are required to have it unless we already have yours on file).

Please return the conflict of interest certification as soon as convenient (not later than when you complete your peer review). Electronic submission is fine (either scanned signature or digital signature is acceptable).

Access instructions to the on-line calculator are provided in the SOW/Charge. Please contact me right away if you have problems accessing the site. We would appreciate it if you do not circulate the site, users name, or password.

While it is not germane to the peer review, I would appreciate it if you would keep track of how many hours you put into this peer review and let me know when you complete and return the purchase order for payment. This will assist us in designing future peer reviews.

Don't hesitate to call or email me if you have questions. Once again, I very much appreciate your willingness to help make this tool a better product.

(See attached file: Peer Review PO Gogolak.pdf)

(See attached file: SPRG Peer Review Charge 01-16-08.pdf)

(See attached file: Peer Reviewer Conflict of Interest Certification.pdf)

(See attached file: IRS Form w-9.pdf)

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www.emsus.com users_guide_01142007 with cvg annotations.pdf

Waste and Cleanup Risk Assessment

https://epa-sprg.ornl.gov/users_guide.shtml
Last updated on Tuesday, January 15th, 2008.

You are here: EPA Home OSWER Waste and Cleanup Risk Assessment Databases and Tools Radionuclide Outdoor Surfaces SPRG Calculator

SPRG Home SPRG Search User's Guide What's New Frequently Asked Questions Equations Download Area

Preliminary Remediation Goals for Radionuclides in Outdoor Surfaces (SPRG)

User's Guide

Adobe PDF Version

Disclaimer

This guidance document sets forth recommended approaches based on EPA's best thinking to date with respect to risk assessment for response actions at CERCLA sites. This document does not establish binding rules. Alternative approaches for risk assessment may be found to be more appropriate at specific sites (e.g., where site circumstances do not match the underlying assumptions, conditions and models in the guidance). The decision whether to use an alternative approach and a description of any such approach should be placed in the Administrative Record for the site. Accordingly, if comments are received at individual sites questioning the use of the approaches recommended in this guidance, the comments should be considered and an explanation provided for the selected approach.

The policies set out in the Radionuclide SPRG User Guide provide guidance to EPA staff. The User's Guide also provides recommended guidance to the public and regulated community on how EPA intends the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) to be implemented. EPA may change this recommended guidance in the future, as appropriate. This calculator is intended for use by risk assessors, health physicists and other qualified environmental protection specialists.

It should also be noted that calculating a human radiological SPRG addresses neither human cancer risk from nonradiological (chemical) contaminants, noncancer toxicity, nor potential ecological risk. Of the radionuclides generally found at CERCLA sites, only uranium has potentially significant noncancer toxicity. When assessing sites with radiological contaminants which include uranium, it may also be necessary to consider the noncancer toxicity of uranium. Similarly, some sites with radiological contaminants in sensitive ecological settings may also need to be evaluated for potential ecological risk. EPA's guidance "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessment" contains an eight step process for using benchmarks for ecological effects in the remedy selection process. Evaluation of radionuclides in soil should be conducted using the EPA's PRG calculator and the EPA's BPRG calculator should be used for evaluation inside buildings.

This web calculator is intended to be a generic steady-state screening assessment tool. The calculator is flexible and may also be used to derive site-specific risk assessments. Site-specific information should be gathered. The use of models reviewed by EPA in the Soil Screening Guidance - Radionuclide Technical Background Document at http://www.epa.gov/superfund/resources/radiation/tbd-part-3-clean.pdf section 3-2, is recommended. This report provides a detailed technical analysis of five unsaturated zone fate and transport models for radionuclides. This report supports the information provided in Part 3 - Unsaturated Zone Models for Radionuclide Fate and Transport [PDF 383KB, 25 pages] of the Soil Screening Guidance for Radionuclides: Technical Background Document on determining the general applicability of the models to subsurface conditions and includes an assessment of each model's potential applicability to the soil screening process.

1. Introduction

Generally, these recommended radionuclide outdoor surfaces preliminary remediation goals (SPRGs) are reasonable maximum exposure (RME) concentrations derived from standardized equations that combine exposure information and toxicity information in the form of slope factors (SFs). Recommended SPRGs are presented for residential and worker exposure.

The intent of this calculator is to address hard outside surfaces such as building slabs, outside building walls, sidewalks and roads.

Generally under the NCP, PRGs are risk-based, conservative screening values to identify areas and contaminants of potential concern (COPCs) that either do or do not warrant further investigation.

This calculator is based on Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals) (RAGS Part B). RAGS Part B provides guidance on using EPA toxicity values and exposure information to calculate risk-based recommended SPRGs. Recommended for initial use at the scoping phase of a project using readily available information, risk-based recommended SPRGs may be modified based on site-specific data gathered during the RI/FS study. SPRG development and screening should assist staff in streamlining the consideration of remedial alternatives. Chemical-specific SPRGs typically are from two general sources: (1) concentrations based on potential Applicable or Relevant and Appropriate Requirements (ARARs) and (2) risk-based concentrations. ARARs include concentration limits set by other environmental regulations such as Safe Drinking Water Act maximum contaminant levels (MCLs). A second source for SPRGs, and the focus of this database tool, can be risk-based calculations that set concentration limits using carcinogenic toxicity values under specific exposure conditions.

The recommended approach for developing remediation goals is to identify SPRGs at scoping, modify them as needed at the end of the RI or during the FS based on site-specific information from the baseline risk assessment, and ultimately select remediation levels in the Record of Decision (ROD). In order to set radionuclide-specific SPRGs in a site-specific context, however, assessors should answer fundamental questions about the site. Information on the radionuclides that are present onsite, the specific contaminated media, land-use assumptions, and the exposure assumptions behind pathways of individual exposure normally is necessary in order to develop radionuclide-specific SPRGs. The recommended SPRG calculator provides the ability to modify the standard default SPRG exposure parameters to calculate site-specific SPRGs.

This database tool presents recommended standardized risk-based SPRGs and variable risk-based SPRG calculation equations for radioactive contaminants. Ecological effects are not considered in the calculator for radionuclides SPRGs.

SPRGs are presented for residents and workers using both soil volume and ground plane slope factors. The recommended risk-based SPRGs for radionuclides are based on the carcinogenicity of the contaminants. Cancer slope factors used are from HEAST.

Non-carcinogenic effects generally are not considered for radionuclide analytes, except for uranium for which both carcinogenic and non-carcinogenic effects are considered.

The standardized recommended SPRGs are based on default exposure parameters and incorporate exposure factors that present RME conditions. This database tool presents SPRGs in both activity and mass units. Once this database tool is used to retrieve recommended standard SPRGs or calculate site-specific SPRGs, it is important to clearly demonstrate the equations and exposure parameters used in the calculations. A discussion of the assumptions that go into the recommended SPRGs calculated should be included in the document where the SPRGs are presented, such as a Remedial Investigation (RI) Report or Feasibility Study.

This website combines current EPA recommended slope factors with "standard" exposure factors to estimate contaminant concentrations in environmental media (hard outside surfaces) that are designed to be protective of humans (including sensitive groups) over a lifetime. Sufficient knowledge about a given site may warrant the use of site-specific assumptions, which may differ from the recommended defaults. Exceeding a recommended SPRG usually suggests that further evaluation of the potential risks is appropriate. The recommended SPRG concentrations presented on this website can be used to screen pollutants in environmental media, trigger further

Summary of Comments on https://epa-sprg.ornl.gov/users_guide.shtml

Page: 1

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Refer reader to where it is explained how to do this.

investigation, and provide initial cleanup goals, if applicable. The recommended SPRGs should be applied in accordance with guidance from EPA Regions.

2. Understanding the SPRG Website

2.1 General Considerations

Generally, these recommended SPRGs are isotope concentrations that correspond to certain levels of risk in dust, streets, sidewalks, finite slabs and building materials. Slope factors (SFs), for a given radionuclide generally represent the risk equivalent per unit intake (i.e., ingestion or inhalation) or external exposure of that radionuclide. In risk assessments, these SFs normally are used in calculations with radionuclide concentrations and exposure assumptions to estimate cancer risk from exposure to radioactive contamination. The calculations may be rearranged to generate SPRGs for a specified level of risk. SFs may be specified for specific body organs or tissues of interest, or as a weighted sum of individual organ dose, termed the effective dose equivalent. These SFs may be multiplied by the total activity of each radionuclide inhaled or ingested per year, or the external exposure concentration to which a receptor may be exposed, to estimate the risk to the receptor. Cancer slope factors from HEAST and FGR13 [illegible]d be used.

The most common land uses and exposure assumptions are included in the equations on this website: Residential, Outdoor Worker, and Indoor Worker.

The recommended SPRGs are generated with standard exposure route equations, EPA SFs and exposure parameters.

2.2 Slope Factors (SFs)

EPA classifies all radionuclides as carcinogenic to humans. The radionuclide table from HEAST lists ingestion, inhalation and external exposure cancer slope factors (risk coefficients for total cancer morbidity) for radionuclides in conventional units of picocuries (pCi). Ingestion and inhalation slope factors are central estimates in a linear model of the age-averaged, lifetime attributable radiation cancer incidence (fatal and nonfatal cancer) risk per unit of activity inhaled or ingested, expressed as risk/pCi. External exposure slope factors are central estimates of lifetime attributable radiation cancer incidence risk for each year of exposure to external radiation from photon-emitting radionuclides distributed uniformly in a thick layer of soil, and are expressed as risk/yr per pCi/gram soil. When combined with site-specific media concentration data and appropriate exposure assumptions, slope factors can be used to estimate lifetime cancer risks to members of the general population due to radionuclide exposures.

