1

Welcome – Thanks for joining us.
ITRC's Internet-based Training Program

Decontamination and Decommissioning of Radiologically-Contaminated Facilities

ITRC Technical and Regulatory Guidance Document: Decontamination and Decommissioning of Radiologically Contaminated Facilities (RAD-5, 2008)

Sponsored by: Interstate Technology and Regulatory Council (www.itrcweb.org)
Hosted by: US EPA Clean Up Information Network (www.cluin.org)

The decontamination and decommissioning (D&D) of radiologically-contaminated facilities presents numerous challenges. Many tasks are involved, each of which requires adherence to a complex array of federal and state regulations and policies, attention to health and safety issues for workers and the public, monitoring and management of schedules and costs, and interaction with a potentially large number of stakeholders who have an interest in the present activities and future plans for sites undergoing D&D. Since large-scale D&D operations at nuclear facilities began in the 1970s, one of the most noticeable advances has been dramatic decreases in decommissioning cost. This change is the result of a combination of accumulated decommissioning operational experience reducing the high initial cost estimates (which were high due to uncertainties and poorly defined boundaries), evolution of regulatory guidance, and continuously-developing technologies.

A large body of knowledge has already been accumulated on D&D operations. At the present time, approximately 90 commercial power reactors, 250 research reactors, 100 mines, 5 reprocessing facilities, and 14 fuel fabrication plants have been retired from operation, with some having been fully dismantled. In addition, the largest environmental cleanup projects ever undertaken are in progress or have recently been completed at several large DOE facilities in the nuclear weapons complex. Technologies developed for the D&D portions of these cleanups are part of the lessons learned from these projects.

This training introduces regulators, cleanup contractors, site owners/operators, and technology providers to ITRC's Technical/Regulatory Guidance, Decontamination and Decommissioning of Radiologically-Contaminated Facilities (RAD-5, 2008), created by ITRC's Radionuclides Team. The curriculum is composed of four modules as follows:

Module 1: Introduction and Regulatory Basis for D&D

Module 2: Factors for Implementing D&D

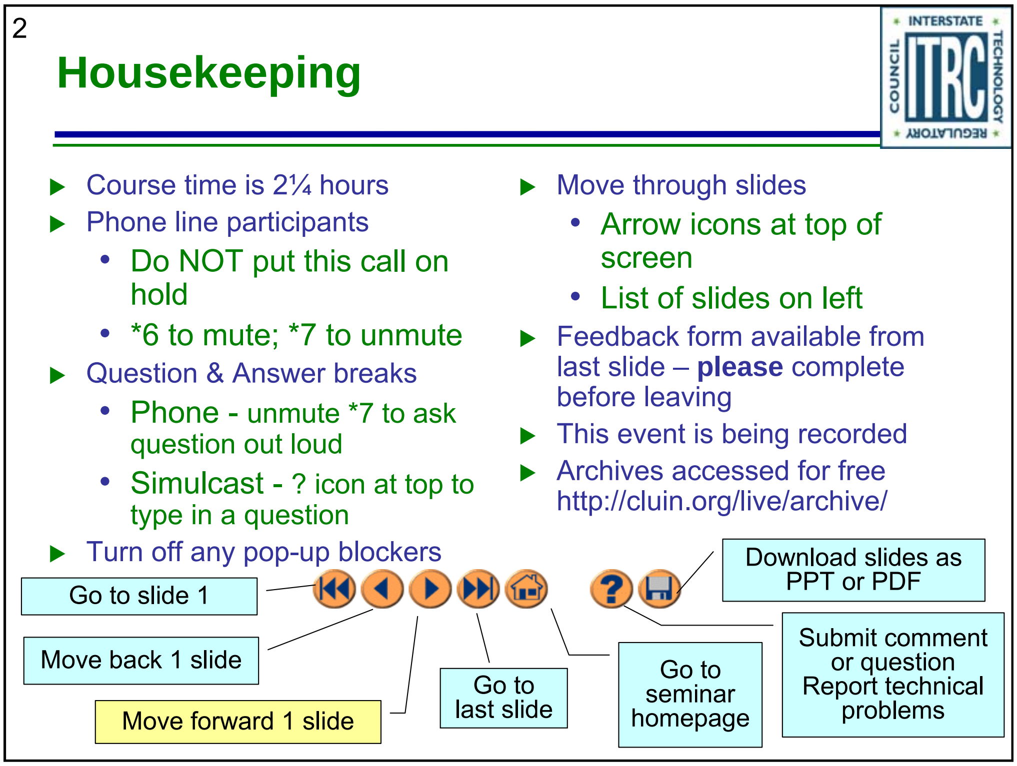
Module 3: Preliminary Remediation Goal (PRG) Calculators

Module 4: Case Studies and Lessons Learned

ITRC (Interstate Technology and Regulatory Council) www.itrcweb.org

Training Co-Sponsored by: US EPA Technology Innovation and Field Services Division (TIFSD) (www.clu-in.org)

ITRC Training Program: training@itrcweb.org; Phone: 402-201-2419



Although I'm sure that some of you are familiar with these rules from previous CLU-IN events, let's run through them quickly for our new participants.

We have started the seminar with all phone lines muted to prevent background noise. Please keep your phone lines muted during the seminar to minimize disruption and background noise. During the question and answer break, press *7 to unmute your lines to ask a question (note: *6 to mute again). Also, please do NOT put this call on hold as this may bring unwanted background music over the lines and interrupt the seminar.

You should note that throughout the seminar, we will ask for your feedback. You do not need to wait for Q&A breaks to ask questions or provide comments using the ? icon. To submit comments/questions and report technical problems, please use the ? icon at the top of your screen. You can move forward/backward in the slides by using the single arrow buttons (left moves back 1 slide, right moves advances 1 slide). The double arrowed buttons will take you to 1st and last slides respectively. You may also advance to any slide using the numbered links that appear on the left side of your screen. The button with a house icon will take you back to main seminar page which displays our agenda, instructor bios, links to the slides and additional resources. Lastly, the button with a computer disc can be used to download and save today's presentation slides.

3

ITRC Disclaimer and Copyright

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•Although we discuss various technologies, processes, and vendor's products, we are not endorsing any of them.

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4

ITRC (www.itrcweb.org) – Shaping the Future of Regulatory Acceptance

- Host organization — ECOS
- Network
  - State regulators
    - All 50 states, PR, DC
  - Federal partners
    - DOE DOD EPA
  - ITRC Industry Affiliates Program — IAP
  - Academia
  - Community stakeholders
- Wide variety of topics
  - Technologies
  - Approaches
  - Contaminants
  - Sites
- Products
  - Technical and regulatory guidance documents
  - Internet-based and classroom training

The Interstate Technology and Regulatory Council (ITRC) is a state-led coalition of regulators, industry experts, citizen stakeholders, academia and federal partners that work to achieve regulatory acceptance of environmental technologies and innovative approaches. ITRC consists of all 50 states (and Puerto Rico and the District of Columbia) that work to break down barriers and reduce compliance costs, making it easier to use new technologies and helping states maximize resources. ITRC brings together a diverse mix of environmental experts and stakeholders from both the public and private sectors to broaden and deepen technical knowledge and advance the regulatory acceptance of environmental technologies. Together, we're building the environmental community's ability to expedite quality decision making while protecting human health and the environment. With our network of organizations and individuals throughout the environmental community, ITRC is a unique catalyst for dialogue between regulators and the regulated community.

For a state to be a member of ITRC their environmental agency must designate a State Point of Contact. To find out who your State POC is check out the "contacts" section at www.itrcweb.org. Also, click on "membership" to learn how you can become a member of an ITRC Technical Team.

5

ITRC Course Topics Planned for 2010 – More information at www.itrcweb.org

Popular courses from 2009

- Decontamination and Decommissioning of Radiologically-Contaminated Facilities
- Enhanced Attenuation of Chlorinated Organics
- In Situ Bioremediation of Chlorinated Ethene - DNAPL Source Zones
- LNAPL Part 1: An Improved Understanding of LNAPL Behavior in the Subsurface
- LNAPL Part 2: LNAPL Characterization and Recoverability
- Perchlorate Remediation Technologies
- Performance-based Environmental Management
- Phytotechnologies
- Protocol for Use of Five Passive Samplers
- Quality Consideration for Munitions Response
- Survey of Munitions Response Technologies
- Determination/Application of Risk-Based Values
- Use of Risk Assessment in Management of Contaminated Sites

New in 2010

- Decision Framework for Applying Attenuation Processes to Metals and Radionuclides
- LNAPL Part 3: Evaluating LNAPL Remedial Technologies for Achieving Project Goals
- Mining Waste
- Remediation Risk Management: An Approach to Effective Remedial Decisions and More Protective Cleanups

ITRC 2-day Classroom Training: Vapor Intrusion Pathway

More details and schedules are available from www.itrcweb.org under “Internet-based Training” and “Classroom Training.”

Meet the ITRC Instructors

Ann Charles
New Jersey Dept. of Environmental Protection
Trenton, New Jersey
609-984-9752
ann.charles@dep.state.nj.us

Robert Storms
TDEC/DOE-O
Oak Ridge, Tennessee
865-481-0995
Robert.Storms@tn.gov

Stuart Walker
U.S. EPA
Washington, D.C.
703-548-5300
walker.stuart@epa.gov

Rose Weissman
Kleinfelder
Newburgh, New York
845-567-6530
rweissman@kleinfelder.com

Ann Charles is a Research Scientist with the New Jersey Department of Environmental Protection's (NJDEP) Site Remediation Management and Response Program in Trenton, New Jersey. Since 1988, Ann has been working for the NJDEP in the Bureau of Environmental Evaluation and Risk Assessment, overseeing publicly funded investigations and remediations that include radionuclide contaminated sites in the Site Remediation Program. Program and policy initiatives have involved the current development of soil remediation standards for the State of New Jersey, Technical Requirements for Site Remediation, New Jersey remedial process optimization team, and biennial certification and cap value teams. Ann has been a member of the ITRC Radionuclides team since 2004. She earned a Master of Science Degree from Miami University of Ohio in 1990 and a Bachelor of Arts degree from Franklin and Marshall College in 1982.

Robert Storms is the supervisor for the Environmental Restoration Support Section of Radiological Monitoring at the DOE Oversight Division for the Tennessee Department of Environment and Conservation located in Oak Ridge, Tennessee. Since 1988, Robert has been employed with the Tennessee Department of Environment and Conservation with the Division of Groundwater and the Division of Underground Storage Tanks. In 1991, Robert joined the DOE Oversight Division and worked with the Environmental Restoration program for three years prior to joining the Radiological Monitoring program in 1994. He is a member of the East Tennessee Geological Society and an avid mineral collector. Robert enjoys coaching soccer and assisting with the Boy Scouts. Since 2003, Robert has been a member of the ITRC Radionuclides team and became the team's co-leader in 2006. Robert is also the ITRC Point of Contact from Tennessee. Robert earned a bachelor's degree in geology from Tennessee Technological University in Cookeville, Tennessee in 1986 and has continued studies in Environmental Legislation and Health Physics at Pellissippi State and Oak Ridge Associated Universities located in Oakridge, Tennessee. He is a registered Professional Geologist with the State of Tennessee.

Stuart Walker has been employed by U.S. EPA in Washington, DC since 1990 in either the Superfund program (the Office of Superfund Remediation and Technology Innovation) or the Office of Radiation and Indoor Air working on issues regarding the cleanup of contaminated sites. His primary areas of responsibility include serving as the Superfund program's national lead on issues regarding radioactively contaminated CERCLA sites. In this latter role, Stuart develops national policy for characterization, cleanup and management of radioactive contamination at CERCLA sites. Previously Stuart was the lead staff person on remedy selection issues for EPA's CERCLA reauthorization team. Stuart is a member of the ITRC Radionuclides team and is an instructor on several of the team's Internet-based training courses. Stuart earned a bachelor's degree in political science and economics from the American University in Washington, DC in 1985 and a master's degree in policy analysis and development from George Washington University in Washington, DC in 1987.

Rose Weissman is a Senior Project Manager in Newburgh, New York with Kleinfelder with project focus including Department of Energy decommissioning of a legacy research and development facility, public utilities environmental management, retail gasoline operations, and manufacturing environmental compliance. Since 1988, Rose has worked as an environmental professional on RCRA waste management and facility investigations, site assessment, investigation, and remediation, UST management, explosives manufacturing, UXO remediation, and multimedia permitting and compliance. She has worked extensively with the US EPA on Region 2 priority sites in the continental US and Caribbean, as well as with the Army Corps of Engineers in remote areas of Alaska assessing military lands to be returned to Native Alaskan Corporations. She has been qualified as an expert in the areas of site assessment, site investigation, remediation, and UST failure in numerous litigations in New York, New Jersey, and Pennsylvania. Rose is a member of the ITRC Radionuclides team and ITRC UXO team, has been active in community outreach programs and environmental awareness during the course of her professional career, and was awarded a Paul Harris Fellowship for outstanding community service and her work with inner-city youth by the Paterson Rotary Club. She earned a bachelor's degree in biology from Felician College in Lodi, New Jersey in 1988.

7

ITRC Radionuclides Team

- Facilitate the cleanup of radioactively contaminated federal facilities
- Fostering dialogue between states, stakeholders, federal agencies
- Increase awareness of issues and procedures at sites in other states
- Encourage regulatory cooperation
- Share technological successes and approaches
- Current state members
  - Colorado, New Jersey, Ohio, Tennessee, Washington

The ITRC Radionuclides team has emphasized facilitating the cleanup of radioactively contaminated facilities by fostering dialogue between states, stakeholders, and federal agencies, in order to increase awareness of issues and procedures at sites in other states, encourage regulatory cooperation, and share technological successes and approaches.

The team formed in 1999 and is comprised of state and federal regulators, consultants and stakeholders.

8

ITRC Radionuclides Team Products

- Guidance Documents and Internet-based training

Details available in Links page at end of presentation or directly at <u>www.itrcweb.org</u>

The products above have been developed by ITRC's Radionuclides Team – details at www.itrcweb.org

- Radiation Reference Guide: Relevant Organizations and Regulatory Terms (RAD-1, 1999)

- Determining Cleanup Goals at Radioactively Contaminated Sites: Case Studies (RAD-2, 2002)

- Issues of Long-Term Stewardship: State Regulators' Perspectives (RAD-3, 2004)

- Real-Time Data Measurement of Radionuclides in Soil: Technology and Case Studies (RAD-4, 2006)

- Decontamination and Decommissioning of Radiologically Contaminated Facilities (RAD-5, 2008)

The Radionuclides Team has developed internet-based training associated with these documents.

