

PROTOCOL

Human Health Exposure Parameters - RME

Introduction

This protocol has been developed in order to support the Savannah River Site environmental remediation program. It describes the exposure assumptions and input parameters used to derive the PRGs for the reasonable maximum exposure (RME) scenario. The protocol instructions are based on the latest available USEPA guidance and agreement from the staff of USEPA, SCDHEC, and USDOE as members of the Risk Assessment Design Team (RADT).

The exposure parameters defined in this protocol are consistent with standard EPA values, when applicable. In most instances, these are default assumptions (with the exception noted below). More detailed information can be found at the USEPA Region 9 website: www.epa.gov/region09/waste/sfund/prg/index.htm or the USEPA Radionuclide PRGs for Superfund Electronic Calculator website: <http://epa-prgs.ornl.gov/radionuclides/>.

Exposure parameters for concrete media are not described USEPA guidance documents. Assumptions for future industrial worker exposure to concrete are based on agreements from the Risk Assessment Design Team.

Specific conditions at a given unit may justify the use of differing assumptions. These unit-specific assumptions must be justified and approved by the project core team on a case-by-case basis. This protocol only identifies the assumptions for the standard exposure scenarios that are described in the Human Health Receptors and Scenarios Protocol.

Details

1. Non-radiological Constituents

The standard default factors used in the derivation of PRGs by USEPA Region 9 are identified in Table 1:

- Future Industrial Worker
 - soil media
 - groundwater
 - concrete media *
- Future Resident

- soil media
- groundwater (tap water)
- surface water **
- sediment **

2. Radiological Constituents

The inputs used in the derivation of SRS-specific PRGs are identified in Table 2. Default assumptions are applied if appropriate. Exposure assumptions for the derivation of PRGs for concrete media (industrial worker) are also provided in the table.

- Future Industrial Worker
 - soil media
 - groundwater
 - concrete media *
- Future Resident
 - soil media
 - groundwater (tap water)
 - surface water **
 - sediment **

* It is recognized that the exposure assumptions for concrete media should not be the same as the exposure assumptions for soil media; however, no exposure information for concrete is available in technical literature or guidance. Because of the physical nature of concrete, it is expected that the ingestion, inhalation and dermal contact pathways would be much less for concrete as compared to soil. The potential for exposure via these pathways for competent, hardened concrete is considered negligible. However, weathering of concrete could change the physical properties of the medium enough to allow some exposure through the ingestion pathway and potentially provide a media for which exposure could occur. For this reason, the Risk Assessment Design Team agreed that approximately 1/10th of the standard exposure of non-radiological constituents in soil would be a reasonable assumption for the available fraction of concrete due to weathering. This is considered a conservative approach since the ingestion, inhalation, and dermal contact pathways are all taken into consideration in the soil PRG calculation. A value of ten times (10x) the soil PRG shall be used in the risk estimate of non-radiological constituents for concrete media.

** There are no standard default factors for surface water or sediment media. The exposure assumptions are based on a recreational use scenario.