2.2.1 When To Use "+D" SPRGs

Several of the isotopes are listed with a "+D" designation. This designation indicates that the SF includes the contribution from ingrowth of daughter isotopes out to 100 years. The intention of this designation is to make realistic PRGs by including the contributions from their short-lived decay products, assuming equal activity concentrations (i.e. ,secular equilibrium) with the principal or parent nuclide in the environment. (Note that there is one exception to the assumption of secular equilibrium. For the inhalation slope factor for Rn-222+D reported in the table, EPA assumes a 50% equilibrium value for radon decay products (Po-218, Pb-214, Bi-214 and Po-214) in air.) Before applying PRGs to a site, it should be determined if the isotopes present are in secular equilibrium. If the isotopes are found to be in secular equilibrium, the +D PRGs should be used for the parent isotope and the daughters included in the +D can be ignored. If the isotopes are not in secular equilibrium, PRGs should be applied for each daughter isotope. However, in the absence of empirical data, the "+D" values for radionuclides should be used unless there are compelling reasons not to.

For example, if analytical data from a site reveal that Th-228, Ra-224, Rn-220 are detected at a site and that they are in secular equilibrium, the PRG for Th-228+D should be applied and the Ra-224 and Rn-220 can be ignored.

Another example could concern a decay chain in secular equilibrium like Th-232. Even though the decay chain for Th-232 is very long, there is no Th-232+D slope factor. In this case the PRGs for Th-232, Ra-228+D, and Th-228+D should be used. If no part of the decay chain is in secular equilibrium, the user should use each of the PRGs for isotopes in the decay chain that have slope factors (e.g., Th-232, Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Po-212, and Tl-208). If part of the decay chain is in secular equilibrium, then the user may use that particular +D slope factor that covers that part of the decay chain, while using the slope factors for the other radionuclides.

2.2.2 Associated Decay Chains for "+D" SPRGs

Selected radionuclides and radioactive decay chain products are designated with the suffix "+D" to indicate that cancer risk estimates for these radionuclides include the contributions from their short-lived decay products, assuming equal activity concentrations (i.e., secular equilibrium) with the principal or parent nuclide in the environment. For all radionuclides without the "+D" suffix, only intake or external exposure to the single radionuclide is considered. Most radionuclides with a +D designation include the entire decay chain to the stable terminal nuclide in the slope factors. HEAST provides a table of +D radionuclides that decay for longer than 100 years. This table provides the associated decay chain included and the terminal radionuclide used in the slope factors. This table is reproduced below.

Principal Radionuclide (half-life in years)	Associated decay chain	Terminal Radionuclide	Half-life (years)
Am-242m+D (152)	Am-242, Cm-242, Np-238	Pu-238	87.7
Am-243+D (7.4E+03)	Np-239	Pu-239	2.40E+04
Np-237+D (2.1E+06)	Pa-233	U-233	1.6E+05
Pu-244+D (8.3E+07)	U-240, Np-240m	Pu-240	6.50E+03
Ra-226+D (1.6E+03)	Rn-222, Po-218, Pb-214, At-218, Bi-214, Po-214, Tl-210	Pb-210	22
Ra-228+D (6)	Ac-228	Th-228	2
U-235+D (7.0E+08)	Th-231	Pa-231	3.3E+04
U-238+D (4.5E+09)	Th-234, Pa-234m, Pa-234	U-234	2.4E+05

Ingestion and inhalation slope factors are missing for some of the +D isotopes. These have not been derived yet. Use caution when selecting a SPRG to make sure that as many routes of exposure are accounted for.

2.3 SPRG in Context of Superfund Modeling Framework

This recommended SPRG calculator focuses on the application of generic and simple site-specific approaches that are part of a larger framework for calculating concentration levels that are designed to be consistent with risk based criteria. Generic recommended SPRGs for a 1×10^{-6} cancer risk standard are provided by viewing either the tables in the Download Area of this calculator or by running the SPRG Search of this calculator with the "Get Default SPRGs" option. Part 3 of the Soil Screening Guidance for Radionuclides: Technical Background Document provides more information about more detailed approaches that are part of the same framework.

Generic recommended SPRGs can be calculated from the same equations presented in the site-specific portion of the calculator, but typically are based on a number of default assumptions chosen to be protective of human health for most site conditions. Generic recommended SPRGs can be used in place of site-specific SPRG levels; however, in general, they are expected to be more conservative than site-specific levels. The site manager should weigh the cost of collecting the data necessary to develop site-specific SPRGs with the potential for deriving a higher SPRG that provides an appropriate level of protection.

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Author: Carl Gogolak
Subject: Note
Date: 2/14/2008 4:15:00 PM
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Author: Carl Gogolak
Subject: Note
Date: 2/14/2008 4:14:10 PM
Many of these links say authorization required.
Why is this since I already entered a password?

3. Using the SPRG Table

The SPRG "Download Area" provides generic recommended concentrations in the absence of site-specific exposure assessments. Screening concentrations can be used for:

- Prioritizing multiple sites within a facility or exposure units
- Setting risk-based detection limits for contaminants of potential concern (COPCs)
- Focusing future risk assessment efforts
- When appropriate for the site, consideration as risk-based cleanup levels

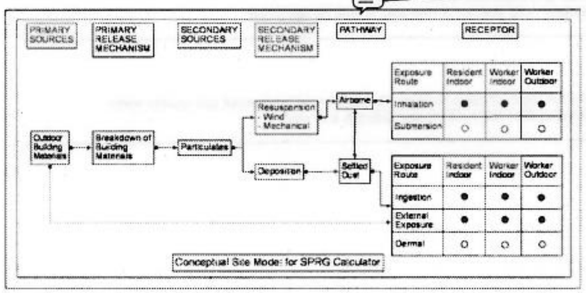
3.1 Developing a Conceptual Site Model

When using SPRGs, the exposure pathways of concern and site conditions should match those taken into account by the screening levels. (Note, however, that future uses may not match current uses. Future uses of a site should be logical as conditions which might occur at the site in the future.) Thus, it generally is necessary to develop a conceptual site model (CSM) to identify likely contaminant source areas, exposure pathways, and potential receptors. This information can be used to determine the applicability of screening levels at the site and the need for additional information. The final CSM represents linkages among contaminant sources, release mechanisms, exposure pathways, and routes and receptors based on historical information. It summarizes the understanding of the contamination problem. A separate CSM for ecological receptors can be useful. Part 2 and Attachment A of the Soil Screening Guidance for Radionuclides: Users Guide (EPA 2000a) contains the recommended steps for developing a CSM.

Existing EPA documents with additional CSM guidance are:

1. Risk Assessment Guidance for Superfund: Volume I Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments). See Planning Table 1; and
2. Soil Screening Guidance for Radionuclides: User's Guide. See Attachment A.

CSMs can be tabular, graphical or stem-and-leaf. Section 4 of the user guide presents links to graphical CSMs for each scenario. Below is a stem-and-leaf CSM showing the exposure routes quantified and not quantified in this calculator.



As a final check, the CSM generally should answer the following questions:

- Are there potential ecological concerns?
- Is there potential for land use other than those listed in the SPRG calculator (e.g., recreational, agricultural or trespasser)?
- Are there other likely human exposure pathways that were not considered in development of the SPRGs?
- Are there unusual site conditions (e.g. large areas of contamination, high fugitive dust levels, potential for indoor air contamination)?

The SPRGs may need to be adjusted to reflect the answers to these questions, and additional tools or assessment methodologies may need to be considered (e.g., if there may be potentially significant ecological risk). The recommended default scenarios in this calculator are the same default scenarios EPA addresses in its guidance. Other scenarios may be investigated, using the recommended SPRG calculator, by altering site-specific exposure parameters.

3.2 Radionuclide Background

Natural background radiation should be considered prior to applying SPRGs as cleanup levels. Background and site-related levels of radiation should be addressed as they are for other contaminants at CERCLA sites. For further information see EPA's guidance "Role of Background in the CERCLA Cleanup Program", April 2002, (OSWER 9285.6-07P). It should be noted that certain ARARs specifically address how to factor background into cleanup levels. For example, some radiation ARAR levels are established as increments above background concentrations. In these circumstances, background should be addressed in the manner prescribed by the ARAR. Additional information on radioactive materials present in building materials can be found in Volume 105, Number 2, March-April 2000, Journal of Research of the National Institute of Standards and Technology, Radioactivity Measurements on Glazed Ceramic Surfaces.

3.3 Potential Problems

As with any risk based tool, the potential exists for misapplication. In most cases, this results from not understanding the intended use of the recommended SPRGs. In order to prevent misuse of the recommended SPRGs, the following should be avoided:

- Applying recommended SPRG levels to a site without adequately developing a conceptual site model that identifies relevant exposure pathways and exposure scenarios.
- Use of recommended SPRG levels as cleanup levels without the consideration of other relevant criteria such as ARARs.
- Use of recommended SPRG levels as cleanup levels without verifying numbers with a health physicist/risk assessor.
- Use of outdated SPRG tables that have been superseded by more recent publications.
- Not considering the effects from the presence of multiple isotopes.

4. Technical Support Documentation

The recommended SPRGs consider human exposure from direct contact with contaminated outdoor dust on solid surfaces and external exposure to contaminated streets, sidewalks, finite slabs and building materials. The equations and technical discussion are aimed at developing concentration levels for risk-based SPRGs. The following text presents the recommended land use equations and their exposure routes. Table 1 presents the suggested definitions of the variables and their default values. Any alternative values or assumptions used in remedy evaluation or selection on a CERCLA site should be presented with supporting rationale in the Administrative Record.

