U.S. EPA Superfund Remedial Program's Approach for Risk Harmonization when addressing Chemical and Radioactive Contamination

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EPA Addresses Site Cleanup Under Several Laws, Programs

- This talk discusses only the Comprehensive Environmental Response, Compensation & Liability Act, CERCLA or “Superfund”
- National Contingency Plan (NCP) is regulation for CERCLA
- National Priorities List (NPL) guides EPA’s remedial program on which sites need further attention

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Purpose

- Provide brief description of CERCLA remedial program process
- Provide overview and comparison of key EPA CERCLA remedial program guidance and tools that specifically address radionuclides and their chemical precursor document
  - Radionuclides are also addressed with other hazardous substances under general EPA CERCLA guidelines

CERCLA Programs

- Removal actions – short-term response actions
  - » Emergency
  - » Time-Critical
  - » Non-Time Critical (addressed by remedial program)
- Remedial – long-term response actions (focus of this talk)

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Remedial Process

- Preliminary Assessment/Site Inspection (PA/SI)
- Hazard Ranking System (HRS) Scoring
- NPL Site Listing Process
- **Remedial Investigation/Feasibility Study (RI/FS)**
- **Record of Decision (ROD)**
- Remedial Design/Remedial Action (RD/RA)
- Construction Completion
- Post Construction Completion activities

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Superfund NPL (remedial) sites: Number and Progress *(old data)*

- 1,320 NPL sites
  - »66 are radiation sites
- 59 mores sites proposed for NPL
  - »1 is a radiation site
- 1,174 NPL sites are “construction completion”
  - »38 are radiation sites
- 389 Sites have been deleted from NPL
  - »9 are radiation sites

How to Address Radiation in a Chemical Program?

- With only 66 radioactively contaminated sites out of 1,320 total, the focus of the Superfund remedial program has been on chemicals.
- **Question:** How best address radiation?
- **Answer:** Address radiation in a consistent manner with chemicals, except to account for the technical differences posed by radiation
  - » Radiation easily fits within Superfund framework
  - » Improves public confidence by taking mystery out of radiation

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Why Does Radiation Easily Fit within the Superfund Remedial Program's Framework?

- Primary effect is cancer
- People ingest, inhale, eat, same amount of contaminated dust and food whether it is chemical or radioactive contamination
- Dust gets resuspended the same whether it is chemically or radioactively contaminated
- Inorganic elements move through the subsurface whether they are radioactive or not

Part 1.
Technical Guidance & Tools for the Superfund Remedial Program

Nine CERCLA Remedy Selection Criteria – Two Threshold

- Two threshold criteria (both must be met)
  1. Protect human health and the environment
  2. Comply (attain or waive) with other federal and state laws: Applicable or Relevant and Appropriate Requirements (ARARs)
     - Protect current or future sources of drinking water (e.g., attain MCLs or more stringent state standards)

CERCLA Cleanup Levels

- ARARs often determine cleanup levels
- Where ARARs are not available or protective, EPA sets site-specific cleanup levels that
  - » For carcinogens, represent an increased cancer risk of 1×10^{-6} to 1×10^{-4}
    - —10^{-6} used as “point of departure”
    - —PRGs are established at 1×10^{-6}
  - » For non-carcinogens, will not result in adverse effects to human health (hazard index (HI) <1)
- Address ecological concerns
- To-be-considered (TBC) material may help determine cleanup level

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CERCLA Cleanup Levels Are NOT Based On

- NRC decommissioning requirements (e.g., 25, 100 mrem/yr mrem/yr [0.25, 1 mSv/yr] dose limits) 10 CFR 20 Subpart E
  - » If used as an ARAR, 10^{-6} still used as point of departure, and 10^{-4} to 10^{-6} risk range must be met
- Guidance outside risk range and/or if expressed as a dose (# mrem/year). This includes:
  - » DOE orders, NRC guidance (e.g., NUREGs), ICRP guidance, IAEA guidance, NCRP guidance, ANSI/HPS guidance, EPA/DHS PAGs, and Federal guidance

Risk-based Cleanup Levels for Radioactive Contamination

- Superfund uses radiation cleanup levels expressed as risk levels, **not** mrem [mSv]
- Superfund uses “slope factors” instead of dose conversion tables to estimate cancer risk from radioactive contaminants
  - » Slope factors have been updated with new information from ICRP 107

Site consistency

- To help facilitate compliance with NCP and cleanup sites, EPA Headquarters provides:
  - Guidance documents
  - Models (calculators)
  - Training (developed with State led ITRC)
  - 14 Annual Meetings with EPA Regions
- Guidance, models, training are available for free on the internet

Guidance: Risk Assessment Q&A
Old Superceded

- *Radiation Risk Assessment at CERCLA Sites: Q&A* (12/99) OSWER Directive 9200.4-31P
- Provides overview of **then** current EPA guidance for radiation risk assessment
- Written for users familiar with Superfund but not radiation
- Adds some new guidance
  - » Dose assessment only for ARAR compliance
  - » No dose-based TBCs (including ***No*** 15 mrem/yr [0.15 mSv/yr])
  - » Direct exposure rate may supplement sampling