The ITRC website (www.itrcweb.org) includes the published documents (under "Guidance Documents" and "Radionuclides") and the associated training courses (under "Internet-based Training" and "Radionuclides").

9

Why We Are Here Today...

- Discuss regulatory environment for decontamination and decommissioning (D&D)
- Explain factors in implementing D&D
- Describe available tools for D&D
  - Technologies
  - Online risk calculators
- Share accumulated D&D operational experience

No associated notes

10

Who Will Benefit from This Training...

- Regulators
  - States
  - U.S. Environmental Protection Agency (EPA)
  - Nuclear Regulatory Commission (NRC)
- Site owners/operators
  - DOE sites
  - DoD sites
  - Commercial reactors
  - Medical research facilities dealing with Rads
- Contractors and consultants
- Community stakeholders

This topic has wide applicability to radionuclide contaminated site cleanup - be they DOE, DOD, NRC or other response actions.

States – Superfund sites, NORM, Agreement states (NORM = naturally occurring radioactive material)

DOD – Depleted uranium sites, accident sites, storage sites

DOE – many sites

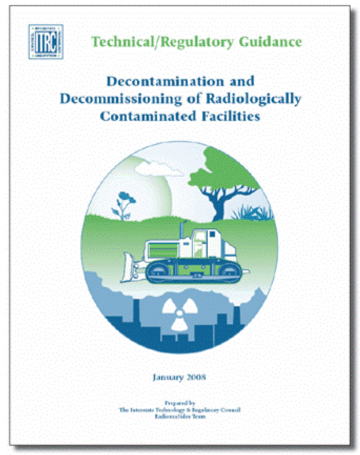
NRC – Decommissioning and Decontamination (D&D) projects

USEPA – Superfund and other sites

11

Presentation Overview

- Module 1: Introduction and Regulatory Basis for D&D
- Module 2: Factors for Implementing D&D
- Module 3: Preliminary Remediation Goal (PRG) Calculators
- Module 4: Case Studies and Lessons Learned



This training introduces state and federal regulators, environmental consultants, site owners, and community stakeholders to Decontamination and Decommissioning of Radiologically-Contaminated Facilities (RAD-5, 2008), created by ITRC's Radionuclides Team, and provides information on the basics of Decontamination and Decommissioning (D&D)

Decontamination and Decommissioning of Radiologically-Contaminated Facilities

MODULE 1:

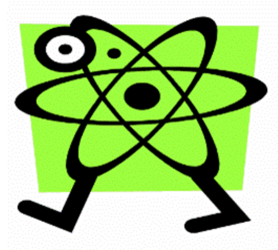
Introduction and Regulatory Basis for D&D

No associated notes

13

Module 1: Introduction and Regulatory Basis for D&D

- In this module, you will learn about
  - Definitions
  - Types of facilities undergoing decontamination and decommissioning (D&D)
  - Process outline
  - Regulatory organizations
  - D&D under the Atomic Energy Act
  - D&D under CERCLA



We'll be referring to decontamination and decommissioning as D&D.

14

Definitions

- Decontamination
- Decommissioning
- Deactivation, demolition, dismantlement

D&D activities at Rocky Flats Site, CO

For the purposes of this ITRC training,

Decontamination - removal or reduction of radioactive or other hazardous contamination from facilities

Decommissioning - actions taken at the end of the life of a radiologically contaminated facility to retire it from service

Deactivation, demolition and dismantlement - activities that may be undertaken in the decommissioning process.

Deactivation - puts the facility in a stable condition that is economical to monitor until the eventual decommissioning.

Demolition - tearing down of a structure, usually without the intent of reuse.

Dismantlement - piece by piece removal of equipment with the intent of reuse.

15

Radioactive Waste Management Definitions

- High-level waste
- Transuranic waste
- Low-level waste
- Mixed waste
- Special case waste
- Naturally occurring radioactive material (NORM)
- Technologically enhanced naturally occurring radioactive material (TENORM)

High-Level Waste HLW includes spent (used) fuel from nuclear reactors and waste generated from reprocessing of spent fuel. Spent nuclear fuels are spent nuclear fuel assemblies produced from commercial or government-owned nuclear reactors.

Transuranic Waste TRU waste is defined by DOE Order 435.1 as radioactive waste containing more than 100 nCi (3700 Bq) of alpha-emitting TRU isotopes (isotopes of elements with an atomic number greater than 92 – i.e. that of uranium) per gram of waste, with half-lives greater than 20 years.

Low-Level Waste LLW is defined by the Low-Level Radioactive Waste Policy Amendments Act of 1985 as "radioactive material that: (A) is not high-level radioactive waste, spent nuclear fuel, or byproduct material as defined in section 11e.2 of the Atomic Energy Act of 1954) and; and (B) NRC, consistent with existing law and in accordance with paragraph (A), classifies as low-level radioactive waste." There are four classes of LLW, in ascending order of hazard: Class A, B, C, and GTCC (Greater Than Class C). For Classes A, B, and C, the NRC has regulations (10 CFR Part 61) that set concentration limits for both short-lived and long-lived radionuclides. These limits are actually formulas that reflect both the half-lives and the hazards of the radionuclides in each class.

Mixed Waste Mixed waste (MW) is defined as radioactive waste containing both radioactive and hazardous waste.

Special Case Waste Special case waste is defined as radioactive waste owned or generated by DOE that does not fit into typical management plans developed for the major radioactive waste types

For more information, see Chapter 2 of the companion ITRC D&D document

16

Radioactive Waste Management: Mixed Waste

- Mixed waste contains both radioactive and hazardous waste
- Regulatory framework
  - Hazardous waste regulated by EPA or authorized states under Resource Conservation Recovery Act (RCRA)
  - Radioactive waste regulated by NRC or DOE under Atomic Energy Act (AEA)
  - EPA has regulatory authority to address radionuclides under CERCLA for onsite responses
- Waste handlers need to comply with both RCRA and AEA regulations

For further information on mixed waste, see Section 2.3.4 of the companion ITRC D&D document.

The ITRC D&D document (Decontamination and Decommissioning of Radiologically-Contaminated Facilities (RAD-5, 2008)) is available on the ITRC website (www.itrcweb.org) under “Guidance Documents” and “Radionuclides.”

There will be further discussion in Module 1 about D&D under CERCLA in forthcoming slides.

17

Types of Facilities Undergoing D&D

- Federal government
  - Approximately 20,000 nuclear weapons research and development facilities
  - > 80 EPA National Priorities List sites with radiological contamination
- Commercial nuclear energy industry
  - Approximately 100 nuclear power reactors and 250 research reactors
- Thousands of licensed commercial facilities
  - Medical, pharmaceutical, research

This topic has wide applicability to radionuclide contaminated site cleanup.

18

D&D Process Outline

1. **Planning** D&D of the facility
   - Future land use ? Cleanup levels ?
2. **Performing** D&D of the facility
   - Modifications to the remediation plan?
3. **Closure / transfer** of the facility
   - Long-term surveillance and maintenance ?

What is the future land use for the site?
Has the public had input into the future land use decision?

Are records of facility operations available?
Is characterization adequate to determine contamination levels and safety hazards?
To what level(s) must the facility be remediated?

What technologies are available and how do they compare?
What amount and types of resources will be required?
Are there nearby structures, utilities, or areas of contamination that must be considered?
In what sequence must the tasks occur?

Have all regulatory requirements been satisfied?

19

Regulatory Organizations

- Nuclear Regulatory Commission (NRC)
- Department of Energy (DOE)
- Environmental Protection Agency (EPA)
- Defense Nuclear Facilities Safety Board (DNFSB)

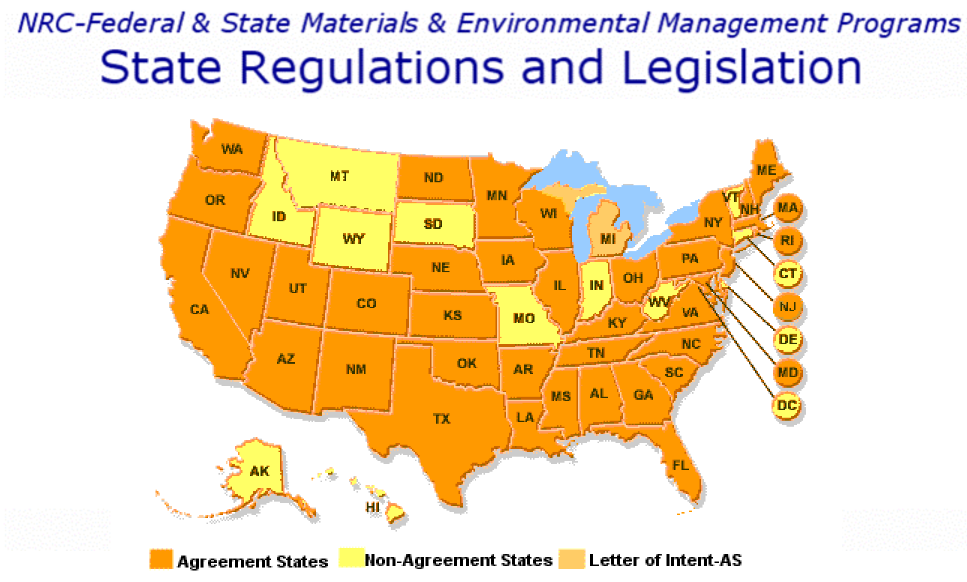
Radiologically-contaminated sites pose unique challenges and risks. Cleanup may involve management of low-activity radioactive wastes which include a broad spectrum of materials for which a regulatory framework has evolved in a piecemeal fashion since the late 1940s. This regulatory framework has often focused on the source rather than on inherent radiological properties or risk.

The Atomic Energy Act of 1946 gave the federal government control of the production and use of fissionable material and established the Atomic Energy Commission (AEC). The Energy Reorganization Act of 1974 abolished the AEC, creating instead the Energy Research and Development Administration (ERDA, which later became the DOE when the Department of Energy Organization Act passed in 1977) to assume AEC's research and development responsibilities, and the NRC to assume the Commission's licensing and regulatory functions.

See Chapter 1 of the companion document for further information on the regulatory organizations. The ITRC D&D document (Decontamination and Decommissioning of Radiologically-Contaminated Facilities (RAD-5, 2008)) is available on the ITRC website (www.itrcweb.org) under "Guidance Documents" and "Radionuclides."

20

Regulatory Organizations - Agreement States



For more information on the Agreement States, non-Agreement States, and intended Agreement States, see http://nrc-stp.ornl.gov/rulemaking.html

21

D&D Requirements under the Atomic Energy Act – DOE

- Real Property Asset Management, Order 430.1B
- Implementation guides
- Program and Project Management for the Acquisition of Capital Assets, Order 413.3
- Operational Readiness Review (ORR)

Workers treating radioactive sludge at Hanford Site, following ORR

DOE Order 430.1B, Real Property Asset Management is the management approach to disposing of DOE's excess facilities. The objective of the order is to establish a performance based approach that links planning, programming, budgeting and evaluation. The Order was issued in 2003.

DOE has developed four implementation guides for decommissioning projects. The guides are entitled, Decommissioning Implementation Guide, Implementation Guide for Surveillance and Maintenance during Facility Transition and Disposition, Deactivation Implementation Guide, and Transition Implementation Guide.

DOE Order 413.3 "Program and Project Management for the Acquisition of Capital Assets" was issued October 2000 with a change in January 2005. It is intended to create a consistent DOE-wide definition of what is required of a DOE project manager as part of a response to criticism (NRC 1999) of DOE's project management approach. The order applies to all DOE projects regardless of funding type or phase of execution.

For more information, see Chapter 4 of the companion document. The ITRC D&D document (Decontamination and Decommissioning of Radiologically-Contaminated Facilities (RAD-5, 2008)) is available on the ITRC website (www.itrcweb.org) under "Guidance Documents" and "Radionuclides."

For web links to DOE Orders and Guidance addressing decommissioning, see http://www.em.doe.gov/Pages/DeactivationDecommissioning.aspx

22

D&D Requirements under the Atomic Energy Act – NRC

- Dose-based radiological criteria for license termination
- Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans (NUREG-1700)
- Consolidated Decommissioning Guidance (NUREG-1757)
- Agreement States

Susquehanna, PA power reactor

NRC regulates 103 civilian nuclear power reactors and 37 non-power reactors. While the NRC is not directly involved in regulating the decommissioning of DOE's nuclear facilities, they regularly cooperate and exchange technical expertise on D&D matters.

NUREG-0586, is the "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," August 1988, at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0586/

For the NRC rule establishing dose-based cleanup standards, see "Radiological Criteria for License Termination", Federal Register July 21, 1997.

NUREG-1757 is a three-volume series. Volume 1 is entitled "Decommissioning Process for Materials Licensees", Volume 2 "Characterization, Survey, and Determination of Radiological Criteria", and Volume 3 "Financial Assurance, Recordkeeping, and Timeliness".

Further details may be found in Chapter 2 of our companion document. The ITRC D&D document (Decontamination and Decommissioning of Radiologically-Contaminated Facilities (RAD-5, 2008)) is available on the ITRC website (www.itrcweb.org) under "Guidance Documents" and "Radionuclides."

Web links to various NRC regulations and guidance on decommissioning may be found at http://www.nrc.gov/about-nrc/regulatory/decommissioning/reg-guides-comm.html

23

Decommissioning Process under the Atomic Energy Act – DOE and NRC

- Deactivation
- Decontamination
- Dismantlement
- Demolition
- Surveillance and maintenance

Rocky Flats Site before D&D activities

No associated notes

24

Decommissioning Paths under the Atomic Energy Act – DOE

- End State = vision for the site at the end of the cleanup effort
- Reflects planned future land use
- Protective consistent with that land use
- Iterative process

Rocky Flats Site post-D&D

For further information on End States, see July 2003 DOE Policy 455.1, “Use of Risk-Based End States” at http://www.directives.doe.gov/pdfs/doe/doetext/neword/455/p4551.pdf

The Rocky Flats D&D case study is presented in Chapter 8 of our companion document. The ITRC D&D document (Decontamination and Decommissioning of Radiologically-Contaminated Facilities (RAD-5, 2008)) is available on the ITRC website (www.itrcweb.org) under “Guidance Documents” and “Radionuclides.”