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Author: Carl Gogolak
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Author: Carl Gogolak
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Author: Carl Gogolak
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I guess open circles signify not quantified?

Author: Carl Gogolak
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In the Surface PRG calculations, the 3 choices are resident, indoor worker and outdoor worker. Where do these other scenarios fit in?

For a graphical representation and brief description of the routes of exposure for each exposure scenario, click on the name of the exposure scenarios below:

- Resident - Exposure to Settled Dust on Outdoor Surfaces
- Resident - 3-D Direct External Exposure to Fixed Contaminated Building Materials
- Resident - 3-D Direct External Exposure to Fixed Settled Dust on Outdoor Surfaces
- Resident - 2-D Direct External Exposure to Fixed Contaminated Finite Slabs
- Resident - 2-D Direct External Exposure to Fixed Settled Dust on Finite Slabs
- Outdoor Worker - Exposure to Settled Dust on Outdoor Surfaces
- Outdoor Worker - 3-D Direct External Exposure to Fixed Contaminated Building Materials
- Outdoor Worker - 3-D Direct External Exposure to Fixed Settled Dust on Outdoor Surfaces
- Outdoor Worker - 2-D Direct External Exposure to Fixed Contaminated Finite Slabs
- Outdoor Worker - 2-D Direct External Exposure to Fixed Settled Dust on Finite Slabs
- Indoor Worker - Exposure to Settled Dust on Outdoor Surfaces
- Indoor Worker - 3-D Direct External Exposure to Fixed Contaminated Building Materials
- Indoor Worker - 3-D Direct External Exposure to Fixed Settled Dust on Outdoor Surfaces
- Indoor Worker - 2-D Direct External Exposure to Fixed Contaminated Finite Slabs
- Indoor Worker - 2-D Direct External Exposure to Fixed Settled Dust on Finite Slabs

4.1 Residential Surfaces

The recommended residential outdoor surfaces land use equation, presented here, contains the following exposure pathways and exposure routes:

- exposure to contamination deposited on streets and sidewalks (age-adjusted incidental ingestion, age-adjusted inhalation of particulates and external exposure to ionizing radiation from settled dust using ground plane toxicity values)

$$SPRG_{dr\text{-}total}\left(\frac{pCi}{cm^2}\right)=\frac{TR\times t_r\,(yrs)\times\lambda\left(\frac{1}{years}\right)}{\left(\frac{1-e^{-kt_r}}{kt_r}\right)\times\left(1-e^{-\lambda t_r}\right)\times EF_r\left(\frac{350\,d}{yr}\right)\times ED_r\,(30\,yr)\times\left[\begin{array}{l}\left(SF_{d\text{-}oral}\left(\frac{risk}{pCi}\right)\times IF_r\left(\frac{64.5\,cm^2}{d}\right)\right)+\\ \left(SF_{inh}\left(\frac{risk}{pCi}\right)\times IHF_r\left(\frac{18\,m^3}{d}\right)\times\left(\frac{1\,d}{24\,hr}\right)\times\frac{1}{PEF\left(\frac{m^3}{Kg}\right)}\times SLF\left(\frac{6.\hat{u}E+00\,cm^2}{Kg}\right)\times\left[ET_{o,r}\left(\frac{1.752\,hr}{d}\right)+ET_{i,r}\left(\frac{16.4\,hr}{d}\right)\times DF_i\,(0.4)\right]\right)+\\ \left(SF_{d\text{-}ext}\left[\frac{\left(risk/yr\right)}{\left(pCi/cm^2\right)}\right]\times F_{AM}\times F_{OFF\text{-}SET}\times ACF\,(1.0)\times\left(\frac{1\,d}{24\,hr}\right)\times\left[ET_{o,r}\left(\frac{1.752\,hr}{d}\right)\times GSF_o\,(1.0)+ET_{i,r}\left(\frac{16.4\,hr}{d}\right)\times GSF_i\,(0.4)\right]\times\left(\frac{1\,yr}{365\,d}\right)\right)\end{array}\right]}$$

where

$$IF_r\left(\frac{64.5\,cm^2}{day}\right)=\left[\begin{array}{l}\left(FTSS_h\,(0.5)\times ET_{h,c}\left(\frac{4\,hrs}{day}\right)\times SE\,(0.5)\times ED_c\,(6\,yrs)\times SA_c\left(\frac{15\,cm^2}{event}\right)\times FQ_c\left(\frac{9.5\,events}{hour}\right)\right)+\\ \left(FTSS_h\,(0.5)\times ET_{h,a}\left(\frac{4\,hrs}{day}\right)\times SE\,(0.5)\times ED_a\,(24\,yrs)\times SA_a\left(\frac{45\,cm^2}{event}\right)\times FQ_a\left(\frac{1\,event}{hour}\right)\right)\end{array}\right]\Big/\left(ED_a\,(24\,yrs)+ED_c\,(6\,yrs)\right)$$ and

$$IHF_r\left(\frac{18\,m^3}{day}\right)=\left[\left(HR_a\left(\frac{20\,m^3}{day}\right)\times ED_a\,(24\,yrs)\right)+\left(HR_c\left(\frac{10\,m^3}{day}\right)\times ED_c\,(6\,yrs)\right)\right]\Big/\left(ED_a\,(24\,yrs)+ED_c\,(6\,yrs)\right)$$

The resulting units for this recommended SPRG are in pCi/cm². The units are based on area because the SF used is the ground plane for external exposure and the ingestion route is based on hand surface area contacting dust on surfaces and subsequent hand to mouth transfer events. This equation is for values of k that are greater than 0; when k=0, the dissipation term is not quantified to avoid division by zero.

- 3-D Exposure to Direct External Exposure (Materials with fixed contamination at infinite depth in outside walls, streets and sidewalks using infinite soil volume toxicity values)

$$SPRG_{3\text{-}Dr\text{-}sv}\left(\frac{pCi}{g}\right)=\frac{TR\times t_r\,(years)\times\lambda\left(\frac{1}{years}\right)}{\begin{array}{l}SF_{ext}\left[\left(\frac{risk}{year}\right)\Big/\left(\frac{pCi}{g}\right)\right]\times F_{CD}\times F_{AM}\times F_{OFF\text{-}SET}\times EF_r\left(\frac{350\,days}{year}\right)\times ED_r\,(30\,years)\times\left(\frac{1\,day}{24\,hours}\right)\times ACF\,(1.0)\times\left(1-e^{-\lambda t_r}\right)\times\\ \left[ET_{o,r}\left(\frac{1.752\,hours}{day}\right)\times GSF_o\,(1.0)+ET_{i,r}\left(\frac{16.4\,hours}{day}\right)\times GSF_i\,(0.4)\right]\times\left(\frac{1\,year}{365\,days}\right)\times F_{SURF}\end{array}}$$

The resulting units for this recommended SPRG are in pCi/g. The units are based on mass because the SF used is the soil volume for external exposure.

- 3-D Exposure to Direct External Exposure (Materials with fixed contamination at 1cm in outside walls, streets and sidewalks using 1cm soil volume toxicity values)

$$SPRG_{3\text{-}Dr\text{-}1cm}\left(\frac{pCi}{g}\right)=\frac{TR\times t_r\,(years)\times\lambda\left(\frac{1}{years}\right)}{\begin{array}{l}SF_{ext\text{-}1cm}\left[\left(\frac{risk}{year}\right)\Big/\left(\frac{pCi}{g}\right)\right]\times F_{CD}\times F_{AM}\times F_{OFF\text{-}SET}\times EF_r\left(\frac{350\,days}{year}\right)\times ED_r\,(30\,years)\times\left(\frac{1\,day}{24\,hours}\right)\times ACF\,(1.0)\times\left(1-e^{-\lambda t_r}\right)\times\\ \left[ET_{o,r}\left(\frac{1.752\,hours}{day}\right)\times GSF_o\,(1.0)+ET_{i,r}\left(\frac{16.4\,hours}{day}\right)\times GSF_i\,(0.4)\right]\times\left(\frac{1\,year}{365\,days}\right)\times F_{SURF}\end{array}}$$

The resulting units for this recommended SPRG are in pCi/g. The units are based on mass because the SF used is the soil volume for external exposure.

- 3-D Exposure to Direct External Exposure (Materials with fixed contamination at 5cm in outside walls, streets and sidewalks using 5cm soil volume toxicity values)

$$SPRG_{3\text{-}Dr\text{-}5cm}\left(\frac{pCi}{g}\right)=\frac{TR\times t_r\,(years)\times\lambda\left(\frac{1}{years}\right)}{\begin{array}{l}SF_{ext\text{-}5cm}\left[\left(\frac{risk}{year}\right)\Big/\left(\frac{pCi}{g}\right)\right]\times F_{CD}\times F_{AM}\times F_{OFF\text{-}SET}\times EF_r\left(\frac{350\,days}{year}\right)\times ED_r\,(30\,years)\times\left(\frac{1\,day}{24\,hours}\right)\times ACF\,(1.0)\times\left(1-e^{-\lambda t_r}\right)\times\\ \left[ET_{o,r}\left(\frac{1.752\,hours}{day}\right)\times GSF_o\,(1.0)+ET_{i,r}\left(\frac{16.4\,hours}{day}\right)\times GSF_i\,(0.4)\right]\times\left(\frac{1\,year}{365\,days}\right)\times F_{SURF}\end{array}}$$

The resulting units for this recommended SPRG are in pCi/g. The units are based on mass because the SF used is the soil volume for external exposure.