New 2014 Risk Assessment Q&A issued June 2014

- *Radiation Risk Assessment at CERCLA Sites: Q&A* (5/2014) OSWER Directive 9200.4-40
- Provides overview of **current** EPA guidance for radiation risk assessment
- Written for users familiar with Superfund but not radiation

Summary of Key Policy Points of New 2014 Risk Assessment Q&A

1. Still do not use dose based (expressed as # millirem per year (mrem/yr) guidance as TBCs
   - » Including NRC, DOE, or international guidance
2. Dose based ARARs not protective if greater than 12 mrem/yr, instead of 15 mrem/yr
3. Use EPA Superfund risk assessment models (PRG and DCC calculators)
4. Don’t use Area Averaging (MARSSIMM) survey method for rad when using Not To Exceed for chemicals

Reflect Superfund Recommended guidance issued since 1999

1. Rad SSG User Guide 2000
2. Rad SSG TBD 2000
3. PRG calculator 2002
4. Common Rads found at Superfund sites 2002
5. DCC calculator 2004
6. SF Rad Risk Assessment & How You Can Help 2005
7. BPRG calculator 2006
8. SPRG calculator 2009
9. BDCC calculator 2010
10. SDCC calculator 2010
11. CPM calculator 2016?
12. Eco calculator 2016?

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Update Policies Based on Newer Science

- For an effective dose standard ARAR to be considered protective, it should be 12 mrem/yr or less.
  - Change from 15 mrem/yr based on risk to dose estimate in Federal Guidance 13
  - Cleanup levels not based on an ARAR continue to be based on cancer risk range (10-4 to 10-6) **not** dose

Update Policies Based on Newer Science, cont.

- To comply with UMTRCA indoor radon standard as an ARAR, users may assume the following concentrations correspond to 0.02 Working Levels:
  - 5 pCi/l of Rn-222
  - 7.5 pCi/l of Rn-220
- The methodology for making these conversions is discussed in ICRP “Lung Cancer Risk from Radon and Progeny”

More consistency on Risk Assessments (Rad & Chem)

- Explain what type of circumstances these Superfund guidance and tools are recommended
- Reiterate more strongly that risk assessments (e.g., models used) should be consistent with chemicals at site and with other regional sites
- Don’t use a steady state model for chemical and a transfer/dynamic model for radionuclides
  - Such as using RSL calculator for chemicals then RESRAD for radionuclides

More consistency on Surveys (Rad & Chem)

- Explain what type of circumstances these Superfund guidance and tools are recommended
- Reiterate more strongly that site surveys (e.g., characterization and confirmation) should be consistent with chemicals at site and with other regional sites
- Don’t use not-to-exceed (NTE) for chemicals and area averaging (AA) for radionuclides for residential
  - NTE for residential cleanup of chemicals but AA approach like MARSIMM for the radionuclides

Guidance: chemical SSG

- Soil Screening Guidance [SSG] documents (7 & 5/96) OSWER Directives 9355.4-23 and 9355.4-17A
  - » User Guide
  - » Technical Background Document
- Guidance to screen out areas, pathways, and/or chemicals early in the process
  - » 1 x 10^{-6} and MCLs (leaching from soil)
  - » Residential land use
  - » Survey procedures for site characterization
  - » Evaluates 9 soil to groundwater models

Guidance: Rad SSG

- Soil Screening Guidance for Radionuclides [rad SSG] documents (10/00) OSWER Directives 9355.4-16A and 9355.4-16
  - User Guide
  - Technical Background Document
- Guidance to screen out areas, pathways, and/or radionuclides early in the process
- Consistent with 1996 chemical SSG
  - 1×10^{-6} and MCLs (leaching from soil)
  - Residential land use
  - Survey procedures for site characterization
  - Evaluates 5 soil to groundwater models
  - Accounts for technical differences of radiation

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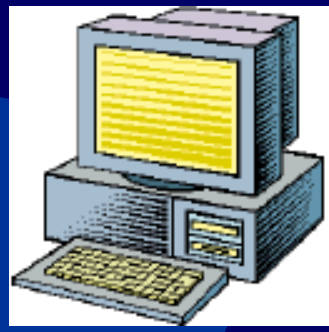
Guidance: Chemical RSL Calculator

- Calculator to establish Screening Levels/PRGs, when:
  - » ARAR is either not available or sufficiently protective
- Electronic equations (risk and leaching to groundwater) also are on Internet
  - » $1x10^{-6}$ and MCLs (leaching from soil)
  - » Includes dermal exposure

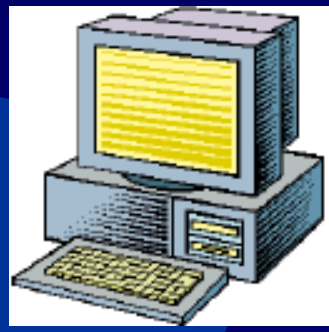


Guidance: Chemical RSL Calculator (continued)