25

Decommissioning Paths under the Atomic Energy Act – NRC

- DECON
- SAFSTOR
- ENTOMB

Entombed reactor at Piqua, OH

Current NRC regulations require decommissioning to be completed within 60 years of when the facility ceases operations. Since most power reactors will have radionuclides in concentrations that exceed the limits for unrestricted use even after 100 years, NRC handles entombment requests on a case by case basis.

26

D&D Requirements under CERCLA

- CERCLA and the National Contingency Plan (NCP)
  - Release or threat of release
- EPA - DOE Joint Policy, 1995
- EPA - NRC Memorandum of Understanding, 2002
- Risk based cleanup levels

Hanford Site before remedial and D&D activities

DOE-owned and -operated or NRC-licensed facilities are generally subject to those agencies' authorities under the Atomic Energy Act. EPA's involvement in decommissioning facilities normally arises as part of cleanup actions designed to address contamination at a site.

In 1995, EPA and DOE issued a joint policy on decommissioning Department of Energy Facilities Under CERCLA . See http://www.epa.gov/fedfac/documents/doe595.htm

This EPA - DOE joint policy also addresses sites under the Resource Conservation Recovery Act. States authorized by EPA to administer state hazardous waste programs have authority under to enforce requirements applicable to D&D activities such as waste management and corrective action.

In 2002, EPA and NRC issued a Memorandum of Understanding on decommissioning, "Consultation and Finality of Decommissioning and Decontamination of Contaminated Sites". For more information, see http://epa.gov/superfund/health/contaminants/radiation/mou.htm

27

D&D Process under CERCLA

- Remedial sequence
  - National Priorities List (NPL)→
  - Remedial Investigation Feasibility Study →
  - Record of Decision →
  - Remedial Design Remedial Action →
  - Long Term Surveillance and Maintenance →
  - Deletion from NPL
- Short-term response actions

Remedial activities at Hanford Site

ITRC's Radionuclides Team offers internet based training on CERCLA requirements for radiation site cleanup, including the development of site-specific remedial cleanup levels. See the Links to Additional Resources slide, which is the final slide of our training today. Information is also available at the ITRC website (www.itrcweb.org) under "Internet-based Training" and "Radionuclides."

The National Contingency Plan sets forth nine criteria for evaluating alternatives when selecting a Superfund remedial alternative. The criteria can be separated into three levels: threshold, balancing, and modifying. The first two criteria are known as "threshold" criteria. They are a reiteration of the CERCLA mandate that remedies must ensure overall protection of human health and the environment and compliance with applicable or relevant and appropriate requirements. The five balancing criteria assess tradeoffs between alternatives. The final two modifying criteria are state and community acceptance.

Generally, response actions under CERCLA are either removal or remedial actions. Removal actions are short-term response actions to mitigate imminent and substantial threats to human health and the environment. EPA divides removal actions into three categories: emergency; time-critical; and non-time-critical, based on the type of situation, the urgency and threat of the release or potential release, and the subsequent time frame in which the action must be initiated .

Further information may be found in Chapter 3 of the companion document. The ITRC D&D document (Decontamination and Decommissioning of Radiologically-Contaminated Facilities (RAD-5, 2008)) is available on the ITRC website (www.itrcweb.org) under "Guidance Documents" and "Radionuclides."

28

D&D Paths under CERCLA

- Acceptable risk level depends on reasonably anticipated future land use
- Institutional controls
  - Legal controls
- Engineering controls
  - Physical controls
- Restricted land use requires periodic reviews to ensure remedy remains protective
- Evaluating ecological effects

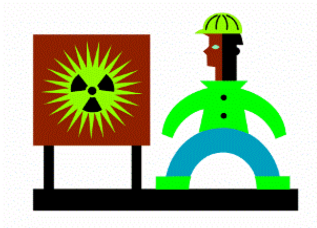
EPA’s policies for how to consider reasonably anticipated future land use in the CERCLA remedy selection process is discussed in "Land Use in the CERCLA Remedy Selection Process," available at http://www.epa.gov/superfund/community/relocation/landuse.pdf

Generally, institutional controls may be included as a supplemental component to the remedy selected at a CERCLA site, not as a substitute for treatment, containment or other remedial action. Institutional controls typically are legal controls intended to affect human activities in a way that prevents or reduces exposure to hazardous substances.

29

Module 1: Introduction and Regulatory Basis for D&D – Recap

- Definitions
- Types of facilities undergoing D&D
- Process outline
- Regulatory organizations
- D&D under the Atomic Energy Act
- D&D under CERCLA



No associated notes.

30

Decontamination and Decommissioning of Radiologically-Contaminated Facilities

MODULE 2:

Factors for Implementing D&D

No associated notes

31

Module 2: Factors for Implementing D&D – Outline

- Cost/Program Management

- Technology

- Health and Safety

No associated notes.

32

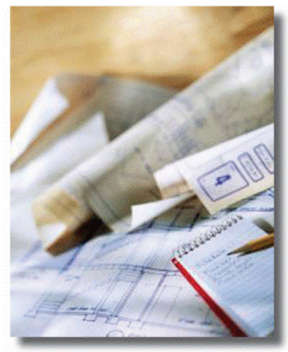
Cost/Program Management

- Major cost elements in a D&D project
  - D&D Plan development
  - Removal of equipment from the structures
  - Construction and operation of support facilities
  - Decontamination and/or removal of empty structures
  - Waste management
  - Contracting and project management

No associated notes.

Cost/PM - D&D Plan Development

- Prior to D&D, need to have
  - Detailed planning
  - Order of events
  - D&D plan
  - Documents
- Financial considerations
- Future use of a facility

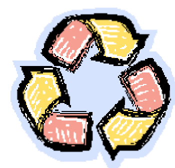


No associated notes.

34

Removal of Equipment and Materials

- Active surveillance and monitoring (S&M) program needed until the contamination is controlled or contained
- Decisions – segregation/decontamination
- Economics of reuse
  - Best to use existing buildings as support facilities for personnel and operations



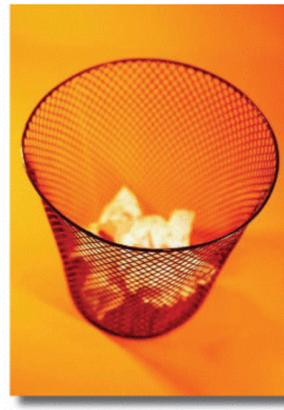
An active S&M program must exist at any radiologically-contaminated structure until the contamination is controlled or contained. These expenditures can be saved with expedited equipment removal actions, done in a safe and orderly manner. Decisions must be made whether and how to segregate and decontaminate the removed equipment and whether or not any of it can be recycled. The large amount of equipment from D&D structures can potentially result in large amounts of low-level radiological waste. Chapter 5 further discusses techniques and experiences that deal with the removal and disposal of equipment.

Equipment and materials can be decontaminated for reuse when economical. However, economics alone do not often justify the cost of decontamination. If items are not releasable to the public they may still find a purpose on a controlled DOE site. Since the public and the regulatory community have a significant interest in how materials and equipment are disposed of or reused, effective communication greatly increases the likelihood of success. Further, as these communications can take a considerable amount of time, the process should be started early. Free release standards should also be discussed with the regulatory community at an early stage in order to avoid any misinterpretations.

35

Waste Management

- Large quantities
- Characterization
- Aggressive waste minimization efforts
  - Decontamination
- Bottlenecks



Large quantities of low-level radiological waste, hazardous waste, and mixed waste will be generated during D&D. Waste management covers safe and economic disposal, including collection, separation, treatment, packaging, and transportation of the products generated from the D&D process. Costs can vary considerably depending on how efficiently a site's waste management strategy addresses each of these elements. A major decision at most sites is whether wastes will be transported to an off site disposal facility or if some wastes can be disposed of in facilities constructed onsite. Classification of radiological waste is described in Section 2.5. Examples of waste management strategies are described in the case studies (Chapter 7).

Characterization, tailored or graded within the context of DQO considerations, of hazardous substances to determine their identities, forms, amounts and locations will be needed before, during, and after D&D operations. Sampling allows wastes to be segregated, determining how various waste streams have to be dispositioned. It is sometimes more cost effective and safer to assume a whole structure or part of a structure is contaminated and dispose of it as such in an acceptable landfill rather than attempt to segregate the waste into component streams. Historical knowledge of the contaminated structure (to assist characterization), available landfill space, and disposal costs have to be considered.

If classified wastes are encountered, the site must be secure enough to handle, maintain, and protect those specific wastes. The facility must then incur the added cost of security (guards, fencing, and personnel security clearance) to handle classified waste onsite or ship it offsite to a secure facility.

An aggressive waste minimization effort applied to PPE clothing, tools, chemicals, and supplies will help reduce waste disposal costs. The generation of mixed waste in particular should be kept to a minimum due to the expense and difficulty of locating an acceptable location for its disposal. Waste treatment sometimes allows less costly disposal; e.g., the cost of treating mixed waste might be warranted if it could be disposed of as LLW at a significant cost savings.

Before they are disposed onsite or shipped offsite, wastes are subjected to several handling steps. This materials handling often blends the waste so that the portions with elevated concentrations are reduced. Uncontaminated soil can also be added to waste containers to reduce the average radiation levels to below regulatory criteria.

A means of reducing the quantity of waste produced is to decontaminate radioactive materials, primarily metals, to a level sufficient to permit sale to the commercial market. In addition to reducing wastes, this will produce revenue for the project. Recycling metals commonly found at radiologically-contaminated sites (such as steel, stainless steel, nickel, copper, aluminum, mercury, and depleted uranium) can recoup costs, but release standards must be met. Potentially recyclable products should be segregated into clean scrap, contaminated scrap that could be decontaminated economically, and contaminated scrap that cannot be decontaminated economically. A choice must sometimes be made between reducing volume and disposal costs. The cost of decontaminating materials in order to recycle and reuse materials must also be considered. Decontamination will produce a waste stream that will need to be addressed. The cost of recycling is not only a monetary issue since valuable space in landfills can be freed up if the choice is made to decontaminate or recycle.

A number of components of the waste shipment process are capable of creating bottlenecks for the entire D&D process. Several considerations and careful planning can reduce the potential for significant delays. Sufficient onsite storage capacity must be available along with staging areas for loading waste containers. Containers must be compatible with transportation vehicles and unloading equipment at disposal facilities. Optimizing container size and purchasing containers in quantity can often yield significant discounts and reduce delays. The work required to reduce the size of large pieces of contaminated equipment to fit standard waste containers can be expensive, time consuming, and needs to be performed within rigorous safety analysis and control envelopes. Innovative options to size reduction are discussed in Chapter 5. A review of offsite disposal and transportation options needs to include opposition to transportation routes. Besides coordinating with the disposal facility, regulators in the receiving and trans-shipping states need to be aware of, approve, and sometimes inspect shipments.

36

Project Management Considerations

- Requires management structure that is
  - Streamlined
  - Orderly
  - Responsive
  - Focused on safety and cost containment
- Many lessons can be learned

Cost-effective management requires a management structure that is streamlined, orderly, responsive, and focused on safety and cost containment. Management layers need to be minimized using an integrating contractor or a single, independent contractor where possible. Multiple layers of management lead to added cost and a high ratio of management and professional services to cost of execution of the physical decommissioning.

The contractor should be given adequate responsibility and accountability in performing the operations. Fixed-price contracts with incentives for cost and schedule reduction should be used where possible. The roles of the contractor and any sub-contractors should be well defined.

Experience from various D&D projects has led to some general principles that are useful for contractors/project managers to consider:

D&D planning should include

- project schedules with associated management details;
- a pre-cleanup survey, including both radiological measurements and thorough documentation of the previous uses of the facility must be made to assist in planning;
- administrative activities for procurement;
- establishing equipment removal sequences for each area, taking into account the effects on building exhaust, air-supply, power, and communication systems;
- scheduling and supervision of work assignments for specific D&D tasks;
- allotment of sufficient storage space for equipment and materials awaiting disposition.

The early stages of D&D planning should incorporate environmental considerations along with technical and economic issues in decision making.

Selection of suitable disposal or storage sites for contaminated materials is a critical step.

Choosing personnel experienced in D&D processes will increase the efficiency of any task.

D&D projects are labor intensive; final costs are therefore very sensitive to changes in labor rates.

Applying lessons learned from previous projects and from other sites will make a project more efficient and less costly.

Early and frequent input from stakeholders will more likely result in a project that gains and maintains critical support from local governments and politicians.

Consulting with regulatory agencies before and during D&D efforts will save time and effort in the long run.

Close coordination with regulators can allow decisions to be made in the field.

Resources are used more efficiently when similar remediation tasks are done simultaneously.

Plans needs to be open to ideas and scrutiny throughout the entire D&D process.

Environmental efforts must be evaluated to ensure that soils and groundwater are not recontaminated during the process (e.g., contaminated soil should not be staged in an area already remediated).

Holdups in the waste shipment process are capable of creating bottlenecks for the entire D&D process.

Optimize the use of automation and robotics in repetitive operations, taking into consideration factors such as reliability, decontamination needs, additional waste generation, etc. Robotics minimizes the potential exposure and radiation dose to the worker. This in turn reduces the amount of person hours and health and safety monitoring as well.

Optimize the use of heavy equipment for similar operations. The high cost of leasing heavy equipment dictates its prudent use.

Focused demonstrations are necessary to determine which technology is best suited for a particular site and particular project. Major research and development programs usually are not beneficial at this stage.

Sacrificing attention to health and safety requirements will eventually result in costly delays.

Removing classified or high security items early in the process minimizes the need for specialized security monitoring.

Waste reduction efforts can result in tremendous cost savings.

All D&D operations from initial cleanup to the final radiological certification survey must be thoroughly documented.

Technology

- Technologies presented are
  - Readily available
  - Have been used for D&D
- Selection is representative not comprehensive
- Technologies are not endorsed by ITRC

More information is available in section 5 of the ITRC's Technical/Regulatory Guidance, Decontamination and Decommissioning of Radiologically-Contaminated Facilities (RAD-5, 2008). The document is available from www.itrcweb.org under “Guidance Documents” then “Radionuclides.”