- 3-D Exposure to Direct External Exposure (Materials with fixed contamination at 15cm in outside walls, streets and sidewalks using 15cm soil volume toxicity values)

$$SPRG_{3\text{-}Dr\text{-}15cm}\left(\frac{pCi}{g}\right)=\frac{TR\times t_r\,(years)\times\lambda\left(\frac{1}{years}\right)}{\begin{array}{l}SF_{ext\text{-}15cm}\left[\left(\frac{risk}{year}\right)\Big/\left(\frac{pCi}{g}\right)\right]\times F_{CD}\times F_{AM}\times F_{OFF\text{-}SET}\times EF_r\left(\frac{350\,days}{year}\right)\times ED_r\,(30\,years)\times\left(\frac{1\,day}{24\,hours}\right)\times ACF\,(1.0)\times\left(1-e^{-\lambda t_r}\right)\times\\ \left[ET_{o,r}\left(\frac{1.752\,hours}{day}\right)\times GSF_o\,(1.0)+ET_{i,r}\left(\frac{16.4\,hours}{day}\right)\times GSF_i\,(0.4)\right]\times\left(\frac{1\,year}{365\,days}\right)\times F_{SURF}\end{array}}$$

The resulting units for this recommended SPRG are in pCi/g. The units are based on mass because the SF used is the soil volume for external exposure.

- 3-D Exposure to Direct External Exposure (Fixed contaminated dust on surface of outside walls, streets and sidewalks using ground plane toxicity values)

Page: 4

Author: Carl Gogolak
Subject: Note
Date: 2/14/2008 5:08:14 PM
There are 5 residential scenarios in the preceding section, it would be better to have these links associated with the "equation bullets" rather than just lumped together as they are now.

Author: Carl Gogolak
Subject: Note
Date: 2/14/2008 5:20:21 PM
The sheer number of parameters is overwhelming. I suggest that you hyperlink the parameters in the equation to their definition and default values.in Table 1.Otherwise it just gets too hard to follow.

Author: Carl Gogolak
Subject: Note
Date: 2/15/2008 7:55:31 AM
Explain the relationship between this equation and those that follow.
Explain where they will be found in the calculator, and whether or how they should be combined

Author: Carl Gogolak
Subject: Note
Date: 2/14/2008 5:13:13 PM
These four equations seem to vary only with the depth of contamination. This is not readily apparent and causes some considerable redundancy. Use one equation and state which papmeter changes and why.

$$SPRG_{3\text{-}Dr\text{-}gp}\left(\frac{pCi}{cm^2}\right)=\frac{TR \times t_r\,(years) \times \lambda\left(\frac{1}{years}\right)}{SF_{ext}\left[\left(\frac{risk}{year}\right)/\left(\frac{pCi}{cm^2}\right)\right] \times F_{CD} \times F_{AM} \times F_{OFF\text{-}SET} \times EF_r\left(\frac{350\ days}{year}\right) \times ED_r\,(30\ years) \times \left(\frac{1 day}{24 hours}\right) \times ACF\,(1.0) \times \left(1-e^{-\lambda t_r}\right) \times \left[ET_{o,r}\left(\frac{1.752\ hours}{day}\right) \times GSF_o\,(1.0) + ET_{i,r}\left(\frac{16.4\ hours}{day}\right) \times GSF_i\,(0.4)\right] \times \left(\frac{1 year}{365 days}\right) \times F_{SURF}}$$

The resulting units for this recommended SPRG are in pCi/cm². The units are based on area because the SF used is the ground plane for external exposure.

- 2-D Exposure to Direct External Exposure (Materials with fixed contamination in a finite slab using infinite soil volume toxicity values)

$$SPRG_{2\text{-}Dr\text{-}sv}\left(\frac{pCi}{g}\right)=\frac{TR \times t_r\,(years) \times \lambda\left(\frac{1}{years}\right)}{SF_{ext}\left[\left(\frac{risk}{year}\right)/\left(\frac{pCi}{g}\right)\right] \times F_{CD} \times F_{AM} \times F_{OFF\text{-}SET} \times EF_r\left(\frac{350\ days}{year}\right) \times ED_r\,(30\ years) \times \left(\frac{1 day}{24 hours}\right) \times ACF \times \left(1-e^{-\lambda t_r}\right) \times \left[ET_{o,r}\left(\frac{1.752\ hours}{day}\right) \times GSF_o\,(1.0) + ET_{i,r}\left(\frac{16.4\ hours}{day}\right) \times GSF_i\,(0.4)\right] \times \left(\frac{1 year}{365 days}\right)}$$

The resulting units for this recommended SPRG are in pCi/g. The units are based on mass because the SF used is the soil volume for external exposure.

- 2-D Exposure to Direct External Exposure (Materials with fixed contamination in a finite slab at 1cm depth using 1cm soil volume toxicity values)

$$SPRG_{2\text{-}Dr\text{-}1cm}\left(\frac{pCi}{g}\right)=\frac{TR \times t_r\,(years) \times \lambda\left(\frac{1}{years}\right)}{SF_{ext\text{-}1cm}\left[\left(\frac{risk}{year}\right)/\left(\frac{pCi}{g}\right)\right] \times F_{CD} \times F_{AM} \times F_{OFF\text{-}SET} \times EF_r\left(\frac{350\ days}{year}\right) \times ED_r\,(30\ years) \times \left(\frac{1 day}{24 hours}\right) \times ACF \times \left(1-e^{-\lambda t_r}\right) \times \left[ET_{o,r}\left(\frac{1.752\ hours}{day}\right) \times GSF_o\,(1.0) + ET_{i,r}\left(\frac{16.4\ hours}{day}\right) \times GSF_i\,(0.4)\right] \times \left(\frac{1 year}{365 days}\right)}$$

The resulting units for this recommended SPRG are in pCi/g. The units are based on mass because the SF used is the soil volume for external exposure.

- 2-D Exposure to Direct External Exposure (Materials with fixed contamination in a finite slab at 5cm depth using 5cm soil volume toxicity values)

$$SPRG_{2\text{-}Dr\text{-}5cm}\left(\frac{pCi}{g}\right)=\frac{TR \times t_r\,(years) \times \lambda\left(\frac{1}{years}\right)}{SF_{ext\text{-}5cm}\left[\left(\frac{risk}{year}\right)/\left(\frac{pCi}{g}\right)\right] \times F_{CD} \times F_{AM} \times F_{OFF\text{-}SET} \times EF_r\left(\frac{350\ days}{year}\right) \times ED_r\,(30\ years) \times \left(\frac{1 day}{24 hours}\right) \times ACF \times \left(1-e^{-\lambda t_r}\right) \times \left[ET_{o,r}\left(\frac{1.752\ hours}{day}\right) \times GSF_o\,(1.0) + ET_{i,r}\left(\frac{16.4\ hours}{day}\right) \times GSF_i\,(0.4)\right] \times \left(\frac{1 year}{365 days}\right)}$$

The resulting units for this recommended SPRG are in pCi/g. The units are based on mass because the SF used is the soil volume for external exposure.

- 2-D Exposure to Direct External Exposure (Materials with fixed contamination in a finite slab at 15cm depth using 15cm soil volume toxicity values)

$$SPRG_{2\text{-}Dr\text{-}15cm}\left(\frac{pCi}{g}\right)=\frac{TR \times t_r\,(years) \times \lambda\left(\frac{1}{years}\right)}{SF_{ext\text{-}15cm}\left[\left(\frac{risk}{year}\right)/\left(\frac{pCi}{g}\right)\right] \times F_{CD} \times F_{AM} \times F_{OFF\text{-}SET} \times EF_r\left(\frac{350\ days}{year}\right) \times ED_r\,(30\ years) \times \left(\frac{1 day}{24 hours}\right) \times ACF \times \left(1-e^{-\lambda t_r}\right) \times \left[ET_{o,r}\left(\frac{1.752\ hours}{day}\right) \times GSF_o\,(1.0) + ET_{i,r}\left(\frac{16.4\ hours}{day}\right) \times GSF_i\,(0.4)\right] \times \left(\frac{1 year}{365 days}\right)}$$

The resulting units for this recommended SPRG are in pCi/g. The units are based on mass because the SF used is the soil volume for external exposure.

- 2-D Exposure to Direct External Exposure (Materials with fixed contamination in a finite slab using ground plane toxicity values)

$$SPRG_{2\text{-}Dr\text{-}gp}\left(\frac{pCi}{cm^2}\right)=\frac{TR \times t_r\,(years) \times \lambda\left(\frac{1}{years}\right)}{SF_{ext}\left[\left(\frac{risk}{year}\right)/\left(\frac{pCi}{cm^2}\right)\right] \times F_{CD} \times F_{AM} \times F_{OFF\text{-}SET} \times EF_r\left(\frac{350\ days}{year}\right) \times ED_r\,(30\ years) \times \left(\frac{1 day}{24 hours}\right) \times ACF \times \left(1-e^{-\lambda t_r}\right) \times \left[ET_{o,r}\left(\frac{1.752\ hours}{day}\right) \times GSF_o\,(1.0) + ET_{i,r}\left(\frac{16.4\ hours}{day}\right) \times GSF_i\,(0.4)\right] \times \left(\frac{1 year}{365 days}\right)}$$

The resulting units for this recommended SPRG are in pCi/cm². The units are based on area because the SF used is the ground plane for external exposure.