Table 1. Exposure Assumptions for Non-radiological Constituents

Symbol ^a	Definition (units)	Default	Reference
BWa	Body weight, adult (kg)	70	RAGS (Part A), USEPA 1989
BWc	Body weight, child (kg)	15	Exposure Factors, USEPA 1991b
ATc	Averaging time - carcinogens (days)	25550	RAGS (Part A), USEPA 1989
ATn	Averaging time - noncarcinogens (days)	EDc*365	RAGS (Part A), USEPA 1989
SAa	Exposed surface area (cm ² /day) – adult resident – adult worker	5700 3300	Dermal Assessment, USEPA 2004
SAc	Exposed surface area, child (cm ² /day)	2800	Dermal Assessment, USEPA 2004
AFa	Adherence factor, soils/sediment (mg/cm ²) – adult resident – adult worker (soil only)	0.07 0.2	Dermal Assessment, USEPA 2004
AFc	Adherence factor, child (mg/cm ²)	0.2	Dermal Assessment, USEPA 2004
ABS	Skin absorption defaults (unitless): – semi-volatile organics – volatile organics – inorganics	0.1 -- --	Dermal Assessment, USEPA 2004
IRaA	Inhalation rate - adult (m ³ /day)	20	Exposure Factors, USEPA 1991b
IRAc	Inhalation rate - child (m ³ /day)	10	Exposure Factors, USEPA 1991b
IRA-conc	Inhalation rate from concrete	--	RADT Assumption
IRWa	Drinking water ingestion - adult (L/day)	2	RAGS(Part A), USEPA 1989
IRWc	Drinking water ingestion - child (L/day)	1	PEA, Cal-USEPA (DTSC, 1994)
IRWw	Drinking water ingestion - worker (L/day)	1	Exposure Factors, USEPA 1991b
IRWsw-a	Incidental surface water ingestion – adult (L/day)	0.02	USEPA 1995, Region IV Bulletin
IRWsw-c	Incidental surface water ingestion – child (L/day)	0.1	USEPA 1995, Region IV Bulletin
IRSa	Soil/sediment ingestion - adult (mg/day)	100	Exposure Factors, USEPA 1991b
IRSc	Soil/sediment ingestion - child (mg/day)	200	Exposure Factors, USEPA 1991b
IRSo	Soil ingestion - worker (mg/day)	100	Soil Screening Guidance (USEPA 2001)
IRS-conc	Concrete ingestion – worker (mg/day)	10	RADT Assumption
EFr	Exposure frequency - residential (d/y)	350	Exposure Factors, USEPA 1991b
EFo	Exposure frequency - worker (d/y)	250	Exposure Factors, USEPA 1991b
EFsed,sw	Exposure frequency - residential sed/sw (d/yr)	50	USEPA 1995, Region IV Bulletin
EDr	Exposure duration - residential (years)	30 ^b	Exposure Factors, USEPA 1991b
EDc	Exposure duration - child (years)	6	Exposure Factors, USEPA 1991b
EDo	Exposure duration - worker (years)	25	Exposure Factors, USEPA 1991b
	Age-adjusted factors for carcinogens:		
IFSadj	Ingestion factor, soils/sediment ([mg-yr]/[kg-d])	114	RAGS(Part B), USEPA 1991a
SFSadj	Dermal factor, soils/sediment ([mg-yr]/[kg-d])	361	By analogy to RAGS (Part B)
SFWadj-sw	Dermal factor, surface water ([L-yr]/[kg-d])	3074	By analogy to RAGS (Part B)
InhFadj	Inhalation factor, air ([m ³ -yr]/[kg-d])	11	By analogy to RAGS (Part B)
IFWadj	Ingestion factor, drinking water ([L-yr]/[kg-d])	1.1	By analogy to RAGS (Part B)
IFWadj-sw	Ingestion factor, surface water ([L-yr]/[kg-d])	0.05	By analogy to RAGS (Part B)
VFw	Volatilization factor for water (L/m ³)	0.5	RAGS(Part B), USEPA 1991a
PEF	Particulate emission factor (m ³ /kg)	1.316 x 10 ⁹	Soil Screening Guidance (USEPA 1996a,b)
PC	Dermal Permeability Coefficient (cm/hr), surface water	Chemical specific ^c	Dermal Assessment, USEPA 2004
VFs	Volatilization factor for soil (m ³ /kg)	Chemical specific ^c	Soil Screening Guidance (USEPA 1996a,b)
sat	Soil saturation concentration (mg/kg)	Chemical specific ^c	Soil Screening Guidance (USEPA 1996a,b)

^aSymbols are from equations used to derive PRGs; more information can be found at USEPA Region 9 website.

^bExposure duration for lifetime residents is assumed to be 30 years total. For carcinogens, exposures are combined for children (6 years) and adults (24 years).

⁶Equations used to derive chemical -specific volatilization factors and soil saturation limits are presented at the USEPA Region 9 website.

Parameters presented in *italics* apply to water media.