38

Types of Technology

- Site Characterization/ Verification Sampling
- Decontamination
- Contamination Control
- Cutting and Sizing
- Solids Removal
- Liquids Removal
- Robotics
- Large Structure Demolition
- Waste Sampling for Disposition
- Packaging and Transportation
- Work Monitoring

More information is available in section 5 of the ITRC's Technical/Regulatory Guidance, Decontamination and Decommissioning of Radiologically-Contaminated Facilities (RAD-5, 2008). The document is available from www.itrcweb.org under “Guidance Documents” then “Radionuclides.”

39

Technologies Highlighted in this Presentation

- Horizontal Directional Drilling (HDD) and Environmental Measurement While Drilling (EMWD)
- Hydrolasing
- Chemical Decontamination
- Radioactive Tank Cleaning System
- Polyurethane Foam

More information is available in section 5 of the ITRC's Technical/Regulatory Guidance, Decontamination and Decommissioning of Radiologically-Contaminated Facilities (RAD-5, 2008). The document is available from www.itrcweb.org under "Guidance Documents" then "Radionuclides."

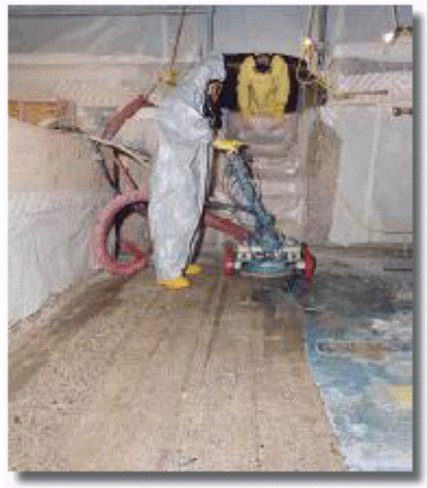
40 **Horizontal Directional Drilling (HDD) and Environmental Measurement While Drilling (EMWD)**

Environmental sampling using HDD at Building 865 at Rocky Flats.

No associated notes.

41

Hydrolasing



Hydrolase System at work at Rocky Flats Site, Colorado removing contaminated paint and underlying surface contamination

No associated notes.

42

Chemical Decontamination

A scrub brush is used during the second phase of the decontamination process

No associated notes.

43

Radioactive Tank Cleaning System

Workers introduce the remote-controlled track vehicle that will remove sludge from a waste tank at Rocky Flats.

No associated notes.

Polyurethane Foam

Spraying structural foam into waste containers such as cargo containers allows waste to be transported safely with no load shifting, tipping or sliding resulting in no damage to the transport container.

No associated notes.

45

Additional Technologies

- Bioremediation of Oils/Water
- Plasma Arc Cutting
- Ultra High Pressure Water Jet – Cutting
- Remote In-situ Size Reduction
- Raschig Ring Vacuum System
- Vac & Ship System
- Harmonic Delamination

Just a few you will find in the Radionuclides Team's Technical/Regulatory Guidance, Decontamination and Decommissioning of Radiologically-Contaminated Facilities (RAD-5, 2008)

More information is available in section 5 of the ITRC's Technical/Regulatory Guidance, Decontamination and Decommissioning of Radiologically-Contaminated Facilities (RAD-5, 2008). The document is available from www.itrcweb.org under "Guidance Documents" then "Radionuclides."

46

Health and Safety

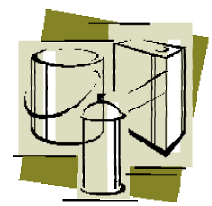
- Addressed by a complex set of technical and managerial practices
- Radiological risks
- Many non-radiological risks
- Occupational Safety and Health Administration (OSHA) regulations
- State occupational safety and health program regulations
- Careful, systematic planning
- Much accumulated experience

No associated notes.

47

Radiological and Non-Radiological Hazards

- Radiological hazards
  - External exposure
  - Ingestion and inhalation
  - Criticality
  - Breach of containment
- Non-radiological hazards
  - Fire
  - Explosions
  - Toxic materials
  - Electrical and physical hazards



In general, radiological hazards fall into four categories: external exposure, ingestion and inhalation of radionuclides, criticality, and breach of containment. Overall radiological risks can be lower during D&D than during regular operation. However, the nature of D&D activities can mean that there is an enhanced risk of exposure for some workers during this phase. Remote handling and robotics technologies can greatly mitigate these risks, but when these are unavailable, worker exposure must be carefully managed. Similarly, the ingestion and inhalation of radionuclides, which originate in surface contamination, present a genuine risk that must be clearly addressed by standard worker protection measures. Criticality and breach of containment are usually of less concern, but in some scenarios – such as the case where fissile material remains in process equipment – the possibility must be recognized and field activities planned accordingly. Containment systems can be particularly problematic. Those used during operation may no longer be working, and even if they are, there is no assurance that they can match the increased and varying demands of D&D activities. Radiological protection against these hazards is provided by a number of technical and managerial measures including isolation and removal of radioactive material; spill prevention and dust/aerosol suppression techniques; bulk shielding of workers; discrete individual shielding through personnel protective clothing, etc.; training; air filtering; and wastewater treatment, and appropriate waste disposal techniques.

Non-radiological hazards include fire (the most common risk due to presence of flames in cutting technologies coupled with the accumulation of potentially combustible wastes), explosions (originating in dusts produced), toxic materials (particularly in aged facilities where material no longer allowable (e.g. asbestos) may be present), and electrical and physical hazards (e.g. noise, confined space risks, impact trauma from falling objects). Standard industrial and commercial safety practices should be employed to address these concerns.

48

Health and Safety Plan

1. Regulatory Framework
2. Key Personnel
3. Hazard Assessment
4. Training Requirements
5. Personal Protective Equipment
6. Extreme Temperature Disorders or Conditions
7. Medical Surveillance

No associated notes.

49

Health and Safety Plan (continued)

8. Exposure Monitoring/Air Sampling
9. Site Control
10. Decontamination
11. Emergency Response/Contingency Plan Background
12. Emergency Action Plan
13. Confined Space Entry
14. Spill Containment

No associated notes.

50

Integrated Safety Management - DOE Approach

- ISM defined by continuous five-step process
  - Define the scope of work
  - Analyze the hazards
  - Develop and implement hazard controls
  - Perform work within controls
  - Provide feedback and continuous improvement

No associated notes.

51

Integrated Safety Management – Eight Guiding Principles

1. Line management responsibility for safety
2. Clear roles and responsibilities
3. Competence commensurate with responsibilities
4. Balanced priorities
5. Identification of safety standards/requirements
6. Hazard controls tailored to work performed
7. Operations authorization
8. Worker involvement

No associated notes.

52

Module 2: Factors for Implementing D&D – Conclusions/Wrap-up

- Cost
- Technology
- Health & Safety

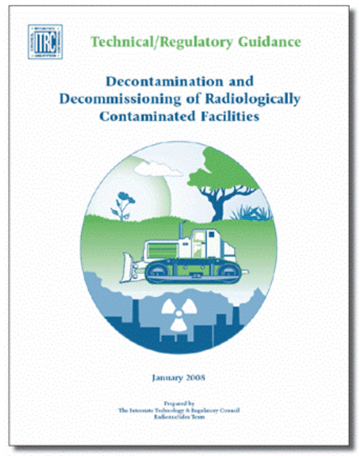
- Land Use / Social Values
- Risk

No associated notes.

53

Questions & Answers

- Module 1: Introduction and Regulatory Basis for D&D
- Module 2: Factors for Implementing D&D
- **Question and Answer Break**
- Module 3: Preliminary Remediation Goal (PRG) Calculators
- Module 4: Case Studies and Lessons Learned



No associated notes.

Decontamination and Decommissioning of Radiologically-Contaminated Facilities

MODULE 3:

EPA CERCLA Preliminary Remediation Goal (PRG) Calculators for Decontamination and Decommissioning

By the end of the module, the participants should be able to:

Understand the concept and assumptions of PRGs

Be able to use Preliminary Remediation Goals (PRGs) appropriately at site

Learn how to calculate PRGs

Become acquainted with EPA's Preliminary Remediation Goals for Radionuclides in Buildings (BPRG), Preliminary Remediation Goals for Radionuclides in Outside Surfaces (SPRG), and ARAR Dose calculators for radionuclides that were developed for D&D types of activities.

These Radionuclide BPRG and SPRG calculators are part of a continuing effort by EPA's Office of Superfund Remediation and Technology Innovation (OSRTI) to provide updated guidance for addressing radioactively contaminated sites consistent with EPA's guidance for addressing chemically contaminated sites, except to account for the technical differences between radionuclides and chemicals.

55

EPA CERCLA PRG Calculators for D&D

- PRGs for the Superfund program are
  - Concentrations based on Applicable or Relevant and Appropriate Requirements (ARARs)
  - Risk-based concentrations, derived from equations combining standardized exposure assumptions with EPA toxicity data
- PRGs are not de facto cleanup standards and should not be applied as such

PRGs (Preliminary Remediation Goals) for Radionuclides, the focus of Module 3 of this training, presented on this site, for the Superfund/RCRA programs are risk-based concentrations, derived from standardized equations combining exposure information assumptions with EPA toxicity data. They are considered by the Agency to be protective for humans (including most sensitive groups), over a lifetime. However, these risk-based PRGs are not always applicable to a particular site and do not address non-human health endpoints such as ecological impacts. The PRGs contained in the BPRG and SPRG tables are generic; that is, they are calculated without site-specific information. They may be re-calculated using site-specific data.

They are used for site "screening" and as initial cleanup goals if applicable. PRGs are not de facto cleanup standards and should not be applied as such. The PRG's role in site "screening" is to help identify areas, contaminants, and conditions that do not require further attention at a particular site. Generally, at sites where contaminant concentrations fall below PRGs, no further action or study is warranted under the Superfund program, so long as the exposure assumptions at a site match those taken into account by the PRG calculations. Chemical concentrations above the PRG would not automatically designate a site as "dirty" or trigger a response action. However, exceeding a PRG suggests that further evaluation of the potential risks that may be posed by site contaminants is appropriate. PRGs are also useful tools for identifying initial cleanup goals at a site. In this role, PRGs provide long-term targets to use during the analysis of different remedial alternatives. By developing PRGs early in the decision-making process, design staff may be able to streamline the consideration of remedial alternatives.

56

What are Risk-Based PRGs?

- They are contaminant levels considered by the EPA to be protective for humans (including most sensitive groups), over a lifetime.
- PRGs role in site "screening" is to help identify areas, contaminants, and conditions that do not require further attention at a particular site.

No associated notes

57

Recommended Approach for Developing PRGs

- Identify PRGs at scoping
- Modify them as needed at the end of the Remedial Investigation (RI) or during the Feasibility Study (FS) based on site-specific information from the baseline risk assessment, and
- Ultimately select remediation levels in the Record of Decision (ROD)

PRGs are identified early in the CERCLA process. PRGs are modified as needed at the end of the Remedial Investigation (RI) or during the Feasibility Study (FS) based on site-specific information from the baseline risk assessment. Ultimately the remediation levels are selected through the use of the 9 NCP remedy selection criteria. The 9 NCP criteria are:

Threshold - the two most important criteria that must be satisfied by any alternative in order to be eligible for selection

1. Overall protection of human health and the environment
2. Compliance with applicable or relevant and appropriate requirements

Primary Balancing Criteria - are used to identify major trade-offs between remedial alternatives

1. Long-term effectiveness and permanence
2. Reduction of toxicity, mobility, or volume through treatment
3. Short-term effectiveness
4. Implementability
5. Cost

Modifying Criteria

1. State acceptance
2. Community acceptance

The NCP describes how the detailed analysis of alternatives is to be performed using these 9 criteria (see 55 FR 8719 to 8723, March 8, 1990).

EPA's requirements and policies for selecting remedies during D&D type activities at radioactively contaminated CERCLA sites is discussed in Chapter 3 of the ITRC D&D document.

58

Buildings
– BPRG Calculator for Radionuclides

- Preliminary Remediation Goals for Radionuclides in Buildings (BPRG) calculator
  - http://epa-bprg.ornl.gov/
- Establish 1 x 10^{-6} risk based PRGs
  - For inside radioactively contaminated buildings

This tool presents standardized risk-based PRGs and variable risk-based PRG calculation equations for radioactive contaminants. BPRGs are presented for settled dust and fixed 3-D external exposure for both residents and indoor workers. The risk-based PRGs for radionuclides are based on the carcinogenicity of the analytes. Non-carcinogenic effects are not considered for radionuclide analytes, except for uranium for which carcinogenic and non-carcinogenic effects are considered. To determine PRGs for the chemical toxicity of uranium, and for other chemicals, go to the following webpage:

http://epa-bprg.ornl.gov/documents/copc_benchmark.pdf

The standardized BPRGs are based on default exposure parameters and incorporate exposure factors that present RME conditions. This database tool presents BPRGs in both activity and mass units. Cancer slope factors used are from HEAST.

The Radionuclide BPRG calculator is part of a continuing effort by EPA's Office of Superfund Remediation and Technology Innovation (OSRTI) to provide updated guidance for addressing radioactively contaminated sites consistent with EPA's guidance for addressing chemically contaminated sites, except to account for the technical differences between radionuclides and chemicals.

59

Outside Surfaces – SPRG Calculator for Radionuclides

- Preliminary Remediation Goals for Radionuclides in Outside Surfaces (SPRG) calculator
  - http://epa-sprg.ornl.gov/
- Establish 1 x 10^{-6} risk based PRGs
  - For radioactively contaminated outside hard surfaces
  - For example, slabs, pavement, sidewalks, and sides off buildings

This tool presents standardized risk-based PRGs and variable risk-based PRG calculation equations for radioactive contaminants. SPRGs are presented for removable and fixed 3-D external exposure contamination for residents, indoor and outdoor workers. The risk-based PRGs for radionuclides are based on the carcinogenicity of the analytes. Non-carcinogenic effects are not considered for radionuclide analytes, except for uranium for which carcinogenic and non-carcinogenic effects are considered.

The standardized 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. Cancer slope factors used are from HEAST.

This Radionuclide SPRG calculator is part of a continuing effort by EPA's Office of Superfund Remediation and Technology Innovation (OSRTI) to provide updated guidance for addressing radioactively contaminated sites consistent with EPA's guidance for addressing chemically contaminated sites, except to account for the technical differences between radionuclides and chemicals.