4.2 Worker

4.2.1 Outdoor Worker

The outdoor worker land use equation, presented here, contains the following exposure pathways and exposure routes:

- exposure to contamination deposited on streets and sidewalks (incidental ingestion, inhalation of particulates and external exposure to ionizing radiation from settled dust using ground plane toxicity values)

$$SPRG_{dow\text{-}total}\left(\frac{pCi}{cm^2}\right)=\frac{TR \times t_w\,(25\ years) \times \lambda\left(\frac{1}{year}\right)}{\left(\frac{1-e^{-kt_w}}{kt_w}\right) \times \left(1-e^{-\lambda t_w}\right) \times EF_w\left(\frac{225\ days}{year}\right) \times ED_w\,(25\ years) \times \left[\begin{array}{l}\left(SF_{d\text{-}oral}\left(\frac{risk}{pCi}\right) \times IF_w\left(\frac{90\ cm^2}{day}\right)\right) + \\ \left(SF_{inh}\left(\frac{risk}{pCi}\right) \times IR_w\left(\frac{2.5\ m^3}{hour}\right) \times \frac{1}{PEF\left(\frac{m^3}{Kg}\right)} \times SLF\left(\frac{6.6E+08\ cm^2}{Kg}\right) \times ET_w\left(\frac{8\ hours}{day}\right)\right) + \\ \left(SF_{d\text{-}ext}\left[\left(\frac{risk}{year}\right)/\left(\frac{pCi}{cm^2}\right)\right] \times F_{AM} \times F_{OFF\text{-}SET} \times GSF_o\,(1.0) \times ACF\,(1.0)\left(\frac{1 day}{24 hours}\right) \times ET_w\left(\frac{8\ hours}{day}\right) \times \left(\frac{1 year}{365 days}\right)\right)\end{array}\right]}$$

where

$$IF_w\left(\frac{90\ cm^2}{day}\right)=FTSS_h\,(0.5) \times ET_w\left(\frac{8\ hours}{day}\right) \times SE\,(0.5) \times SA_w\left(\frac{45\ cm^2}{event}\right) \times FQ_w\left(\frac{1\ event}{hour}\right)$$

The resulting units for this recommended SPRG are in pCi/cm². The units are based on area because the SF used is the ground plane for external exposure and the ingestion route is based on hand surface area contacting dust on surfaces and subsequent hand to mouth transfer events. This equation is for values of k that are greater than 0; when k=0, the dissipation term is not quantified to avoid division by zero.

- 3-D Exposure to Direct External Exposure (Materials with fixed contamination at infinite depth in outside walls, streets and sidewalks using infinite soil volume toxicity values)

$$SPRG_{3\text{-}Dow\text{-}sv}\left(\frac{pCi}{g}\right)=\frac{TR \times t_w\,(25\ years) \times \lambda\left(\frac{1}{years}\right)}{SF_{ext}\left[\left(\frac{risk}{year}\right)/\left(\frac{pCi}{g}\right)\right] \times F_{CD} \times F_{AM} \times F_{OFF\text{-}SET} \times EF_w\left(\frac{225\ days}{year}\right) \times ED_w\,(25\ years) \times \left(\frac{1\ day}{24\ hours}\right) \times GSF_o\,(1.0) \times ACF\,(1.0) \times \left(1-e^{-\lambda t_w}\right) \times ET_w\left(\frac{8\ hours}{day}\right) \times \left(\frac{1\ year}{365\ days}\right) \times F_{SURF}}$$

Page: 5

Author: Carl Gogolak
Subject: Note
Date: 2/14/2008 5:12:51 PM
Sane as comment above

Author: Carl Gogolak
Subject: Note
Date: 2/14/2008 5:16:12 PM
Same comments as for residential

The resulting units for this recommended SPRG are in pCi/g. The units are based on mass because the SF used is the soil volume for external exposure.

- 3-D Exposure to Direct External Exposure (Materials with fixed contamination at 1cm in outside walls, streets and sidewalks using 1cm soil volume toxicity values)

$$SPRG_{3\text{-}Dow\text{-}1cm}\left(\frac{pCi}{g}\right)=\frac{TR\times t_w(25\text{ years})\times\lambda\left(\frac{1}{\text{years}}\right)}{SF_{ext\text{-}1cm}\left[\left(\frac{\text{risk}}{\text{year}}\right)/\left(\frac{pCi}{g}\right)\right]\times F_{CD}\times F_{AM}\times F_{OFF\text{-}SET}\times EF_w\left(\frac{225\text{ days}}{\text{year}}\right)\times ED_w(25\text{ years})\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times GSF_0(1.0)\times ACF(1.0)\times\left(1-e^{-\lambda t_w}\right)\times ET_w\left(\frac{8\text{ hours}}{\text{day}}\right)\times\left(\frac{1\text{ year}}{365\text{ days}}\right)\times F_{SURF}}$$

The resulting units for this recommended SPRG are in pCi/g. The units are based on mass because the SF used is the soil volume for external exposure.

- 3-D Exposure to Direct External Exposure (Materials with fixed contamination at 5cm in outside walls, streets and sidewalks using 5cm soil volume toxicity values)

$$SPRG_{3\text{-}Dow\text{-}5cm}\left(\frac{pCi}{g}\right)=\frac{TR\times t_w(25\text{ years})\times\lambda\left(\frac{1}{\text{years}}\right)}{SF_{ext\text{-}5cm}\left[\left(\frac{\text{risk}}{\text{year}}\right)/\left(\frac{pCi}{g}\right)\right]\times F_{CD}\times F_{AM}\times F_{OFF\text{-}SET}\times EF_w\left(\frac{225\text{ days}}{\text{year}}\right)\times ED_w(25\text{ years})\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times GSF_0(1.0)\times ACF(1.0)\times\left(1-e^{-\lambda t_w}\right)\times ET_w\left(\frac{8\text{ hours}}{\text{day}}\right)\times\left(\frac{1\text{ year}}{365\text{ days}}\right)\times F_{SURF}}$$

The resulting units for this recommended SPRG are in pCi/g. The units are based on mass because the SF used is the soil volume for external exposure.

- 3-D Exposure to Direct External Exposure (Materials with fixed contamination at 15cm in outside walls, streets and sidewalks using 15cm soil volume toxicity values)

$$SPRG_{3\text{-}Dow\text{-}15cm}\left(\frac{pCi}{g}\right)=\frac{TR\times t_w(25\text{ years})\times\lambda\left(\frac{1}{\text{years}}\right)}{SF_{ext\text{-}15cm}\left[\left(\frac{\text{risk}}{\text{year}}\right)/\left(\frac{pCi}{g}\right)\right]\times F_{CD}\times F_{AM}\times F_{OFF\text{-}SET}\times EF_w\left(\frac{225\text{ days}}{\text{year}}\right)\times ED_w(25\text{ years})\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times GSF_0(1.0)\times ACF(1.0)\times\left(1-e^{-\lambda t_w}\right)\times ET_w\left(\frac{8\text{ hours}}{\text{day}}\right)\times\left(\frac{1\text{ year}}{365\text{ days}}\right)\times F_{SURF}}$$

The resulting units for this recommended SPRG are in pCi/g. The units are based on mass because the SF used is the soil volume for external exposure.

- 3-D Exposure to Direct External Exposure (Fixed contaminated dust on surfaces of outside walls, streets and sidewalks using ground plane toxicity values)

$$SPRG_{3\text{-}Dow\text{-}gp}\left(\frac{pCi}{cm^2}\right)=\frac{TR\times t_w(25\text{ years})\times\lambda\left(\frac{1}{\text{years}}\right)}{SF_{ext}\left[\left(\frac{\text{risk}}{\text{year}}\right)/\left(\frac{pCi}{cm^2}\right)\right]\times F_{CD}\times F_{AM}\times F_{OFF\text{-}SET}\times EF_w\left(\frac{225\text{ days}}{\text{year}}\right)\times ED_w(25\text{ years})\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times GSF_0(1.0)\times ACF(1.0)\times\left(1-e^{-\lambda t_w}\right)\times ET_w\left(\frac{8\text{ hours}}{\text{day}}\right)\times\left(\frac{1\text{ year}}{365\text{ days}}\right)\times F_{SURF}}$$

The resulting units for this recommended SPRG are in pCi/cm². The units are based on area because the SF used is the ground plane for external exposure.

- 2-D Exposure to Direct External Exposure (Materials with fixed contamination in a finite slab using infinite soil volume toxicity values)

$$SPRG_{2\text{-}Dow\text{-}sv}\left(\frac{pCi}{g}\right)=\frac{TR\times t_w(25\text{ years})\times\lambda\left(\frac{1}{\text{years}}\right)}{SF_{ext}\left[\left(\frac{\text{risk}}{\text{year}}\right)/\left(\frac{pCi}{g}\right)\right]\times F_{CD}\times F_{AM}\times F_{OFF\text{-}SET}\times EF_w\left(\frac{225\text{ days}}{\text{year}}\right)\times ED_w(25\text{ years})\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times GSF_0(1.0)\times ACF\times\left(1-e^{-\lambda t_w}\right)\times ET_w\left(\frac{8\text{ hours}}{\text{day}}\right)\times\left(\frac{1\text{ year}}{365\text{ days}}\right)}$$

The resulting units for this recommended SPRG are in pCi/g. The units are based on mass because the SF used is the soil volume for external exposure.