Table 2. Exposure Assumptions for Radiological Constituents^a

Symbol ^b	Definition (units)	Default	Reference
ED	Exposure duration (years) -resident -outdoor worker	30 25	USEPA Website standard default parameter
EF	Exposure frequency (days/year) - resident (soil, tapwater) - <i>resident (surface water, sediment)</i> - outdoor worker (soil, concrete, groundwater)	350 50 225	USEPA Website standard default parameter Exposure factors, USEPA 1991b USEPA Website standard default parameter
IRs	Ingestion rate (mg/day) -resident (soil, sediment) -outdoor worker (soil) -outdoor worker (concrete)	120 100 10	USEPA Website standard default parameter USEPA Website standard default parameter Concrete ingestion rate per Risk Assessment Design Team meeting, March 23, 2005
<i>IRw</i>	<i>Ingestion rate of water (liters/day)</i> - <i>resident (tapwater)</i> - <i>outdoor worker</i> - <i>resident (surface water)</i>	2 1 0.02	USEPA Website standard default parameter Exposure factors, USEPA 1991b USEPA 1995, Region IV Bulletin
IRi	Inhalation rate (meters ³ /day) -resident (soil) -resident (tap water) -outdoor worker (soil) -outdoor worker (concrete)	18 20 20 --	USEPA Website standard default parameter Concrete inhalation rate per Risk Assessment Design Team meeting, March 23, 2005
t	Time of exposure over which the radionuclide decays (yrs) -resident -outdoor worker	30 25	USEPA Website standard default parameter
<i>K</i>	<i>Andelman volatilization factor (liters/cubic meter) (tap water only)</i> - <i>resident</i> - <i>outdoor worker</i>	0.5 --	USEPA Website standard default parameter (applies to tritium and C-14 only; zero for all other radionuclides)
ETo	Outdoor exposure time fraction (unitless) - resident (soil) - outdoor worker - resident (surface water, sediment)	0.073 0.333 0.083	USEPA Website standard default parameter USEPA Website standard default parameter 2 hr / 24 hr
ETi	Indoor exposure time fraction (unitless) - resident (soil) - outdoor worker - resident (surface water, sediment)	0.683 -- 0	USEPA Website standard default parameter 0 hr / 24 hr
DFi	Indoor dilution factor (unitless)	0.4	USEPA Website standard default parameter
ACF	Area correction factor (unitless) Shoreline reduction factor (sediment)	0.9 0.2	USEPA Website standard default parameter USEPA 1993
PEF	Particulate Emission Factor for southeast (meters ³ per kg)	9.44E+09	USEPA Website parameter for Charleston, SC
GSF	Gamma shielding factor (unitless) GSF for concrete media	0.4 1.0	USEPA Website standard default parameter GSF for concrete per Risk Assessment Design Team meeting, March 23, 2005
Lambda	Ln 2/ radionuclide half life	radionuclide specific	--

^aExposure assumptions for radiological constituents are described in the appropriate Engineering Calculation.

^bSymbols are from appropriate Engineering Calculation to derive radiological PRGs.

Parameters presented in *italics* apply to water media.

Sources

EPA 1989. *“Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A),”* Interim Final, EPA/540/1-89/002, Office of Emergency and Remedial Response, USEPA, Washington, D.C., December 1989.

EPA 1991b. *“Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Supplemental Guidance, Standard Default Exposure Factors,”* Interim Final, OSWER Directive: 9285.6-03, Office of Emergency and Remedial Response Toxics Integration Branch, USEPA, Washington, D. C., March 25, 1991.

EPA 1991a. *“Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals),”* Interim, PB92-963333, Office of Emergency and Remedial Response Toxics Integration Branch, USEPA, Washington, D. C., December 1991.

EPA 1996a, *Soil Screening Guidance: Technical Background Document.* EPA/540/R-95/128. Office of Emergency and Remedial Response, Washington, DC. PB96-963502.

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EPA 2001. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites,* Interim Guidance. OSWER 9355.4-24.

EPA 2004. *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment),* Interim Guidance. EPA/540/R-99/005. Office of Solid Waste and Emergency Response, Washington, DC. PB99-963312.