- Nine scenarios/land uses available
  1. Residential
  2. Recreator
  3. Construction
  4. Indoor workers
  5. Outdoor workers
  6. Fish ingestion
  7. Tap water
  8. Soil to groundwater
  9. Air
- Includes chemical toxicity of uranium

Guidance: Rad PRG Calculator

- Calculator to establish PRGs, when:
  - » ARAR is either not available or sufficiently protective (e.g., 25 mrem/yr [0.25 mSv/yr] or more)
- Electronic equations (risk and leaching to groundwater) also are on Internet
  - » $1x10^{-6}$ and MCLs (leaching from soil)
  - » Accounts for technical differences of radiation (e.g., gamma, plant uptake)



Guidance: Rad PRG Calculator (continued)

- Ten scenarios/land uses available

1. Residential
2. Recreator
3. Construction
4. Indoor workers
5. Outdoor workers
6. Fish ingestion
7. Tap water
8. Soil to groundwater
9. Air
10. Farmer

- Chemical RSL Internet equations should be used for chemical toxicity of uranium
- EPA developed Internet-based training with States (ITRC) on calculator and radiation risk assessment
  - » http://www.clu-in.org/conf/itrc/rads_051507/

Guidance: ARAR Dose Calculator

- Calculator to establish Dose Compliance Concentrations (DCC) for single dose limit ARARs requiring a dose assessment
- Ten scenarios/land uses available
  1. Residential
  2. Recreator
  3. Construction
  4. Indoor workers
  5. Outdoor workers
  6. Fish ingestion
  7. Tap water
  8. Soil to groundwater
  9. Air
  10. Farmer
- Equations similar to those used for PRG calculator, except dose conversion factors (ICRP 107, 72, 32) used instead of slope factors