60

BPRG and SPRG Calculators for Radionuclides

- Based on the carcinogenicity (risk-based) of the analytes
  - In general, only uranium is considered significant for non-carcinogenic toxicity
- Quantities expressed
  - In units of activity (e.g., pCi)
  - In addition to units of mass (e.g., mg) for volumetric contamination
- Does not address non-human health endpoints such as ecological impacts

At Superfund radiation sites, EPA generally evaluates potential human health risks based on the radiotoxicity, rather than on the chemical toxicity, of each radio-nuclide present. Uranium, in soluble form, is a kidney toxin at mass concentrations slightly above background levels, and is the only radionu-clide for which the chemical toxicity has been identified to be comparable to or greater than the radiotoxic-ity, and for which a refer-ence dose (RfD) has been established to evaluate chemical toxicity. For radioisotopes of uranium, both effects (radiogenic cancer risk and chemical toxicity) should be considered. To determine PRGs inside of buildings for the chemical toxicity of uranium, and for other chemicals, go to the following webpage:

http://epa-bprg.ornl.gov/documents/copc_benchmark.pdf

Typically units of decay rate (activity) instead of mass are used to quantify the concentration of radioactive material in soil because the carcinogenic risks of exposure to soils contaminated with radioactive materials are related more to the decay rate of the material than to its mass. The Radionuclide BPRG and SPRG calculators provide outputs in mass units also for volumetric contamination since mass provides insight and information into treatment selection, treatment compatibility, and treatment efficiency, particularly for remedial actions involving mixed waste. For more discussion of activity and mass units, see Appendix B to the Soil Screening Guidance for Radionuclides: Technical Background Document.

The EPA guidance “Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments” contains an eight step process for using benchmarks for ecological effects in the remedy selection process.

61

Calculating Radionuclide PRGs

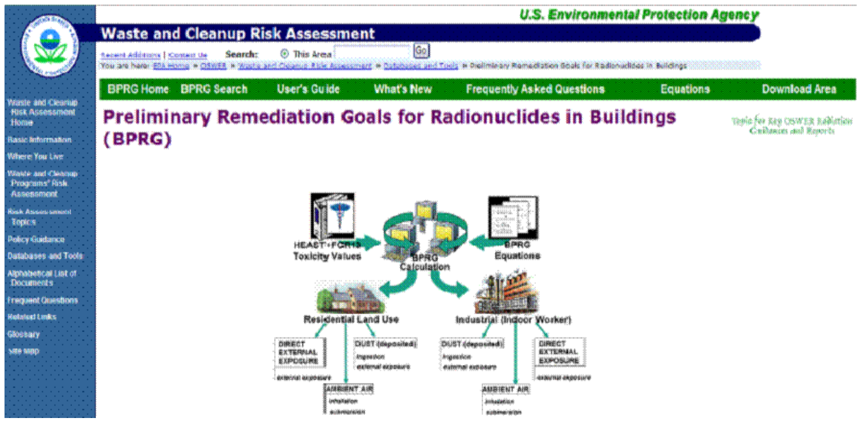
- These two calculation tools provide the ability to
  - Generate generic PRGs based on standard default exposure parameters
  - Modify the standard default exposure parameters to calculate site-specific PRGs
- In order to set PRGs in a site-specific context, we need
  - Information on the radionuclides that are present onsite
  - Specific contaminated media
  - Land-use assumptions
  - Assumptions behind pathways of individual exposure

The recommended approach for developing remediation goals is to identify PRGs at scoping, modify them as needed at the end of the RI or during the FS based on site-specific information form the baseline risk assessment, and ultimately select remediation levels in the ROD. In order to set radionuclide-specific PRGs in a site-specific context, however, assessors must 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 is necessary in order to develop radionuclide-specific PRGs.

These calculation tools provide the ability to modify the standard default BPRG and SPRG exposure parameters to calculate site-specific BPRGs and SPRGs. The online Users Guide for both calculators provides information on adjusting the default parameters in these calculators with site-specific information.

The BPRG and SPRG calculators establish PRG concentrations for each radionuclide, as if it were the only radionuclide present. Cancer risk from all radiological and non-radiological contaminants should be summed to provide risk estimates for persons exposed to both types of carcinogenic contaminants.

62 **Preliminary Remediation Goals for Radionuclides in Buildings (BPRG): Risk-based Calculation**



http://epa-bprg.ornl.gov/

BPRG Calculator ➔ the latest updated compilation of radiation risk assessment factors and methodology.

Does not include a food or groundwater pathway.

The next 10 slides will show how the calculator works

Following slides are in order presented in BPRG Calculator.

63

BPRG Rad Calculator –
Risk-Based BPRG Selection

1) Please select Building's PRGs and analytes you wish to search:

- ❑ Residential
- ❑ Commercial/Industrial: Indoor Worker

2) Please select desired units option:

- ❑ pCi/g
- ❑ Bq/g

Step 1, select one or more of the exposure scenarios for which you want to develop PRGs.

Step 2, select output units for activity in either picocuries per gram or bequerals per gram. Outputs for volumetric contamination will also be given in units of mass.

64

BPRG Rad Calculator – Risk-Based BPRG Selection

3) Radionuclides

- Ac-223
- Ac-224
- Ac-225
- Ac-226
- Ac-227
- Ac-227+D
- Ac-228
- Ag-102
- Ag-103
- Ag-104
- Ag-104m
- Ag-105
- Ag-106
- Ag-106m
- Ag-108
- Ag-108m
- Ag-109m

4)
- ❑ Get Default BPRGs
- ❑ Calculate Site-specific BPRGs

5) You must select one of the following output options:
- ❑ View on Screen
- ❑ Tab delimited file

Step 3, that allows for selection of radionuclide of concern, allows selection anywhere from Actinium to Zirconium, including the radioactive decay chain products (with suffix "+D") and metastable isotopes (with suffix "m")

First Order Decay

Selected radionuclides and radioactive decay chain products are designated with the suffix "+D" (e.g., U-238+D, Ra-226+D, Cs-137+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.

Assumes secular equilibrium with the parent radionuclide in the environment.

Decay chain ends @ 100 years

Step 4 – allows for selection of BPRGs using default parameters or using site-specific measurements. The calculations used to come up with BPRGs is shown in the following slides.

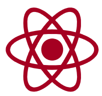
Step 5 is basically providing the output mode to show the calculated BPRGs.

65

Settled Dust BPRG Calculation

Total Risk from Settled Dust

= Risk from Direct Ingestion of radionuclides in dust
(SFo X intake from direct ingestion of dust)



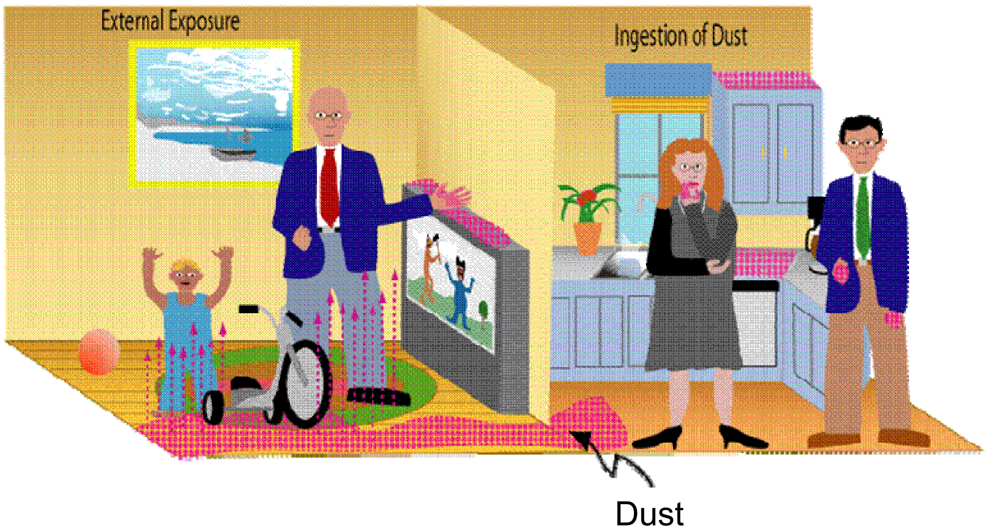
+ Risk from External Radiation from gamma-emitting of radionuclides in dust
(SFe X concentration of gamma-emitting radionuclides in dust)

The scenario specific calculations for BPRGs are built in the calculator and the following set of slides will show you some of the major scenario calculations of risk and BPRG. First, we are calculating scenario specific risk and then the relative BPRG. The risk calculated for the specific scenario is then plugged into the equation for BPRG.

What is built into the settled dust scenario – types of exposures added to make the residential settled dust total risk are shown on this slide.

66

Settled Dust – Residential Exposure Routes



This is a graphical representation of the routes of exposure in the BPRG settled dust exposure scenario.

67

Residential Settled Dust BPRG Equation

$$PRG_{d\text{-}total}=\frac{TR\times t_r\times\lambda}{F_{in}\times F_i\times\left(\frac{1-e^{-kt_r}}{kt_r}\right)\times\left(1-e^{-\lambda t_r}\right)\times\left[\left(SF_{d\text{-}oral}\times IF\times EF_r\right)+\left(SF_{d\text{-}ext}\times F_{AM}\times F_{OFF\text{-}SET}\times\left(\frac{1\ yr}{365\ d}\right)\times ET_r\times\left(\frac{1\ d}{24\ hr}\right)\times EF_r\times ED_r\right)\right]}$$

where

$$IF=\left\{\left[\left(FTSS_h\times ET_{h,c}\right)+\left(FTSS_s\times ET_{s,c}\right)\right]\times SE\times ED_c\times SA_c\times FQ_c\right\}+\left\{\left[\left(FTSS_h\times ET_{h,a}\right)+\left(FTSS_s\times ET_{s,a}\right)\right]\times SE\times ED_a\times SA_a\times FQ_a\right\}$$

Where:

TR - target risk level (unitless)

t - time/duration over which the radionuclide decays (years)

Lambda (λ) - defined as 0.693/radionuclide half life

ED - exposure duration (years)

The calculation for specific BPRG -- i.e. concentrations of soil based on specific target risk, exposure duration and total risk from soil – is shown in this slide. The numerator is the unitless target risk that factors in the duration (in years) and radionuclide half-life, both for accommodating the fate and decay of radionuclides over time. The denominator is the Total Risk, calculated for scenarios shown in the last slide, adjusted for exposure duration.

The Total Risk calculations show the input parameters for the two the sub-scenarios for residential settled dust: 1)incidental ingestion of dust, and 2) external radiation.

68

BPRG Settled Dust Parameters That May be Modified

- TR – target excess individual lifetime cancer risk (unitless)
- ED – exposure duration (yr)
- t – duration of radionuclide decay (yr)
- IF - age-adjusted dust ingestion factor (cm^2-yr/day)
- EF - exposure frequency (days per 365 days) (unitless)
- ET – exposure time (hr/day)
- Fin - fraction of time the receptor spends indoors (unitless)

The previous equation for calculating BPRG can use the defaults for the various input parameters or one can put in site-specific values for the parameters shown in this and the next slide.

Users should note ED and t are generally equal to one another.

69

BPRG Settled Dust Parameters That May be Modified (continued)

- F_i – fraction of time the receptor spends in compartment (unitless)
- K – dissipation rate ($years^{-1}$)
- F_{AM} – area and material factor (unitless)
- $F_{OFF\text{-}SET}$ – off-set factor (unitless)
- FTSS – fraction transferred from surfaces to skin (unitless)
- SE – saliva extraction factor (unitless)
- SA – surface area of fingers (cm^2)
- FQ – frequency of hand to mouth (events/hour)

Additional examples of input parameters where either the defaults or site-specific values may be used.

Ambient Air BPRG Calculation

Total Risk from Ambient Air

= **Risk from Inhalation of radionuclides in air**
(SFi X inhalation of volatiles and suspended particulates)

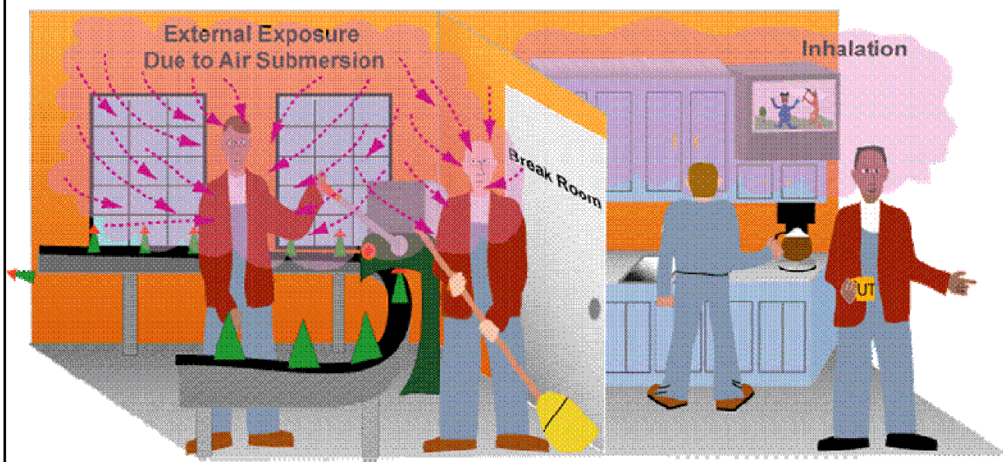
+ **Risk from External Radiation from gamma-emitting of radionuclides in air**
(SFe X concentration of gamma-emitting radionuclides in air)

Similar to the settled dust scenario, the total risk from ambient air exposures are shown on this slide. The total ambient air risk adds up risk of the residents from inhaling radionuclides in the air and the external exposure from those same airborne radionuclides.

For SF, we start using unit risk for inhalation, in chemical risk but for rad risk, we will still continue to use slope factors.

71

Ambient Air – Indoor Worker Exposure Routes



This is a graphical representation of the routes of exposure in the BPRG ambient air exposure scenario.