- 2-D Exposure to Direct External Exposure (Materials with fixed contamination in a finite slab at 1cm depth using 1cm soil volume toxicity values)

$$SPRG_{2\text{-}Dow\text{-}1cm}\left(\frac{pCi}{g}\right)=\frac{TR\times t_w(25\text{ years})\times\lambda\left(\frac{1}{\text{years}}\right)}{SF_{ext\text{-}1cm}\left[\left(\frac{\text{risk}}{\text{year}}\right)/\left(\frac{pCi}{g}\right)\right]\times F_{CD}\times F_{AM}\times F_{OFF\text{-}SET}\times EF_w\left(\frac{225\text{ days}}{\text{year}}\right)\times ED_w(25\text{ years})\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times GSF_0(1.0)\times ACF\times\left(1-e^{-\lambda t_w}\right)\times ET_w\left(\frac{8\text{ hours}}{\text{day}}\right)\times\left(\frac{1\text{ year}}{365\text{ days}}\right)}$$

The resulting units for this recommended SPRG are in pCi/g. The units are based on mass because the SF used is the soil volume for external exposure.

- 2-D Exposure to Direct External Exposure (Materials with fixed contamination in a finite slab at 5cm depth using 5cm soil volume toxicity values)

$$SPRG_{2\text{-}Dow\text{-}5cm}\left(\frac{pCi}{g}\right)=\frac{TR\times t_w(25\text{ years})\times\lambda\left(\frac{1}{\text{years}}\right)}{SF_{ext\text{-}5cm}\left[\left(\frac{\text{risk}}{\text{year}}\right)/\left(\frac{pCi}{g}\right)\right]\times F_{CD}\times F_{AM}\times F_{OFF\text{-}SET}\times EF_w\left(\frac{225\text{ days}}{\text{year}}\right)\times ED_w(25\text{ years})\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times GSF_0(1.0)\times ACF\times\left(1-e^{-\lambda t_w}\right)\times ET_w\left(\frac{8\text{ hours}}{\text{day}}\right)\times\left(\frac{1\text{ year}}{365\text{ days}}\right)}$$

The resulting units for this recommended SPRG are in pCi/g. The units are based on mass because the SF used is the soil volume for external exposure.

- 2-D Exposure to Direct External Exposure (Materials with fixed contamination in a finite slab at15cm depth using 15cm soil volume toxicity values)

$$SPRG_{2\text{-}Dow\text{-}15cm}\left(\frac{pCi}{g}\right)=\frac{TR\times t_w(25\text{ years})\times\lambda\left(\frac{1}{\text{years}}\right)}{SF_{ext\text{-}15cm}\left[\left(\frac{\text{risk}}{\text{year}}\right)/\left(\frac{pCi}{g}\right)\right]\times F_{CD}\times F_{AM}\times F_{OFF\text{-}SET}\times EF_w\left(\frac{225\text{ days}}{\text{year}}\right)\times ED_w(25\text{ years})\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times GSF_0(1.0)\times ACF\times\left(1-e^{-\lambda t_w}\right)\times ET_w\left(\frac{8\text{ hours}}{\text{day}}\right)\times\left(\frac{1\text{ year}}{365\text{ days}}\right)}$$

The resulting units for this recommended SPRG are in pCi/g. The units are based on mass because the SF used is the soil volume for external exposure.

- 2-D Exposure to Direct External Exposure (Materials with fixed contamination in a finite slab using ground plane toxicity values)

$$SPRG_{2\text{-}Dow\text{-}gp}\left(\frac{pCi}{cm^2}\right)=\frac{TR\times t_w(25\text{ years})\times\lambda\left(\frac{1}{\text{years}}\right)}{SF_{ext}\left[\left(\frac{\text{risk}}{\text{year}}\right)/\left(\frac{pCi}{cm^2}\right)\right]\times F_{CD}\times F_{AM}\times F_{OFF\text{-}SET}\times EF_w\left(\frac{225\text{ days}}{\text{year}}\right)\times ED_w(25\text{ years})\times\left(\frac{1\text{ day}}{24\text{ hours}}\right)\times GSF_0(1.0)\times ACF\times\left(1-e^{-\lambda t_w}\right)\times ET_w\left(\frac{8\text{ hours}}{\text{day}}\right)\times\left(\frac{1\text{ year}}{365\text{ days}}\right)}$$

The resulting units for this recommended SPRG are in pCi/cm². The units are based on area because the SF used is the ground plane for external exposure.

4.2.2 Indoor Worker

The indoor worker land use equation, presented here, contains the following exposure pathways:

- exposure to contamination deposited on streets and sidewalks (incidental ingestion, inhalation of particulates and external exposure to ionizing radiation from settled dust using ground plane toxicity values)

Page: 6

Author: Carl Gogolak
Subject: Note
Date: 2/14/2008 5:16:54 PM
Again, same comments as for residential

$$SPRG_{2\text{-Diw-5cm}}\left(\frac{pCi}{g}\right)=\frac{TR \times t_w\,(25\ \text{years}) \times \lambda\left(\frac{1}{\text{years}}\right)}{SF_{ext\text{-}5cm}\left[\left(\frac{\text{risk}}{\text{year}}\right)/\left(\frac{pCi}{g}\right)\right] \times F_{CD} \times F_{AM} \times F_{OFF\text{-}SET} \times EF_w\left(\frac{250\ \text{days}}{\text{year}}\right) \times ED_w\,(25\ \text{years}) \times \left(\frac{1\ \text{day}}{24\ \text{hours}}\right) \times GSF_i\,(0.4) \times ACF \times \left(1-e^{-\lambda t_w}\right) \times ET_w\left(\frac{8\ \text{hours}}{\text{day}}\right) \cdot \left(\frac{1\ \text{year}}{365\ \text{days}}\right)}$$

The resulting units for this recommended SPRG are in pCi/g. The units are based on mass because the SF used is the soil volume for external exposure.

- 2-D Exposure to Direct External Exposure (Materials with fixed contamination in a finite slab at 15cm depth using 15cm soil volume toxicity values)

$$SPRG_{2\text{-Diw-15cm}}\left(\frac{pCi}{g}\right)=\frac{TR \times t_w\,(25\ \text{years}) \times \lambda\left(\frac{1}{\text{years}}\right)}{SF_{ext\text{-}15cm}\left[\left(\frac{\text{risk}}{\text{year}}\right)/\left(\frac{pCi}{g}\right)\right] \times F_{CD} \times F_{AM} \times F_{OFF\text{-}SET} \times EF_w\left(\frac{250\ \text{days}}{\text{year}}\right) \times ED_w\,(25\ \text{years}) \times \left(\frac{1\ \text{day}}{24\ \text{hours}}\right) \times GSF_i\,(0.4) \times ACF \times \left(1-e^{-\lambda t_w}\right) \times ET_w\left(\frac{8\ \text{hours}}{\text{day}}\right) \times \left(\frac{1\ \text{year}}{365\ \text{days}}\right)}$$

The resulting units for this recommended SPRG are in pCi/g. The units are based on mass because the SF used is the soil volume for external exposure.

- 2-D Exposure to Direct External Exposure (Materials with fixed contamination in a finite slab using ground plane toxicity values)

$$SPRG_{2\text{-Diw-gp}}\left(\frac{pCi}{cm^2}\right)=\frac{TR \times t_w\,(25\ \text{years}) \times \lambda\left(\frac{1}{\text{years}}\right)}{SF_{ext}\left[\left(\frac{\text{risk}}{\text{year}}\right)/\left(\frac{pCi}{cm^2}\right)\right] \times F_{CD} \times F_{AM} \times F_{OFF\text{-}SET} \times EF_w\left(\frac{250\ \text{days}}{\text{year}}\right) \times ED_w\,(25\ \text{years}) \times \left(\frac{1\ \text{day}}{24\ \text{hours}}\right) \times GSF_i\,(0.4) \times ACF \times \left(1-e^{-\lambda t_w}\right) \times ET_w\left(\frac{8\ \text{hours}}{\text{day}}\right) \times \left(\frac{1\ \text{year}}{365\ \text{days}}\right)}$$

The resulting units for this recommended SPRG are in pCi/cm^2. The units are based on area because the SF used is the ground plane for external exposure.

4.3 Exposure Parameter Justification

The following sections describe the exposure parameter default variables and the values selected.

4.3.1 Exposure Time (ET)

The exposure time represents the hours per day that a receptor spends exposed to a source. The exposure times vary by exposure scenario, age of the receptor and whether the source is located on a hard or soft surface. This calculator only calculates exposure to hard surfaces. For the resident ingestion pathway the hard surface exposure time of 4 hours per day is used for adult and child value is from the EPA Office of Pesticide Programs (OPP). For inhalation and external exposure the exposure time indoors is set at 16.4 hours per day and the exposure time outdoors is set at 1.752 hours per day. These values are from the 1997 Exposure Factors Handbook. Note, that inhalation and subsequent ingestion of dust particles trapped in mucous is not quantified in the SPRG equations due to lack of exposure information.

For the outdoor and indoor worker, exposure time for the dust ingestion exposure route is based on exposure to hard surfaces. For this calculator, the defaults were set at 8 hr/d. The exposure time for direct external exposure is the entire work day or 8 hr/d.

4.3.2 Fraction Transferred from Surface to Skin (FTSS)

In general, this is the fraction of residue on a surface that can be transferred to skin. US EPA 2003 (pg D-5) states that hand press experiments were conducted on dry skin. Transfers of 50% were observed for hard surfaces. These are considered representative of the WTC situation and were adopted for this calculator.