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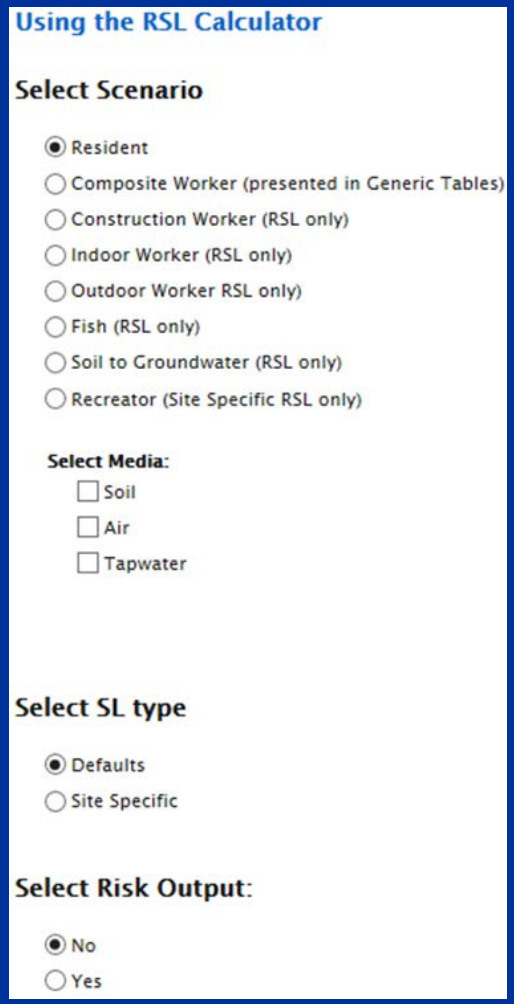
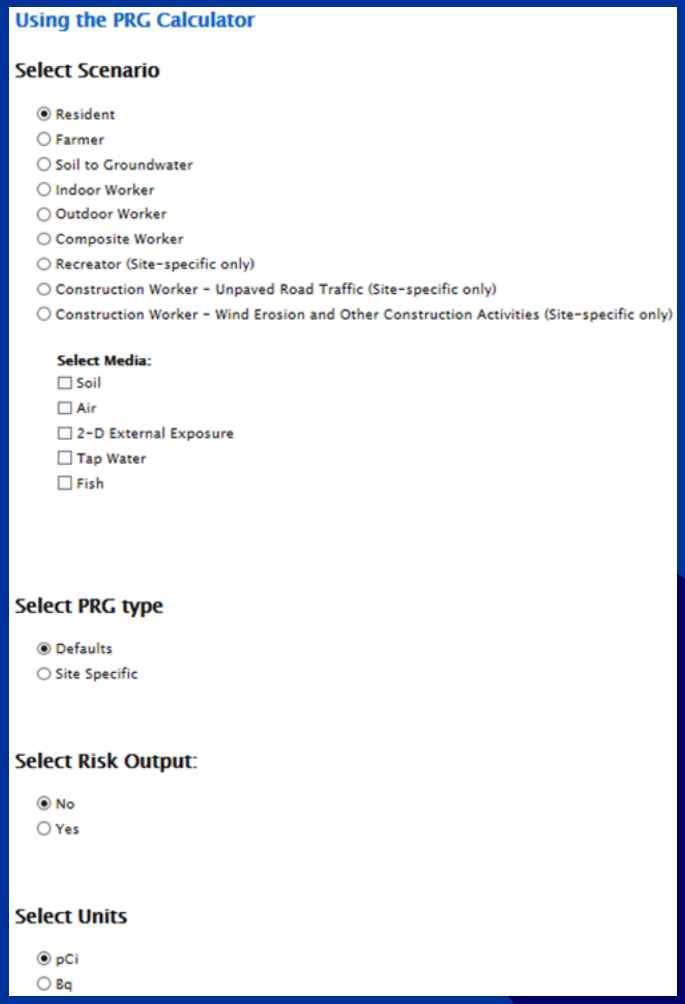
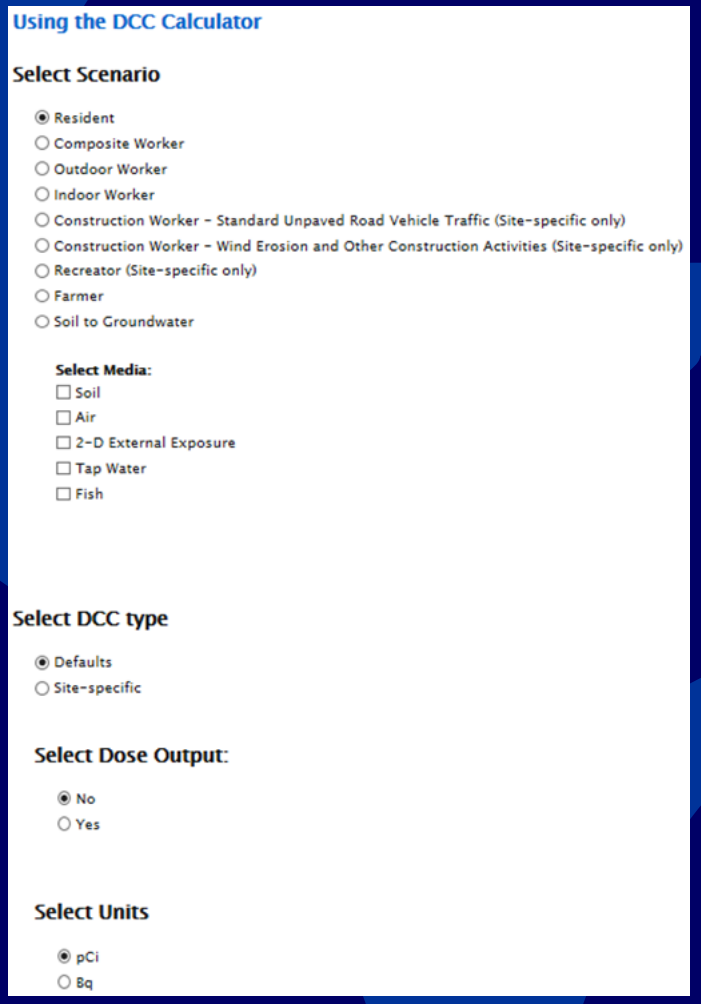
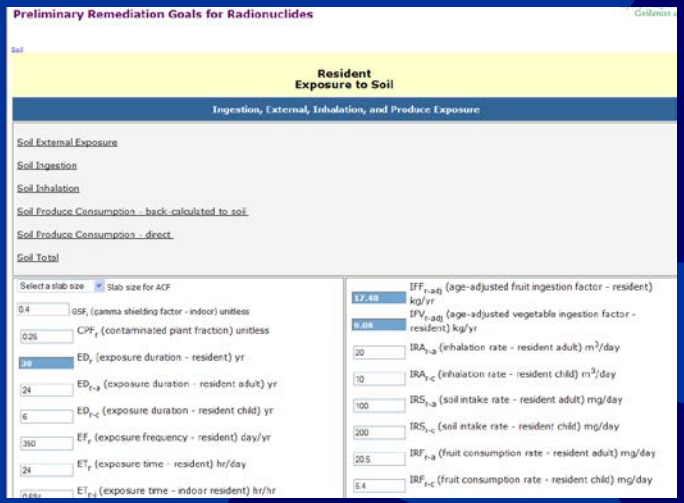
RSL, PRG, DCC, Similar Look and Feel