72

Residential Ambient Air BPRG Equation:

$$PRG_{a\text{-}total} = \frac{TR \times t_r \times \lambda}{ET_r \times \left(\frac{1\ d}{24\ hr}\right) \times EF_r \times ED_r \times F_{in} \times F_i \times (1 - e^{-\lambda t_r}) \times \left[\left(SF_i \times IR_{ir}\right) + \left(SF_{sub} \times \left(\frac{1\ yr}{365\ d}\right) \times GSF\right)\right]}$$

where:

$$IR_{ir} = \frac{ED_c \times IRA_c + ED_a \times IRA_a}{ED_r}$$

- Additional Parameters that may be modified
  - GSF – gamma shielding factor (unitless)
  - IR – inhalation rate (m^3/day)

Again, similar to the settled dust scenario, this slide shows the calculation of BPRG or concentration of air relative to the total risk calculated for the ambient air scenario. The ambient air risk includes inhalation and external exposures.

73

3-D Direct External Exposure BPRG Calculation

Total risk from 3-D Direct External Exposure

= Risk from external radiation from gamma-emitting radionuclides

(SFe X Concentration of gamma-emitting radionuclides in or on walls, ceiling, and floor)

The total risk from 3-D direct external exposure is calculated using the risk from direct external exposures from contamination in or on walls, ceilings, and floors. The Slope factors for calculation are specific to external.

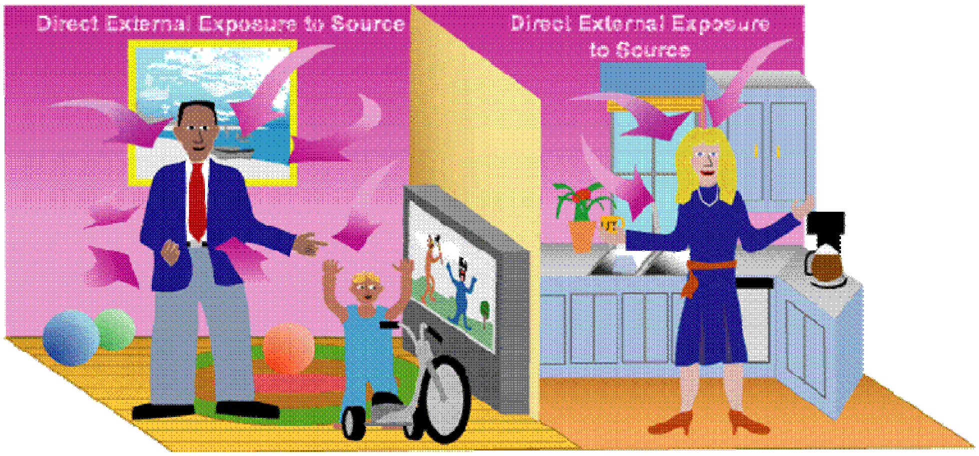
The external slope factors used are:

ground plane, for fixed contamination on the surface, and

soil volume, for fixed volumetric contamination.

74

3-D Direct External – Residential Routes of Exposure



This is a graphical representation of the routes of exposure in the BPRG 3-D direct external exposure scenario.

75

Residential 3-D Direct External Exposure BPRG Equation

$$PRG_{3\text{-}D\_material} = \frac{TR \times t_r \times \lambda}{SF_{ext} \times F_{in} \times F_i \times F_{AM} \times F_{OFF\text{-}SET} \times F_{SURF} \times EF_r \times ED_r \times \left(\frac{1\ yr}{365\ d}\right) \times GSF \times \left(1-e^{-\lambda t_r}\right) \times ET_r \times \left(\frac{1 d}{24\ hr}\right)}$$

- Additional Parameters that may be modified
  - Select room size – 5 room size choices (ft wall x ft wall x ft ceiling)
  - Select room position – 4 choices for location of receptor in room

Following the previous risk calculation, the BPRG for 3-D direct external exposure is calculated using the equation shown here.

In this scenario, one can select from a choice of:

5 room sizes

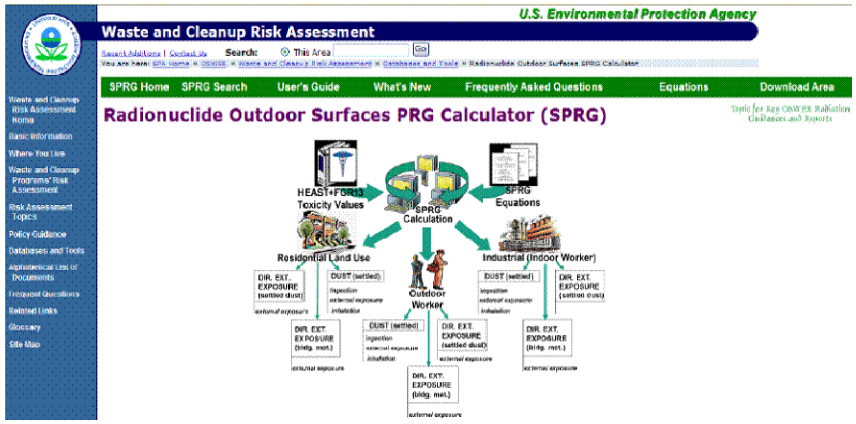
1. 10 x 10 x 10 feet (a square room with walls that are 10 feet wide with a 10 foot ceiling)
2. 50 x 50 x 10 feet
3. 100 x 100 x 10 feet
4. 200 x 200 x 20 feet, and
5. 400 x 400 x 40 feet

4 location of the receptor in the room

1. Averaged position
2. Center of the room
3. Center of the wall, and
4. Corner of two walls

Choosing a room size and a room position for the receptor automatically chooses a radionuclide-specific adjustment factor for modifying the external slope factor. The external slope factor assumes an infinite plane and does not account for the photonic energy of each radionuclide.

76 **Preliminary Remediation Goals for Radionuclides in Outside Surfaces (SPRG): Risk-based Calculation**



http://epa-sprg.ornl.gov/

SPRG Calculator ➔ the latest updated compilation of radiation risk assessment factors and methodology.

Does not include an air, food, or groundwater pathway.

The next 11 slides will show how the calculator works

Following slides are in order presented in SPRG Calculator.

77

SPRG Rad Calculator – Risk-Based SPRG Selection

1) Please select Surface's PRGs and analytes you wish to search:

- ❑ Residential
- ❑ Indoor Worker
- ❑ Outdoor Worker

2) Please select desired units option:

- ❑ pCi/g
- ❑ Bq/g

Step 1, select one or more of the exposure scenarios for which you want to develop SPRGs.

Step 2, select output units for activity in either picocuries per gram or bequerals per gram. Outputs will also be given in units of mass.

78

SPRG Rad Calculator – Risk-Based SPRG Selection

3) Radionuclides

Ac-223
Ac-224
Ac-225
Ac-226
Ac-227
Ac-227+D
Ac-228
Ag-102
Ag-103
Ag-104
Ag-104m
Ag-105
Ag-106
Ag-106m
Ag-108
Ag-108m
Ag-109m

4)

- ❑ Get Default SPRGs
- ❑ Calculate State-specific SPRGs
- ❑ Calculate Site-specific SPRGs

5) You must select one of the following output options:

- ❑ View on Screen
- ❑ Tab delimited file

Step 3, that allows for selection of radionuclide of concern, allows selection anywhere from Actinium to Zirconium, including the radioactive decay chain products (with suffix "+D") and metastable isotopes (with suffix "m")

First Order Decay

Selected radionuclides and radioactive decay chain products are designated with the suffix "+D" (e.g., U-238+D, Ra-226+D, Cs-137+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.

Assumes secular equilibrium with the parent radionuclide in the environment.

Decay chain ends @ 100 years

Step 4 – allows for selection of SPRGs using default parameters or using site-specific measurements. The calculations used to come up with SPRGs is shown in the following slides.

Step 5 is basically providing the output mode to show the calculated SPRGs.

79

Particulate Emission Factor – Wind Driven

(Needed for Contamination on Surfaces for Residential, Outdoor Worker, and/or Indoor Worker land uses)

$$PEF_w = Q/C \times \frac{3{,}600}{0.036 \times (1-V) \times (U_m/U_t)^3 \times F(x)}$$

where

$$\frac{Q}{C_w} = A \times \exp\left[\frac{(\ln A_s - B)^2}{C}\right]$$

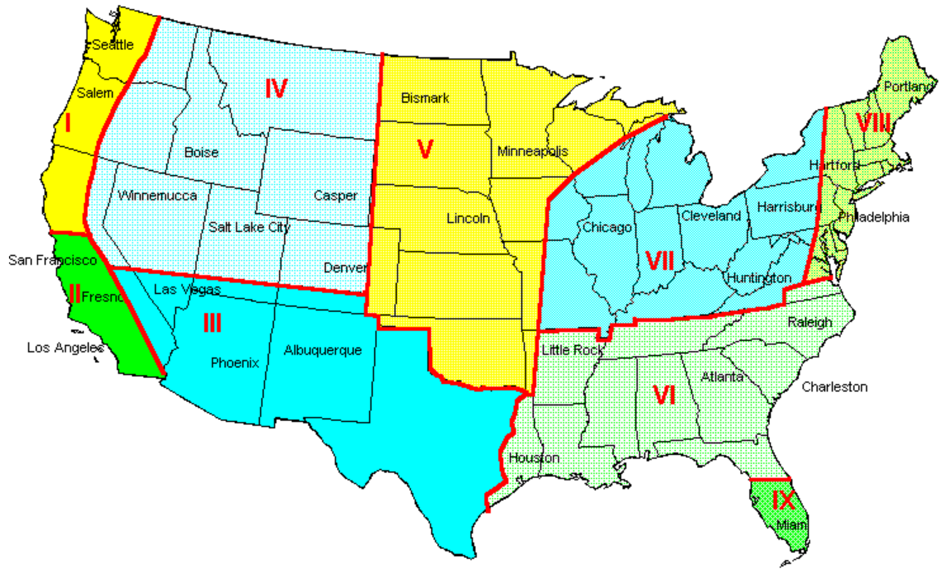
- ❑ City (Climatic Zone)
- ❑ A_s (acres)
- ❑ B (dispersion constant) unitless
- ❑ Q/C (inverse of the mean conc. at the center of a 0.5-acre-square source) g/m^2-s per k g/m^3
- ❑ V (fraction of vegetative cover) unitless
- ❑ U_m (mean annual windspeed) m/s
- ❑ U_t (equivalent threshold value of windspeed at 7 m) m/s
- ❑ F(x) (function dependent on U_m/U_t) unitless

If in Step 4, you choose to calculate SPRGs using state-specific or site-specific parameters, the first screen you will see when you go in site-specific is the calculation of windblown driven Particulate Emission Factor (PEF). PEF is required for calculations in the contamination on surfaces for residential, outdoor and indoor worker.

Wind driven PEF is dependent on the weather conditions in specific cities and the following map provides the climatic zone conditions for the US states/cities.

80

U.S. Climatic Zones for Calculating Particulate Emission Factor



No associated notes.

81

Particulate Emission Factor – Mechanically Driven

(Needed for Contamination on Surfaces for Residential, Outdoor Worker, and/or Indoor Worker land uses) This is equation for default for Paved Public Roads.

$$PEF_{m\text{-}p\text{-}default}\left(\frac{m^3}{kg}\right)=\frac{Q}{C_m}\left(\left(\frac{g}{m^2\text{-}s}\right)\Big/\left(\frac{kg}{m^3}\right)\right)\times\frac{1}{F_D}\times\frac{T\,(\text{seconds})\times A_R\,(m^2)}{\left[k\text{-}pp\left(\frac{4.6\text{ g}}{VKT}\right)\times\left(\frac{sL\left(\frac{0.015\text{ g}}{m^2}\right)}{2}\right)^{0.65}\times\left(\frac{W\,(3.2\text{ tons})}{3}\right)^{1.5}-C\left(\frac{0.1317\text{ g}}{VKT}\right)\right]\times\left[1-\frac{P\left(\frac{\text{rain rays}}{\text{year}}\right)}{4\times\left(\frac{365\text{ days}}{\text{year}}\right)}\right]\times\sum VKT}$$

where

$PEF_{m\text{-}p}$ = paved public road mechanical particulate emission factor $\left(\frac{m^3}{kg}\right)$

$A_R\,(m^2)=L_R\,(\text{length ft})\times W_R\,(\text{width ft})\times 0.092903\ m^2/ft^2$

F_D = dispersion correction factor $= 0.1852+\frac{5.3537}{t_c\,(\text{hours})}+\frac{-9.6318}{t_c^2\,(\text{hours})}$

$\frac{Q}{C_m}\left(\left(\frac{g}{m^2\text{-}s}\right)\Big/\left(\frac{kg}{m^3}\right)\right)=A\times\exp\left[\frac{(\ln A_s\,(\text{acres})-B)^2}{C}\right]$ where A, B and C are unitless dispersion constants

$sL\left(\frac{g}{m^2}\right)$ (road surface silt loading) = 0.015

W (tons) (mean vehicle weight) = 3.2

$L_S\,(\text{Km}) = L_R\,(\text{ft})\times 0.000304799\ \frac{km}{ft}$

$\sum VKT$ (sum of vehicle km traveled during ED) = 2,822,326 where $\sum VKT = \left(\frac{L_S\,(km)\times AKV\left(\frac{km}{yr}\right)\text{ based on California Urban Interstate}}{\text{Km based on California Urban Interstate}}\times ED\,(yr)\right)$

If in Step 4, you choose to calculate SPRGs using state-specific or site-specific parameters, the second screen you will see when you go in site-specific is the calculation of mechanically driven Particulate Emission Factor (PEF). PEF is required for calculations in the contamination on surfaces for residential, outdoor and indoor worker.

Mechanical PEF is dependent on the amount of traffic, vehicle weight, and vehicle speed.

The generic and state-specific options are for public paved roads. The equations for both of these can be found in sections 4.4.2.1.1 and 4.4.2.1.1 of the SPRG User Guide.

The site-specific mechanical PEF can be for three categories of roads:

1. Public paved roads (see 4.4.2.1.3 of the SPRG User Guide)
2. Unpaved public roads (see 4.4.2.2 of the SPRG User Guide)
3. Unpaved industrial roads (see 4.4.2.3 of the SPRG User Guide)

82

Particulate Emission Factor – Mechanically Driven (continued)

(Needed for Contamination on Surfaces for Residential, Outdoor Worker, and/or Indoor Worker land uses)

- ❑ Q/C (inverse of the mean conc. at the center of a 0.5-acre-square source) g/m^2-s per k g/m^3
- ❑ L_R (length of road segment) ft
- ❑ W_R (width of road segment) ft
- ❑ s (road surface silt content) %
- ❑ M_{dry} (road surface material moisture content under dry, uncontrolled conditions) %
- ❑ p (number of days per year with at least 0.01 inches of precipitation
- ❑ km/trip
- ❑ trips/day
- ❑ days/week
- ❑ weeks/yr

Unique Parameter for Dirt Roads

❑ Speed of Vehicle

No associated notes.