4.3.3 Surface Area (SA)

In general, this is the skin area contacted during the mouthing event. The OPP default is 20 cm^2 based on the surface area of the 3 fingers that a child will most likely use for hand to mouth transfer. Total skin surface area increases by about 3 fold from age 2 to an adult. Average area of both hands for an adult is about 900 cm^2, so it would be about 300 cm^2 for a 2 year old. Assuming 3 fingers of one hand represents about 5% of the total area of both hands, it would increase from 15 cm^2 to 45 cm^2 from age 2 to adult. On this basis, the SA values used here are assumed to start at 15 cm^2 and increase linearly to 45 cm^2 at age 17 and remain constant after that.

4.3.4 Frequency of Hand to Mouth (FQ)

The OPP defaults suggest 9.5 events/hr for toddlers, based on observations at day care centers. This will decline with age, but very little data are available for other ages. Michaud et al (1994) assumed a mouthing frequency of twice per day for adults. It was decided to group the age cohort-specific hand-to-mouth frequency as follows: 1 to 6 yr - 9.5 times/hr, 7 to 12yr - 5 times/hr, 8 to 18 yr - 2 times/hr and 19 to 31 yr - 1 time/hr.

4.3.5 Saliva Extraction Factor (SE)

In general, the fraction transferred from skin to mouth will depend on the contaminant, mouthing time and other behavioral patterns. The OPP default is 50%, based on pesticide studies. Michaud et al (1994) assumed that all of the residues deposited on the fingertips would be transferred to the mouth, twice per day. In the Binghamton re-entry guideline derivation, a range of factors were used: 0.05, 0.1, and 0.25 representing the fraction of residue on hand that is transferred to the mouth (Kim and Hawley, 1985). For purposes of this assessment, the OPP default of 50% was selected for all ages.

4.3.6 Resident Age-Adjusted Dust Ingestion Rate (IF_r)

To account for the variability in exposure activities between children and adults, the age-adjusted dust ingestion rate equation was developed. This equation takes into account the differences in hand to mouth behavior, hand surface area, and exposure to hard and soft surfaces over the exposure durations of an adult and child.

4.3.7 Worker Dust Ingestion Rate (IF_w)

This dust ingestion equation calculates the intake for a worker based on exposure to hard surfaces.

4.3.8 Dissipation Rate Constant (k)

In some circumstances, the load of dust on a contaminated surface, to which receptors are exposed, may decline over time. Dissipation of dust may result from weather, cleaning and transfer to skin and clothing. Different surfaces may be cleaned at different rates and any dissipation rate used should consider a representative cleaning frequency. To determine whether dissipation is a factor at a given site, the site manager should establish whether a significant reservoir of contaminated dust is present. Such reservoirs may function as sources of dust and negate the impacts of dissipation mechanisms. The first step in identifying the presence of a reservoir is to examine site history. If a waste site was created through disposal, deposition or equipment leaks over an extended period of time, then the contaminant may have seeped deep into the surface. Porous surfaces such as cement or wood are also more likely to have subsurface contamination. When reservoirs are less likely to exist, such as at sites where contamination is the result of a single spill, dust cloud or event, it may be more important to account for dissipation of surface loads. For fixed contamination in materials (outside walls, streets and pavement), or on material surfaces, in the 3-D and 2-D equations, the dissipation term is not included as dissipation is not expected.

The recommended default value for the dissipation rate constant is 0.0. This assumes that a contaminant reservoir is present. However, the variable is adjustable in the SPRG calculator. If a dissipation rate constant is used, it is assumed that the dust was deposited as a one time event (i.e.; dust cloud). Also, if a dissipation rate is applied, it is assumed that it is applicable from the point in time the SPRG is calculated into the future. The discussion below provides a review of the indoor surfaces

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Author: Carl Gogolak
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Date: 2/14/2008 5:23:16 PM
Can these discussions be hyperlinked to Table 1? There is a lot of info here, but it is not very well organized to be useful. Since this appears to be a web tool, maximum advantage of hyperlinking should be considered. It wotld also be useful to have a self contained help file with the same links.

Author: Carl Gogolak
Subject: Note
Date: 2/15/2008 2:33:58 AM
Did I miss any prior discussion of how this tool should be used differently for children and adults?
Since this is screening, would using the most restrictive be appropriate?, for residential?

roadway classes. Simple website navigation instructions are available. To quickly get to the functional class information make sure the "Highway Information" tab is selected and then make sure the drop-down-menu under "General Maps" indicates "Functional Class". Now the user can use the zoom controls to reach the area of interest. This resource could be consulted to apply site-specific inputs for calculating ADTV and SLF for a risk assessment. Further state-specific information can be found by consulting the contact list.

4.3.11 Area Correction Factor

The RAGS/HHEM Part B model assumes that an individual is exposed to a source geometry that is effectively an infinite slab. The concept of an infinite slab means that the thickness of the contaminated zone and its aerial extent are so large that it behaves as if it were infinite in its physical dimensions. In practice, soil contaminated to a depth greater than about 15 cm and with an aerial extent greater than about 1,000 m^2 will create a radiation field comparable to that of an infinite slab. (U.S. EPA 2000a)

To accommodate the fact that in most residential settings the assumption of an infinite slab source will result in overly conservative SSLs, an adjustment for source area is considered to be an important modification to the RAGS/HHEM Part B model. Thus, an area correction factor, ACF, has been added to the calculation of recommended SPRGs. Because of the likely variation in the dimensions/geometry of outdoor surface contamination, a default ACF of 1.0 is presented for all isotopes for the 3-D exposure models addressing outside walls, streets and sidewalks. For the 2-D exposure models addressing finite slabs, the ACF is made variable by isotope and area for site-specific analysis. This 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 Contaminated Slabs. For a description of other EPA default ACF values, follow the link here.

4.3.12 Surfaces Factor

The 3-D direct external exposure equations (building materials and dust) without F_{SURF} are single surface equations. The surfaces factor, in the default and site-specific equations, are based on exposure to 2 vertical surfaces (outside building surfaces on either side of a street) and a horizontal surface (road and sidewalk). This 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. Please see the attached PDF file for detailed explanation of the process. Side Walk Dose Rate shows that building height doesn't effect the dose rate significantly after 150 feet. The above link 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.

4.4 Supporting Equations

There are two parts in the above land use equations that require further explanation. First is the use of the radionuclide decay constant (λ). Second is the variable particulate emission factor feature of this calculator.

4.4.1 Radionuclide Decay Constant

Each equation (where appropriate by media) has a decay constant term which is based on the half-life of the isotope (λ). λ = Decay constant (0.693/half-life in years). The intention of this term is to derive realistic SPRGs for isotopes with relatively short half-lives, compared to the exposure duration (ED). The term $(1 - e^{-\lambda t})$ takes into account the number of half-lives that will occur within the ED to calculate an appropriate value. Definitions of the input variables are in Table 1.

4.4.2 Particulate Emission Factor (PEF)

Two particulate emission factors can be selected for this calculator: mechanically driven and the traditional wind driven emission factor.

4.4.2.1 Mechanically Driven PEF

This equation allows the user to input vehicle weight, road dimensions, distance traveled and time. Although developed for unpaved roads, this equation can be used to simulate emission factors after an incident. The receptor is assumed to be exposed to contaminants in the form of particulate matter with an aerodynamic particle diameter of less than 10 microns (PM10). Fugitive dust emissions are generated by vehicle traffic on roads. In addition, fugitive dust emissions are generated by wind blowing on surfaces. PEF for wind erosion emissions are assumed to occur at the center of the emission source. The ambient air dispersion of emissions, therefore, is different for these two classes of emission sources. For this reason, the PEF for unpaved road traffic and the PEF for wind erosion are calculated separately.

The following fugitive dust emission equation represents approximations of actual emissions at a specific site. Sensitive emission model parameters include the soil silt content and moisture content. Silt is defined as soil particles smaller than 75 micrometers (Fm) in diameter and can be measured as that proportion of soil passing a 200-mesh screen, using the American Society for Testing and Materials (ASTM) Method C-136. Soil moisture content is defined on a percent gravimetric basis [(g-water/g-soil) x 100] and should be approximated as the mean value for the duration of the construction project. In general, soil silt and moisture content are the most sensitive model parameters for which default values have been assigned, however, site-specific values will produce more accurate modeling results. Other emission model parameters have not been assigned default values and are typically defined on a site-specific basis. These parameters include the total distance traveled by vehicles, mean vehicle weight, average vehicle speed, and the area of roadway.

Mean vehicle weight (W) in tons is calculated by determining vehicle weight classes and numbers in that class. An example is presented below for site specific data. The default mean vehicle weight selected for this calculator is 3.2 tons based on page 4-285 in *PROCEDURES DOCUMENT FOR NATIONAL EMISSION INVENTORY, CRITERIA AIR POLLUTANTS 1985-1999*. EPA-454/R-01-006. However, there is wide variation in vehicle weights when considering industrial facilities. AP42 supporting documentation reveals in Table A1-6 that the mean vehicle weight can range up to 42 tons. Site-specific conditions should be considered or measured. The table is reproduced below.

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Author: Carl Gogolak
Subject: Note
Date: 2/15/2008 2:35:49 AM
Link refers to Table 5.1.
Is there supposed to be a Section 5 in this user's manual?