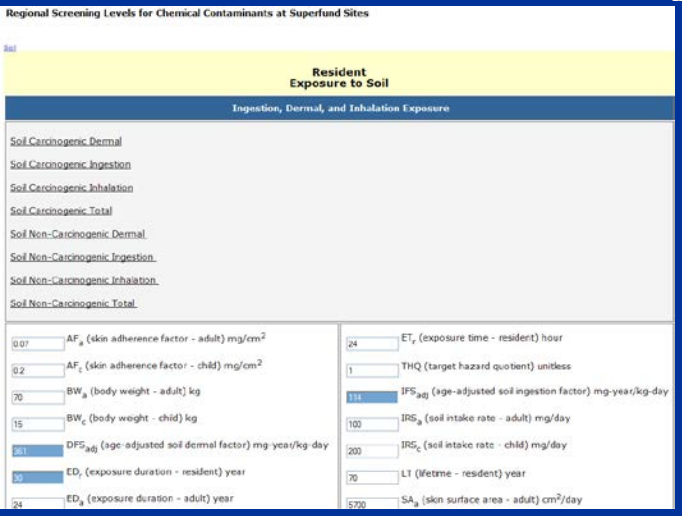


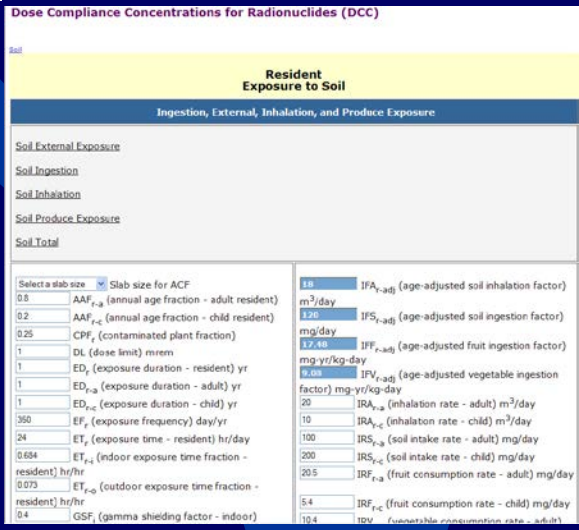




RSL, PRG, DCC, Consistent Exposure Assumptions







RSL, PRG, DCC
Consistent treatment of inorganics

- Resuspension – same
- Soil to groundwater – same
- All 3 steady state models. Not depleting source (transfer/dynamic) models

Guidance: World Trade Center (WTC) Benchmark

- Document used to establish $1x10^{-4}$ risk based cleanup levels for the reuse of chemically contaminated buildings after the 9/11 attacks.
- Equations and parameters were the latest EPA chemical methodology
- Ingestion, inhalation, and dermal
  - » http://www.epa.gov/wtc/reports/contaminants_of_concern_benchmark_study.pdf

World Trade Center Indoor Environment Assessment:
Selecting Contaminants of Potential Concern and
Setting Health-Based Benchmarks

May 2003

Prepared by the Contaminants of Potential Concern (COPC) Committee
of the World Trade Center Indoor Air Task Force Working Group

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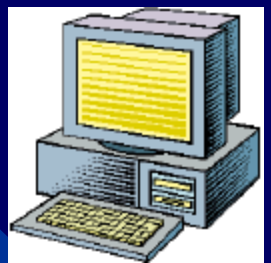
Guidance: World Trade Center (WTC) Benchmark (continued)

- WTC benchmark document includes 1 land use scenario
  - Residential
- This land use includes 2 exposure routes
  - Settled dust
  - Ambient air

Guidance: Building PRG (BPRG) Calculator

- Calculator to establish $1x10^{-6}$ risk based PRGs for the reuse of radioactively contaminated buildings.
- Equations and parameters are derived from latest EPA chemical methodology (e.g., assessment at WTC which used $1x10^{-4}$ cleanup level)
  - » Adjusted to account for technical differences posed by radiation
- EPA and ITRC Internet-based training on BPRG calculator and D&D
  - » http://www.clu-in.org/conf/itrc/radsdd_040308/



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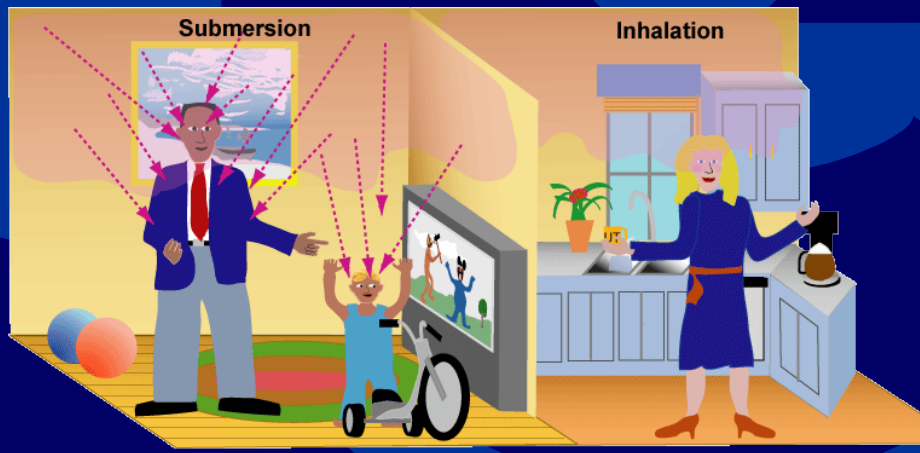
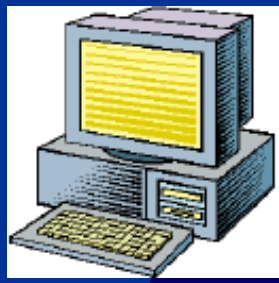
Guidance: Building PRG (BPRG) Calculator (continued)