83

Particulate Emission Factor – Mechanically Driven (continued)

(Needed for Contamination on Surfaces for Residential, Outdoor Worker, and/or Indoor Worker land uses)

State-specific

- ❑ Select a state
- ❑ Select a geographic setting (urban or rural)
- ❑ Select a roadway class (6 choices)

or

Site-specific

- ❑ # of cars
- ❑ # of trucks
- ❑ Tons of cars
- ❑ Tons of trucks

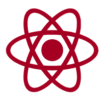
No associated notes.

84

Contamination on Surfaces SPRG Calculation

Total Risk from Contamination on Surfaces

= **Risk from Direct Ingestion of radionuclides in dust**
(SFo X intake from direct ingestion of dust)



\+ **Risk from External Radiation from gamma-emitting of radionuclides in dust**
(SFe X concentration of gamma-emitting radionuclides in dust)

\+ **Risk from Wind Blown Dust Inhalation**
(SFi X inhalation of volatiles and suspended particulates)

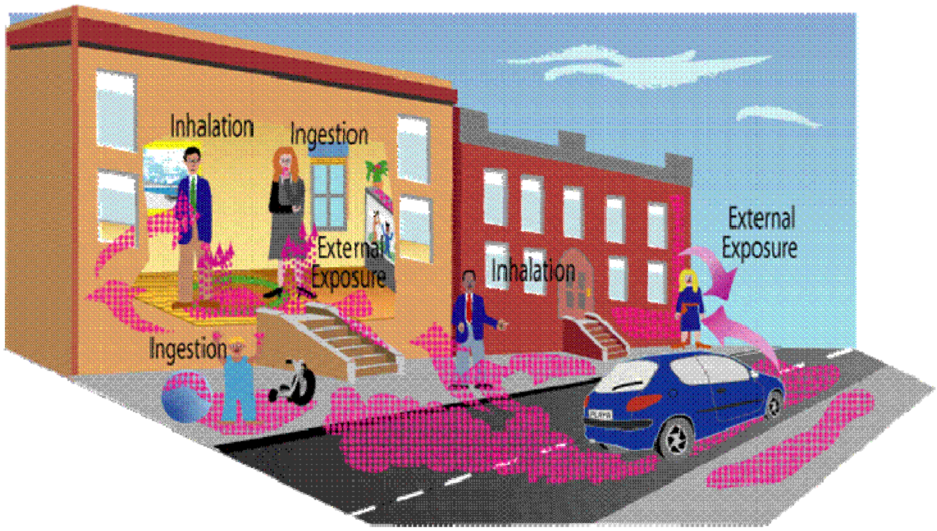
\+ **Risk from Mechanically Resuspended Dust Inhalation**
(SFi X inhalation of volatiles and suspended particulates)

The scenario specific calculations for SPRGs are built in the calculator and the following set of slides will show you some of the major scenario calculations of risk and SPRG. First, we are calculating scenario specific risk and then the relative SPRG. The risk calculated for the specific scenario is then plugged into the equation for SPRG.

What is built into the contamination on surfaces scenario – types of exposures added to make the contamination on surfaces total risk are shown on this slide.

85

Contamination on Surfaces – Residential Routes of Exposure



This is a graphical representation of the routes of exposure in the SPRG contamination on surfaces exposure scenario.

86

Residential Contamination on Surfaces SPRG Equation

$$PRG_{dr\text{-}total}\left(\frac{pCi}{cm^2}\right)=\frac{TR\times t_r\,(yrs)\times\lambda\left(\frac{1}{years}\right)}{\left(\frac{1-e^{-kt_r}}{kt_r}\right)\times\left(1-e^{-\lambda t_r}\right)\times EF_r\left(\frac{350\ d}{yr}\right)\times ED_r\,(30\ yr)\times\left[\begin{array}{l}\left(SF_{d\text{-}oral}\left(\frac{risk}{pCi}\right)\times IF_r\left(\frac{64.5\ cm^2}{d}\right)\right)+\\ \left(SF_{inh}\left(\frac{risk}{pCi}\right)\times HF_r\left(\frac{18\ m^3}{d}\right)\times\left(\frac{1\ d}{24\ hr}\right)\times\frac{1}{PEF\left(\frac{m^3}{Kg}\right)}\times SLF\left(\frac{6.6E+08\ cm^2}{Kg}\right)\times\left[ET_{o,r}\left(\frac{1.752\ hr}{d}\right)+ET_{i,r}\left(\frac{16.4\ hr}{d}\right)\times DF_i\,(0.4)\right]\right)+\\ \left(SF_{d\text{-}ext}\left[\frac{\left(risk/yr\right)}{\left(pCi/cm^2\right)}\right]\times F_{AM}\times F_{OFF\text{-}SET}\times ACF\,(1.0)\times\left(\frac{1\ d}{24\ hr}\right)\times\left[ET_{o,r}\left(\frac{1.752\ hr}{d}\right)\times GSF_o\,(1.0)+ET_{i,r}\left(\frac{16.4\ hr}{d}\right)\times GSF_i\,(0.4)\right]\times\left(\frac{1yr}{365d}\right)\right)\end{array}\right]}$$

where

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

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

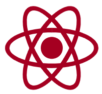
The calculation for specific SPRG -- i.e. concentrations of soil based on specific target risk, exposure duration and total risk from soil – is shown in this slide. The numerator is the unitless target risk that factors in the duration (in years) and radionuclide half-life, both for accommodating the fate and decay of radionuclides over time. The denominator is the Total Risk, calculated for the contamination on surfaces scenario, adjusted for exposure duration.

The Total Risk calculations show the input parameters for the four the sub-scenarios for contamination on surfaces: 1)incidental ingestion of soil, 2) external radiation, 3), inhalation of windblown dust, and 4) inhalation of mechanically resuspended dust .

87

3-D Direct External Exposure SPRG Calculation

Total Risk from 3-D Direct External Exposure



= **Risk from External Radiation from gamma-emitting of radionuclides in dust**

(SFe X concentration of gamma-emitting radionuclides in dust)

The scenario specific calculations for SPRGs are built in the calculator and the following set of slides will show you some of the major scenario calculations of risk and SPRG. First, we are calculating scenario specific risk and then the relative SPRG. The risk calculated for the specific scenario is then plugged into the equation for SPRG.

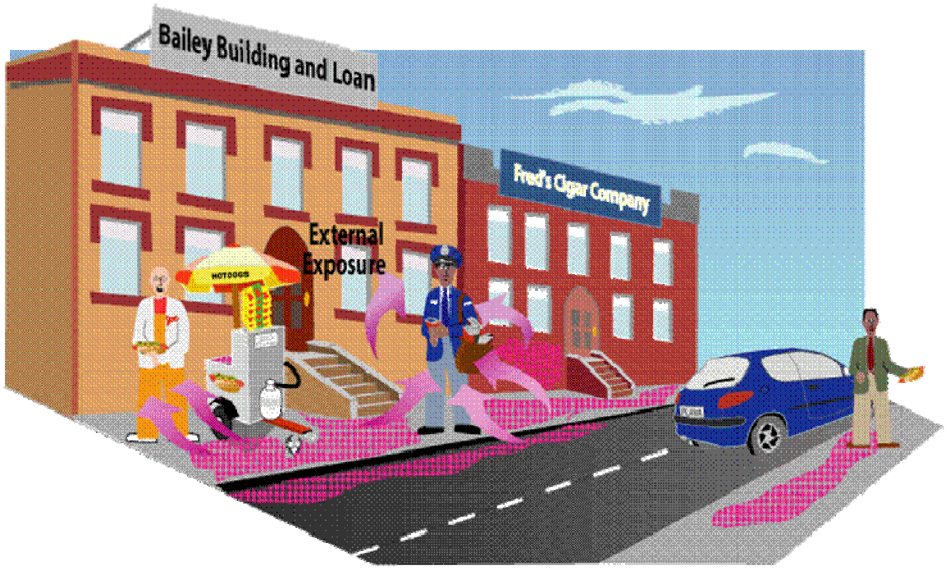
What is built into the 3-D direct external exposure scenario – types of exposures added to make the 3-D direct external exposure total risk are shown on this slide.

The external slope factors used are:

1. ground plane, for fixed contamination on the surface,
2. 1 cm, for fixed contamination extending only 1 centimeter,
3. 5 cm, for fixed contamination extending only 5 centimeters,
4. 15 cm, for fixed contamination extending only 15 centimeters, and
5. soil volume, for fixed volumetric contamination of more than 15 centimeters.

88

3-D Direct External Exposure – Worker Routes of Exposure



This is a graphical representation of the routes of exposure in the SPRG 3-D direct external exposure scenario.

89

Residential 3-D Direct External Exposure SPRG Equation

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

- Unique Parameters that may be modified
  - Select a building size – 5 building height choices (ft)
  - Select a sidewalk/street position – 3 choices for location of receptor on sidewalk or street

The calculation for specific SPRG -- i.e. concentrations of streets, sidewalks, and sides of buildings based on specific target risk, exposure duration and total risk from these outside hard surfaces – is shown in this slide. The numerator is the unitless target risk that factors in the duration (in years) and radionuclide half-life, both for accommodating the fate and decay of radionuclides over time. The denominator is the Total Risk, calculated for the 3-D direct external exposure scenario, adjusted for exposure duration.

The Total Risk calculations show the input parameters for the sub-scenario for residential 3-D direct external exposure of external radiation.

In this scenario, one can select from a choice of:

1. 5 building heights (12.5 feet, 30 feet, 59 feet, 150 feet and 200 feet), and
2. 3 locations of the receptor in the sidewalk or street (near the building wall, middle of the sidewalk, and middle of the street)

Choosing a building size and a sidewalk or street position for the receptor automatically chooses a radionuclide-specific adjustment factor for modifying the external slope factor. The external slope factor assumes an infinite plane and does not account for the photonic energy of each radionuclide.

90

2-D Direct External Exposure SPRG Calculation

Total Risk from 2-D Direct External Exposure

= **Risk from External Radiation from gamma-emitting of radionuclides in dust**

(SFe X concentration of gamma-emitting radionuclides in dust)

The scenario specific calculations for SPRGs are built in the calculator and the following set of slides will show you some of the major scenario calculations of risk and SPRG. First, we are calculating scenario specific risk and then the relative SPRG. The risk calculated for the specific scenario is then plugged into the equation for SPRG.

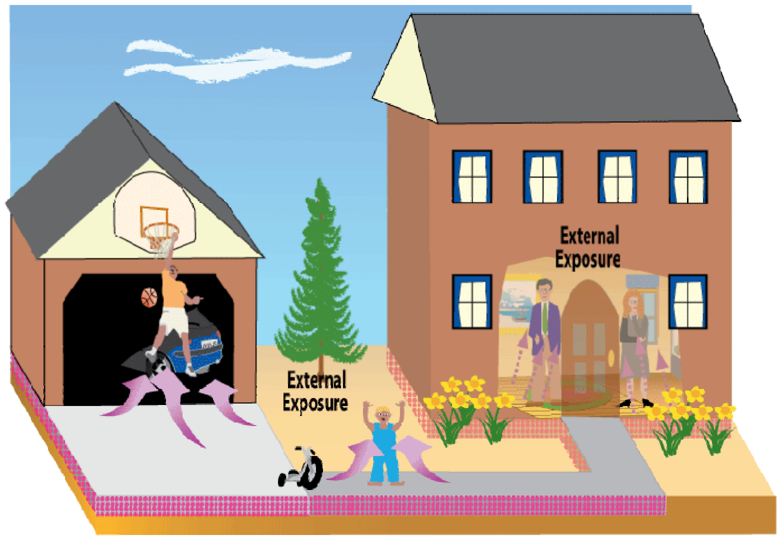
What is built into the 2-D direct external exposure scenario – types of exposures added to make the 2-D direct external exposure total risk are shown on this slide.

The external slope factors used are:

1. ground plane, for fixed contamination on the surface,
2. 1 cm, for fixed contamination extending only 1 centimeter,
3. 5 cm, for fixed contamination extending only 5 centimeters,
4. 15 cm, for fixed contamination extending only 15 centimeters, and
5. soil volume, for fixed volumetric contamination of more than 15 centimeters.

91

2-D Direct External Exposure – Indoor Worker Routes of Exposure



This is a graphical representation of the routes of exposure in the SPRG 2-D direct external exposure scenario.

92

Residential 2-D Direct External Exposure SPRG Equation

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

- Unique Parameters that may be modified:
  - Select a slab size – 8 slab size choices (square meters)

The calculation for specific SPRG -- i.e. concentrations of building foundation slabs based on specific target risk, exposure duration and total risk from these outside hard surfaces – is shown in this slide. The numerator is the unitless target risk that factors in the duration (in years) and radionuclide half-life, both for accommodating the fate and decay of radionuclides over time. The denominator is the Total Risk, calculated for the 2-D direct external exposure scenario, adjusted for exposure duration.

The Total Risk calculations show the input parameters for the sub-scenario for residential 3-D direct external exposure of external radiation.