			EPA 2000b. (pg. 2-18)
GSF_i	Gamma Shielding Factor - Indoor (unitless)	0.4 (assumes shielding)	Other GSFs are presented in these reports. U.S. EPA 2000a. (pg. 2-22). U.S. EPA 2000b. (pg. 2-18)
F_{AM}	Area and Material Factor (unitless)	1.0	ANL 2001 (Fig 8.6)
F_{CD}	Depth and Cover Function (unitless)	1.0	ANL 2001 (Fig 8.6)
$F_{OFF-SET}$	Off-set Factor (unitless)	1.0	ANL 2001 (Fig 8.6)
F_{SURF}	Surfaces Factor (unitless)	isotope-specific	Eckerman 2007
Inhalation and Ingestion Rates			
IF_w	Worker Dust Ingestion Rate - Worker (cm^2/day)	90	Calculated Value based on EPA 2003 (pg. D-4)
IF_r	Age-Adjusted Dust Ingestion Rate - Resident (cm^2/day)	64.5	Calculated Value based on EPA 2003 (pg. D-4)
HF_r	Age adjusted Inhalation Rate (m^3/day)	18	Calculated Value based on U.S. EPA 1991 (pg. 15)
HR_a	Adult Inhalation Rate (m^3/day; based on IRIS default)	20	U.S. EPA 1991 (pg. 15)
HR_c	Child Inhalation Rate (m^3/day; based on IRIS default)	10	U.S. EPA 1991 (pg. 15)
HR_w	Worker Inhalation Rate (m^3/hr)	2.5	U.S. EPA 1997 (pg. 5-25)
Ingestion Rate Variables			
$FTSS_h$	Fraction Transferred Surface to Skin - Hard Surface (unitless)	0.5	EPA 2004 (Exhibit E-1 pg. E-6)
SA_a	Surface Area of Fingers - Adult (cm^2)	45	EPA 2003 (pg. D-5)
SA_c	Surface Area of Fingers - Child (cm^2)	15	EPA 2003 (pg. D-5)
SA_w	Surface Area of Fingers - Worker (cm^2)	45	EPA 2003 (pg. D-5)
FQ_a	Frequency of Hand to Mouth - Adult (events/hour)	1	EPA 2003 (pg. D-5)
FQ_c	Frequency of Hand to Mouth - Child(events/hour)	9.5	EPA 2003 (pg. D-5)
FQ_w	Frequency of Hand to Mouth - Worker (events/hour)	1	EPA 2003 (pg. D-5)
SE	Saliva Extraction Factor (unitless)	0.5	EPA 2003 (pg. D-5)
$ET_{h,a}$	Exposure Time - Adult Hard Surface (hours/day)	4	EPA 2003 (pg. D-4)
$ET_{h,c}$	Exposure Time - Child Hard Surface (hours/day)	4	EPA 2003 (pg. D-4)
$ET_{h,w}$	Exposure Time - Worker Hard Surface (hours/day)	8	EPA 2003 (pg. D-4)
$ET_{o,r}$	Exposure Time Outdoor - Resident (hours/day)	1.752	EPA 1997 (Table 15-132)
$ET_{i,r}$	Exposure Time Indoor - Resident (hours/day)	16.4	EPA 1997 (Table 15-131)
ET_w	Air Exposure Time - Worker (hours/day)	8	EPA 2003 (pg. D-4)
Exposure Frequency, Exposure Duration, and Exposure Time Variables			
EF_{iw}	Exposure Frequency - indoor worker (days/year)	250	U.S. EPA 1991 (pg. 15)
EF_{ow}	Exposure Frequency - outdoor worker (days/year)	225	U.S. EPA 1991 (pg. 15)
EF_r	Exposure Frequency - resident (days/year)	350	U.S. EPA 1991 (pg. 15)
ED_w	Exposure Duration - worker (years)	25	U.S. EPA 1991 (pg. 15)
ED_r	Exposure Duration - resident (years)	30	U.S. EPA 1991 (pg. 15)
ED_a	Exposure Duration - adult resident (years)	24	U.S. EPA 1991 (pg. 15)
ED_c	Exposure Duration - child resident (years)	6	U.S. EPA 1991 (pg. 15)
Particulate Emission Factor Variables			
PEF_w	Wind Particulate Emission Factor - Minneapolis (m^3/kg)	1.36×10^9 Minneapolis-specific	U.S. EPA 1996a (pg. 23), U.S. EPA 1996b (pg. 31)
Q/C_w	Inverse of the Mean Concentration at the Center of a 0.5-Acre-Square Source - wind(g/m^2-s per kg/m^3)	93.77 Minneapolis-specific	U.S. EPA 1996a (pg. 23), U.S. EPA 1996b (pg. 31)
V	(fraction of vegetative cover) unitless	0.5	U.S. EPA 1999b, U.S. EPA 1996a (pg. 23), U.S. EPA 1996b (pg. 31)
U_m	mean annual wind speed) m/s	4.69	U.S. EPA 1999b, U.S. EPA 1996a (pg. 23), U.S. EPA 1996b (pg. 31)
U_t	equivalent threshold value of wind speed at 7m)	11.32	U.S. EPA 1999b, U.S. EPA 1996a

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Author: Carl Gogolak
Subject: Note
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EDUCATION

B.S., Physics, Fordham University, Bronx NY, 1970
M.A., Mathematics, Fordham University, Bronx NY, 1971
Ph.D., Applied Statistics, Polytechnic University, Brooklyn NY, 1986

POSITIONS

2006 – present	Consultant on Environmental Radiation Physics and Statistical Survey Design
1970 - 2005	Physicist, Applied Physics Division, USDHS/EML Principal Investigator, Outreach/Educational Program
1994 - 1995	Acting Director, Radiation Physics Division, USDOE/EML
1990 - 1992	New Production Reactor Research Coordinator, USDOE/EML
1989 - 1994	Radon Research Program Coordinator, USDOE/EML
1987 - 1995	Supervisor, Radon Group, USDOE/EML
1986 - 1995	Adjunct Mathematics Lecturer, Polytechnic University
1982 - 2002	Guest Lecturer, Harvard University School of Public Health Short Course Program
1980, 1983, 1986	Visiting Scientist, Institute for Radiation Hygiene, Federal Health Office, Munich

Dr. Gogolak conducts experimental and theoretical studies of ionizing radiation required for preventing, protecting against, and responding to radiological and nuclear events. His earlier work included research on the impact of non-nuclear energy technologies on the environment and the effect of diurnal radon progeny concentrations on terrestrial gamma-ray exposure rates; testing real-time monitoring instrumentation for ^{85}Kr releases from nuclear reprocessing plants; developing the first mobile computer system for on-site data analysis of in-situ gamma-ray measurements and designing a monitoring program for potential releases from light water reactors employing high pressure ionization chambers and thermoluminescent dosimeters.

Dr. Gogolak was a member of a team which developed statistical procedures for the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). This team was awarded Vice President Albert Gore's Hammer Award for Reinventing Government. In addition, he developed statistical methods for linking data quality objectives and measurement quality objectives for the Multi-Agency Radiological Analytical Laboratory Protocols (MARLAP) Manual. He developed the kriging methodology used by the National Cancer Institute to determine the thyroid dose from ^{131}I releases from atmospheric testing in Nevada during the 1950's and 1960's.

PROFESSIONAL ACTIVITIES

Dr. Gogolak is a member of the National Council on Radiation Protection and Measurements Scientific Committee 64-2, A Design of Effective Effluent and Environmental Monitoring Programs. He is a co-Chair of the Council on Ionizing Radiation Measurements and Standards subcommittee on Public/Environmental Radiation Protection.
He is a Fellow of the Health Physics Society

He has authored or co-authored more than 100 papers, presentations, and technical reports.

Peer Reviewer Conflict of Interest Certification

Peer Review: Preliminary Remediation Goals for Radionuclides in Outdoor Surfaces (SPRG)

A conflict of interest or lack of impartiality exists when the proposed peer reviewer personally (or the peer reviewer's immediate family), or his or her employer, has financial interests that may be affected by the results of the peer review; or may provide an unfair competitive advantage to the peer reviewer (or employer): or if the peer reviewer's objectivity in performing the peer review may be impaired due to other factors. When the Peer Reviewer knows that a reasonable person with knowledge of the facts may question the peer reviewer's impartiality or financial involvement, an apparent lack of impartiality or conflict of interest exists.

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- Have you served on previous advisory panels, committees, or subcommittees that have addressed the topic under consideration? ☒ No ☐ Yes
- Have you made any public statements (written or oral) on the issue? ☒ No ☐ Yes
- Have you made any public statements that would indicate to an observer that you have taken a position on the issue under consideration? ☒ No ☐ Yes
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With regard to real or apparent conflicts of interest or questions of impartiality, the following provisions shall apply for the duration of this peer review:

(a) Peer Reviewer warrants, to the best of his/her knowledge and belief, that there are no relevant facts or circumstances that could give rise to an actual, apparent, or potential organizational or personal conflict of interest, or that Peer Reviewer has disclosed all such relevant information to EMS or to EPA.
(b) Peer Reviewer agrees that if an actual, apparent, or potential personal or organizational conflict of interest is identified during performance of this peer review, he/she immediately will make a full disclosure in writing to EMS. This disclosure shall include a description of actions that Peer Reviewer (or his/her employer) has taken or proposes to take after consultation with EMS to avoid, mitigate, or neutralize the actual, apparent, or potential organizational conflict of interest. Peer Reviewer shall continue performance until notified by EMS of any contrary action to be taken.

[signature] 1/28/08

Signature Date

☐ Check here if any explanation is attached

CARL V. GOGOLAK

Printed Name

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Affiliation/Organization