- BPRG calculator includes 2 land use scenarios
  - » Residential
  - » Indoor worker
- Both land uses include 3 exposure routes
  - » Settled dust
  - » Ambient air
  - » Direct external exposure
    - —5 Room sizes and 4 receptor locations, both
      - –Surface
      - –Volumetric



Building Dose Cleanup Concentrations (BDCC) ARAR Dose Calculator

- BDCC Purpose: to establish BCCs for Inside Buildings for single dose limit ARARs (# mrem/yr)
- BDCC includes 2 land use scenarios (Residential, Indoor Worker)
- 2 land uses include 3 exposure routes (Settled dust, Fixed Direct External 3-D, Ambient Air)
- Equations similar to those used for BPRG calculator, except dose conversion factors used instead of slope factors



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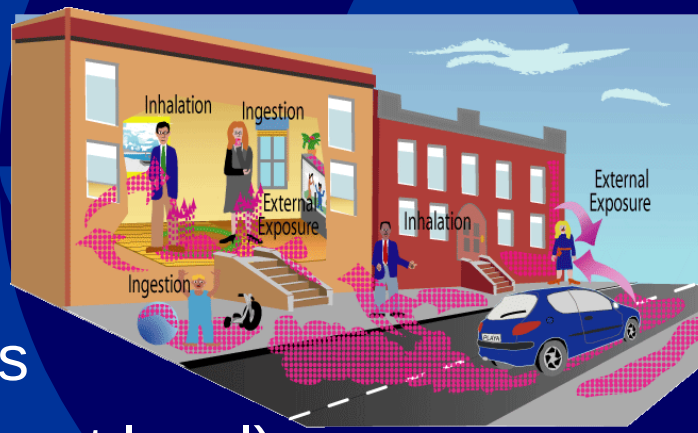
Surfaces PRG (SPRG) Calculator

- Establish 1 x 10^{-6} risk based PRGs for radioactively contaminated ***outside*** hard surfaces (e.g., slabs, pavement, sidewalks, sides of buildings)
- Derived from rad PRG and BPRG calculators

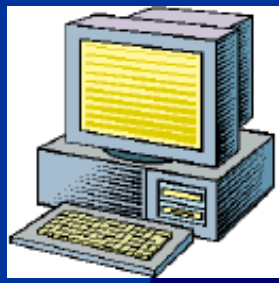
SPRG Exposure Scenarios

- SPRG includes 3 land use scenarios
  - » Residential
  - » Indoor Worker
  - » Outdoor Worker
- 3 land uses include 3 exposure routes
  - » Settled dust (pave and unpaved street level)
  - » Fixed Direct External 3-D (street level)
    - —Surface and Volumetric
  - » Fixed Direct External 2-D (slabs)
    - —Surface and Volumetric



Surface Dose Cleanup Concentrations (SDCC) ARAR Dose Calculator

- SDCC Purpose: to establish DCCs for Outside Hard Surfaces for single dose limit ARARs (# mrem/yr)
- SDCC includes 3 land use scenarios (Residential, Indoor Worker, Outdoor Worker)
- 3 land uses include 3 exposure routes (Settled dust, Fixed Direct External 3-D, Fixed Direct External 2-D (slabs))
- Equations similar to those used for SPRG calculator, except dose conversion factors used instead of slope factors



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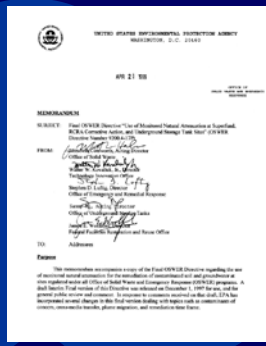
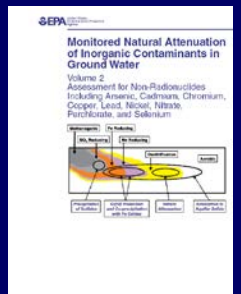
MNA for Inorganics (metals and radionuclides) Policy document *New – September 2015*

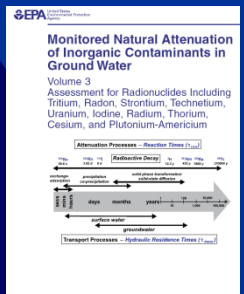


- Complements 1999 overall MNA policy document "Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites"
  - » Helps clarify policy issues unique to inorganics not addressed in 1999
- 3 Volume ORD MNA for inorganics documents is the technical support document for this policy document
  - » Also complemented by 2010 ITRC guidance on MNA for inorganics