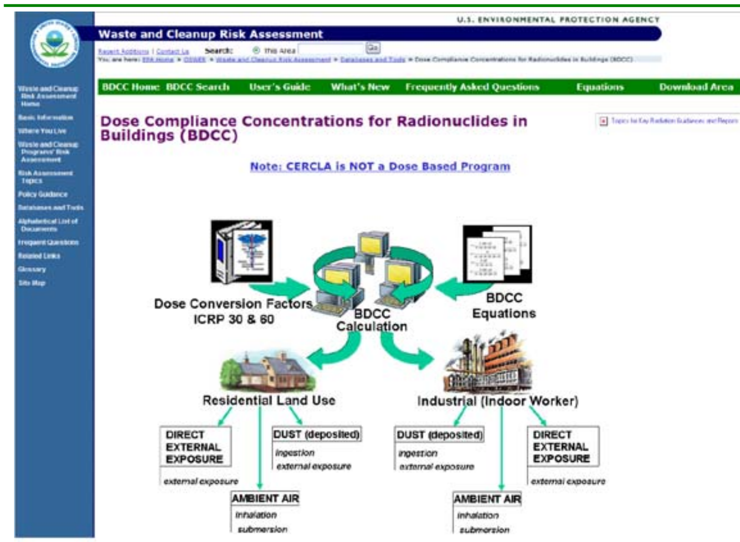
In this scenario, one can select from a choice of 8 slab sizes:

1. 10 square meters,
2. 50 square meters,
3. 100 square meters,
4. 500 square meters,
5. 1,000 square meters,
6. 2,000 square meters,
7. 5,000 square meters,
8. 10,000 square meters)

Choosing a slab size automatically chooses a radionuclide-specific adjustment factor for modifying the external slope factor. The external slope factor assumes an infinite plane and does not account for the photonic energy of each radionuclide.

93

Dose Compliance Concentrations for Radionuclides in Buildings (BDCCs)



http://epa-bdcc.ornl.gov/

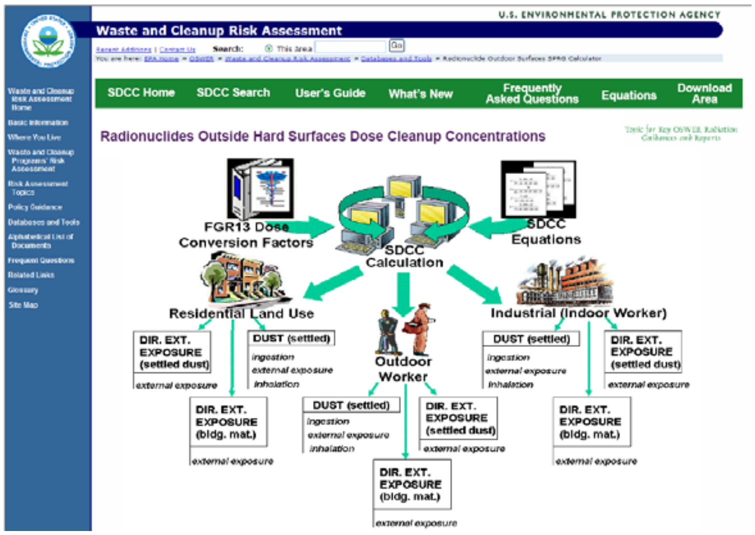
The purpose of this is to provide a radioactive building dose compliance concentrations (BDCC) calculation tool to assist risk assessors, remedial project managers, and others involved with risk assessment and decision-making at CERCLA sites in developing BDCCs. It is EPA's recommendation that dose assessments should only be conducted under CERCLA where necessary to demonstrate ARAR compliance. Further, dose recommendations in guidance should generally not be used as to-be-considered material. Also, EPA generally does not use ARARs greater than 15 mrem/yr to establish cleanup levels at CERCLA sites. Cleanup levels not based on an ARAR should be based on the carcinogenic risk range (generally 10^{-4} to 10^{-6}), with 10^{-6} as the point of departure and 1 x 10^{-6} used for PRGs.

For further information regarding EPA's policy to not establish CERCLA cleanup levels based on dose (mrem/yr) except to comply with ARARs, please see page 2 of December 17, 1999 memo to EPA Regions from Stephen D. Luftig, Director Office of Emergency and Remedial Response and Stephen D. Page Director Office of Radiation and Indoor Air entitled "Distribution of OSWER Radiation Risk Assessment Q & A's Final Guidance", which states:

> "Two issues addressed in this Risk Q & A should be noted here. First, the answer to question 32 in the Risk Q & A is intended to further clarify that 15 millirem per year is not a presumptive cleanup level under CERCLA, but rather site decision-makers should continue to use the risk range when ARARs are not used to set cleanup levels. There has been some confusion among stakeholders regarding this point because of language in the 1997 guidance. EPA is issuing further guidance today to site decision makers on this topic. This Risk Q&A clarifies that, in general, dose assessments should only be conducted under CERCLA where necessary to demonstrate ARAR compliance. Further, dose recommendations (e.g., guidance such as DOE Orders and NRC Regulatory Guides) should generally not be used as to-be-considered material (TBCs). [emphasis added] Although in other statutes EPA has used dose as a surrogate for risk, the selection of cleanup levels for carcinogens for a CERCLA remedy is based on the risk range when ARARs are not available or are not sufficiently protective. Thus, in general, site decision-makers should not use dose-based guidance rather than the CERCLA risk range in developing cleanup levels. This is because for several reasons, using dose-based guidance would result in unnecessary inconsistency regarding how radiological and non-radiological (chemical) contaminants are addressed at CERCLA sites [emphasis added]. These reasons include: (1) estimates of risk from a given dose estimate may vary by an order of magnitude or more for a particular radionuclide, and; (2) dose based guidance generally begins an analysis for determining a site-specific cleanup level at a minimally acceptable risk level rather than the 10^{-6} point of departure set out in the NCP."

94

Dose Compliance Concentrations for Radionuclides in Outside Surfaces (SDCCs)



http://epa-sdcc.ornl.gov/

The purpose of this is to provide a radioactive outside hard surfaces dose compliance concentrations (SDCC) calculation tool to assist risk assessors, remedial project managers, and others involved with risk assessment and decision-making at CERCLA sites in developing SDCCs. It is EPA's recommendation that dose assessments should only be conducted under CERCLA where necessary to demonstrate ARAR compliance. Further, dose recommendations in guidance should generally not be used as to-be-considered material. Also, EPA generally does not use ARARs greater than 15 mrem/yr to establish cleanup levels at CERCLA sites. Cleanup levels not based on an ARAR should be based on the carcinogenic risk range (generally 10^{-4} to 10^{-6}), with 10^{-6} as the point of departure and 1 x 10^{-6} used for PRGs.

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95

Variations between ARAR Dose Calculators and Risk Calculators

- ARAR Dose Calculator computes a Target Dose Limit using Dose Conversion Factors (DCFs) instead of Slope Factors (or sometimes inhalation unit risk in inhalation scenario)
  - Dose = (DCF) X (radionuclide concentration in air) X (breathing rate) X (exposure duration)
- ARAR Dose Calculator uses same basic equations for back-calculating a BPRG/SPRG from an ARAR dose limit
  - Dose limit = DCF X Concentration of Radionuclides in media (BPRG/SPRG) X Exposure
  - BPRG/SPRG = Dose limit/(DCF X Exposure)

An approach similar to that taken for calculation of BPRGs and SPRGs may also be used to calculate building and outside hard surfaces “compliance concentrations” based upon various methods of dose calculation. A set of simple equations for target dose rate (e.g., either critical organ dose or single limits), radionuclide dose conversion factor (DCF), and intake/exposure parameters will be presented for use in calculating soil cleanup concentrations. These equations will be identical to those in the BPRG and SPRG for Radionuclides, except that the target dose rate (ARAR based) will be substituted for the target cancer risk (1 x 10^{-6}), and a DCF will be used in place of the slope factor. Please note that the target dose rate is generally a cleanup level when a dose standard is an ARAR (other than single dose limits greater than 15 mrem/yr such as NRC’s 25/100 mrem/yr decommissioning rule), while the target risk number of 10^{-6} is a preliminary number.

Site decision-makers should choose the DCFs (ICRP 2, 30, or 60) required by the ARAR. Note that this calculator does not address ICRP 2. If DCFs are not specified within the regulation (for example, specifically required for compliance within the Code of Federal Regulations for a federal standard that is being complied with as an ARAR), then site decision-makers should generally use ICRP 2 DCFs for whole body and critical organ dose limits (e.g., 25/75/25 and 25/75 mrem/yr dose limits), and generally use ICRP 60 DCFs for single limit standards (e.g., 10 mrem/yr).

Decontamination and Decommissioning of Radiologically-Contaminated Facilities

MODULE 4:

Case Studies and Lessons Learned

No associated notes.

97

Module 4: Case Studies and Lessons Learned

- Fernald Environmental Management Project
- East Tennessee Technology Park
- Radium Chemical Company, Inc.

No associated notes.

98

Fernald Environmental Management Project, Ohio

- History
- Operations
- Challenges

No associated notes.

99

Fernald Environmental Management Project, Ohio
Consent Agreement and ROD

- Five operable areas
  - Four considered “source” areas
  - One “environmental media” area
- ROD allowed for on-site and off-site disposal

No associated notes.

100

Fernald Environmental Management Project, Ohio
Site-Specific Challenges

- Shutdown status
- Presence of inventoried wastes
- Nature of contaminants

No associated notes.

101

Fernald Environmental Management Project, Ohio
Lessons Learned

- Visual acceptance criteria
- Implosion
- Demolition practices
- Stormwater and waste water controls
- Dust and erosion controls

No associated notes.

102

Fernald Environmental Management Project, Ohio
End State

- October 2006 completion
- On-going groundwater remediation
- Perpetual surveillance and maintenance
- Wildlife habitats restored

No associated notes.

103

East Tennessee Technology Park, Tennessee

- ►History
- ►Operations
- ►Challenges

No associated notes.

104

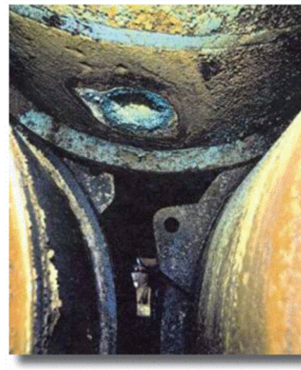
East Tennessee Technology Park, Tennessee

- ETTP Three-Building D&D and Recycle Project
  - Building K-29
  - Building K-31
  - Building K-33

No associated notes.

East Tennessee Technology Park, Tennessee
Site-Specific Challenges

- Shutdown status
- Presence of inventoried wastes
- Regulatory changes
- Nature of contaminants



No associated notes.

East Tennessee Technology Park, Tennessee

Lessons Learned

- Direct contract management for D&D, safety, security and project oversight
- Supercompaction Facility
- Waste management procedures
- Regulatory and policy changes from DOE
- Continuous presence of technical team
- Project scheduling

No associated notes.

East Tennessee Technology Park, Tennessee
End State

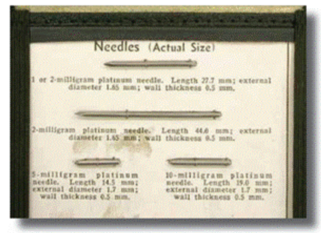
- "Reindustrialization" project
- Heritage Center
  - 125 buildings available for industrial tenants
- Horizon Center
  - 1,000-acre Greenfield site
- Plans to release to the public sector in 2010

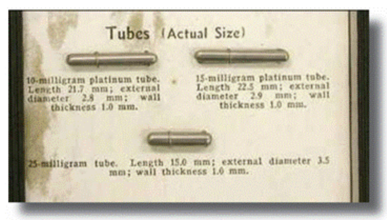
No associated notes.

108

Radium Chemical Company, Inc., New York

- History
- Operations
- Challenges





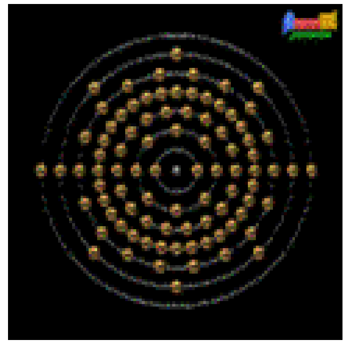
No associated notes.

109

Radium Chemical Co., NY

Site-Specific Challenges

- Sensitive receptors
- Quantity of material
- Nature of material



No associated notes.

110

Radium Chemical Co., NY
Immediate Actions

- Placed on National Priorities List
- US EPA mobilized for removal actions
  - Radioactive needles/tubes
  - Non-rad wastes, flammables, poisons, chemicals and rad-contaminated debris/tools
  - Elemental mercury

No associated notes.

111

Radium Chemical Company, Inc., NY
End State

- Deleted from NPL in 1995
- Disposal of multiple waste streams including
  - 812 tons rad contaminated soil and debris
  - 92 tons mixed wastes
  - 500 lbs of elemental mercury
  - 45 tons elemental lead
  - 20 tons structural steel
- Property released for unrestricted use after demolition complete

No associated notes.

112

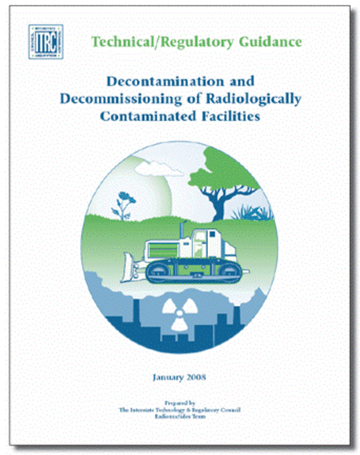
Case Study Lessons Learned

- Proper planning prevents poor performance
- Keep things real(time)
- Manage your waste
- Keep things safe

No associated notes.

Presentation Wrap Up

- Module 1: Introduction and Regulatory Basis for D&D
- Module 2: Factors for Implementing D&D
- Module 3: Preliminary Remediation Goal (PRG) Calculators
- Module 4: Case Studies and Lessons Learned



No associated notes.

114

Thank You for Participating

- 2nd question and answer break
- Links to additional resources
  - http://www.clu-in.org/conf/itrc/radsdd/resource.cfm
- Feedback form – *please* complete
  - http://www.clu-in.org/conf/itrc/radsdd/feedback.cfm

Need confirmation of your participation today?

Fill out the feedback form and check box for confirmation email.

Links to additional resources:
http://www.clu-in.org/conf/itrc/radsdd/resource.cfm

Your feedback is important – please fill out the form at:
http://www.clu-in.org/conf/itrc/radsdd/feedback.cfm

The benefits that ITRC offers to state regulators and technology developers, vendors, and consultants include:

✓Helping regulators build their knowledge base and raise their confidence about new environmental technologies

✓Helping regulators save time and money when evaluating environmental technologies

✓Guiding technology developers in the collection of performance data to satisfy the requirements of multiple states

✓Helping technology vendors avoid the time and expense of conducting duplicative and costly demonstrations

✓Providing a reliable network among members of the environmental community to focus on innovative environmental technologies

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✓Sponsor ITRC's technical team and other activities

✓Use ITRC products and attend training courses

✓Submit proposals for new technical teams and projects