Technical Background Documents for MNA Guidance for Inorganics

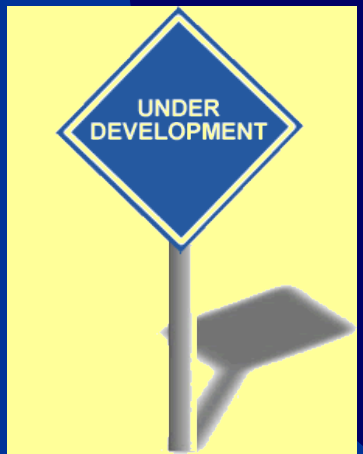
- 3 Technical Reports "Monitored Natural Attenuation of Inorganic Contaminants in Ground Water"
  - » "Volume 1 - Technical Basis for Assessment" 2007
  - » "Volume 2 - Assessment for Non-Radionuclides Including Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Nitrate, Perchlorate, and Selenium" 2007
  - » "Volume 3 - Assessment for Radionuclides Including Americium, Cesium, Iodine, Plutonium, Radium, Radon, Strontium, Technecium, Thorium, Tritium, Uranium" 2010





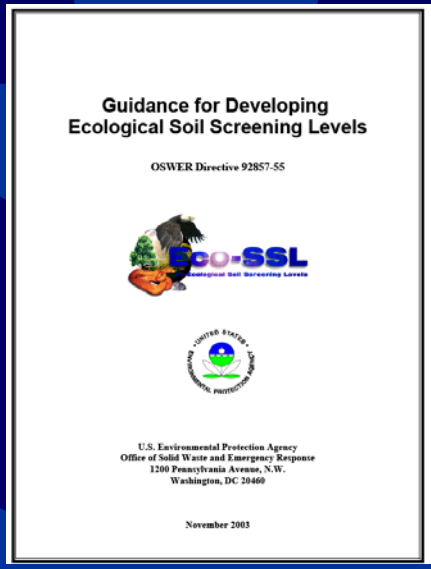
Guidance under Development for the Superfund Remedial Program

1. Radionuclide Ecological Benchmark calculator
2. Counts Per Minute (CPM) calculator



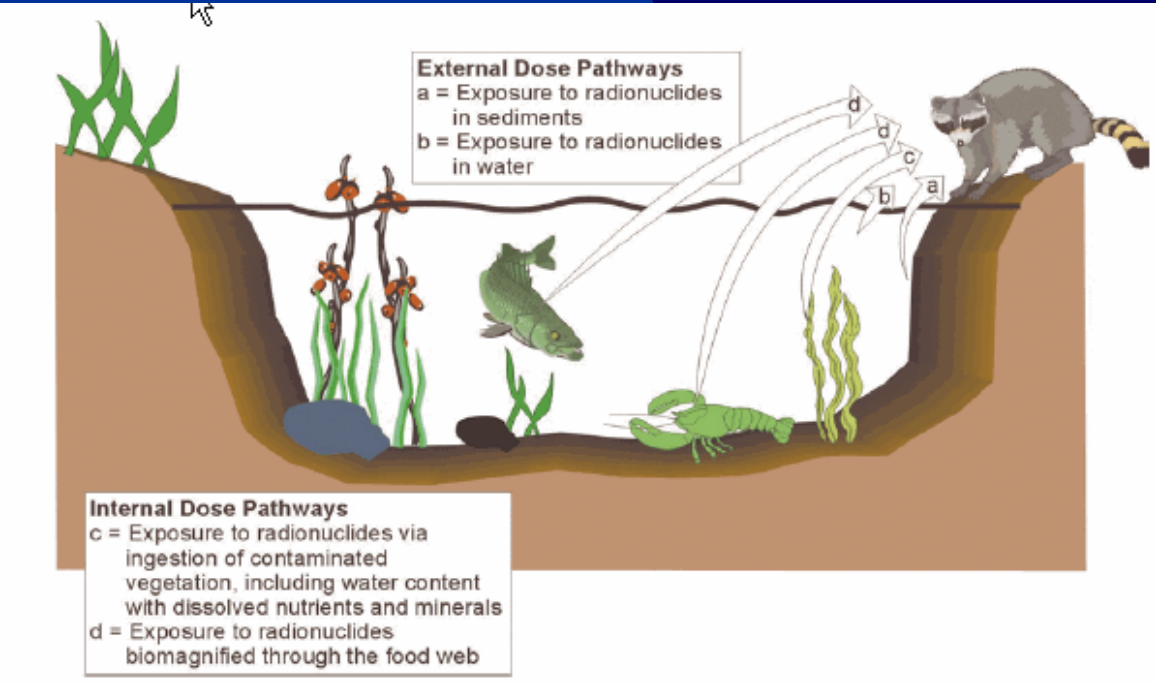
Radionuclide Ecological Benchmark (REB) Calculator

- Establish risk-based Biota Concentration guides (BCGs), or ecological benchmarks, for radioactively contaminated sites
- Fits with Superfund framework for developing eco benchmarks
- Derived from DOE Graded Approach guidance
  - » Includes same dose levels for tissue death
  - » Strong recommendation to look at chemical eco effects



REB Exposure Scenarios

- Includes 12 animal or plant benchmark scenarios
  - »6 generic composite only
  - »6 species-specific/site-specific



CPM Calculator Scenarios

- The CPM calculator has three major sub calculators based on the field survey scenario:

1. Ground based scanning of surface contamination
2. Ground based scanning of volumetric contamination
3. Air based scanning of contamination *(under consideration)*

CPM tool caveats

- The CPM tool is intended to facilitate use of Real-Time measurement techniques to supplement sampling **NOT** replace sampling
- The CPM tool only addresses gamma emitters
- The CPM tool assumes uniform contamination

Part 3.
Involving Stakeholders at Superfund Remedial Program Sites

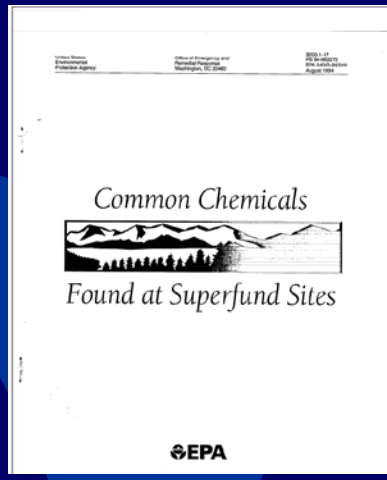
Community Involvement

- EPA has many tools to facilitate meaningful involvement by communities near sites
- EPA hosts a community involvement national conference
- EPA has 2 tools designed specifically for use at radiation sites that are based on earlier tools for chemical sites

Booklet: Common Chemicals

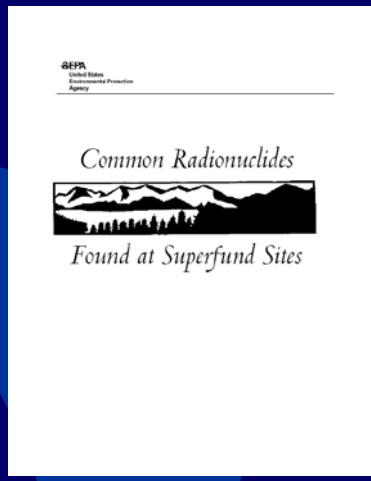
- *Common Chemicals Found at Superfund Sites* (8/94) OSWER Directive 9203.1-17
- Booklet for the general public. It contains information on
  - » Health effects of chemicals commonly found at Superfund sites
  - » EPA policies for cleaning up these chemicals

    Note this booklet has been superceded by a website



Booklet: Common Radionuclides
Old Superceded

- *Common Radionuclides Found at Superfund Sites* (7/02) OSWER Directive 9200.1-34
- Booklet for the general public. It contains information on
  - » Health effects of radionuclides commonly found at Superfund sites
  - » EPA policies for cleaning up these radionuclides



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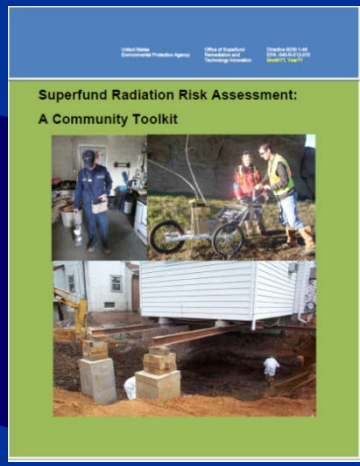
Toolkit: Radiation Risk Assessment
New – issued June 2014

- *Superfund Radiation Risk Assessment: A Community Toolkit*
- Collection of 22 fact sheets for the general public. It contains fact sheets on
  - » Superfund and Radiation
  - » Superfund risk assessment process at radiation sites
  - » Each of the 6 PRG and DCC calculators
  - » Replacement for the Common Rad booklet fact sheets

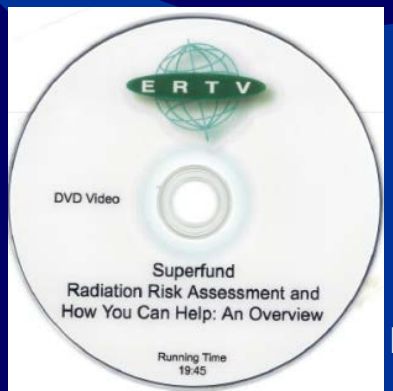


Video: Chemical Risk Assessment

- *Superfund Risk Assessment and How you can Help, an Overview* (1999) OSWER Directive 9285.7-29A
- Video for the general public. It contains information on:
  - » The Superfund risk assessment process when addressing chemical contamination
  - » How the public is involved site-specifically

Video: Radiation Risk Assessment

- *Superfund Radiation Risk Assessment and How you can Help, an Overview* (3/05) OSWER Directive 9200.4-37
- Video for the general public. It contains information on:
  - » The Superfund risk assessment process when addressing radioactive contamination
  - » How the public is involved site-specifically



For More Copies or Information

- Guidance documents are on Superfund Radiation Webpage:
  - http://www2.epa.gov/superfund/radiation-superfund-sites

  EPA/ITRC training on EPA Superfund radiation approach
  - http://www.clu-in.org/conf/itrc/radscleanup_060507/
- For further information or questions, Stuart Walker
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  - Email: Walker.Stuart@epa.gov


Questions
Answers