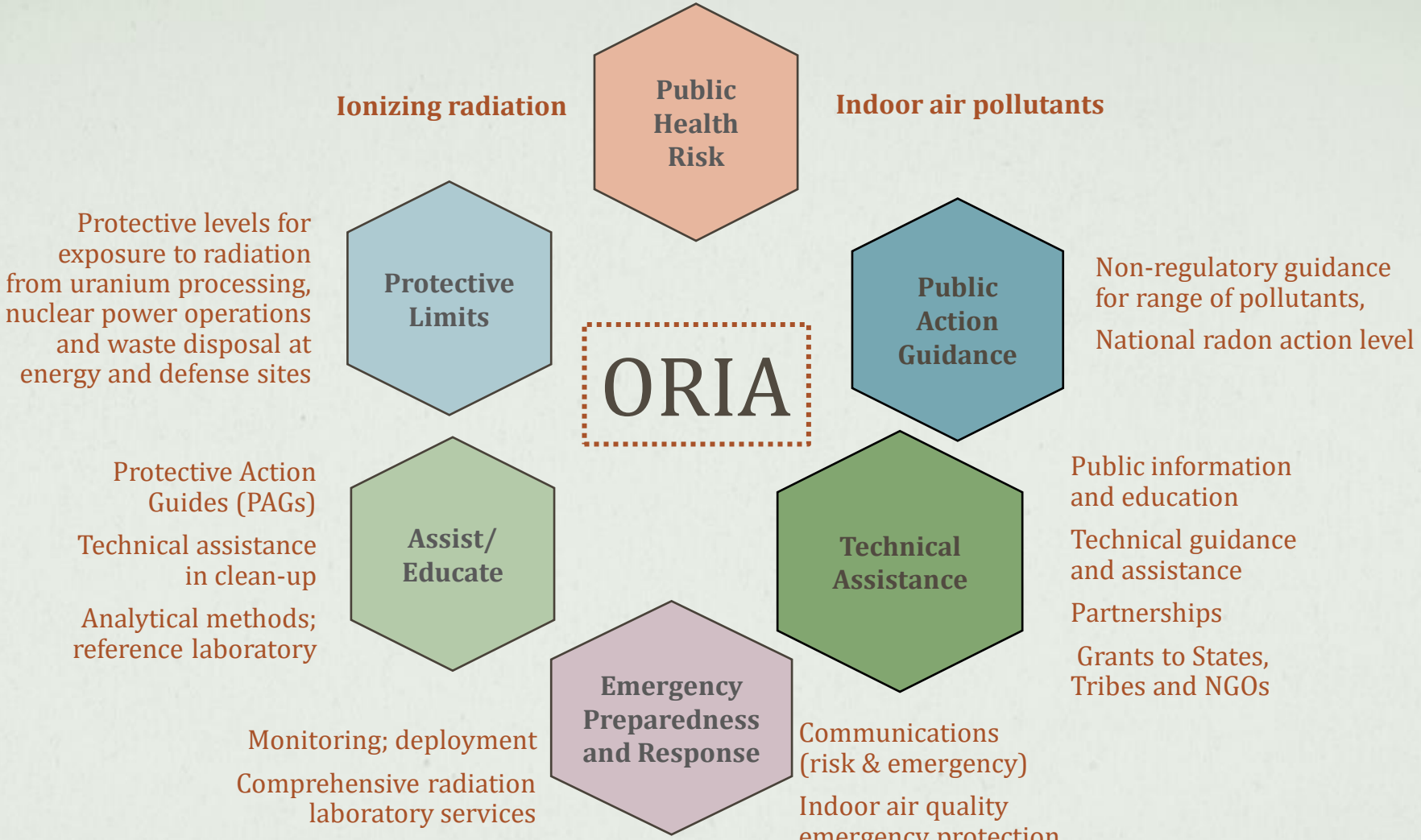
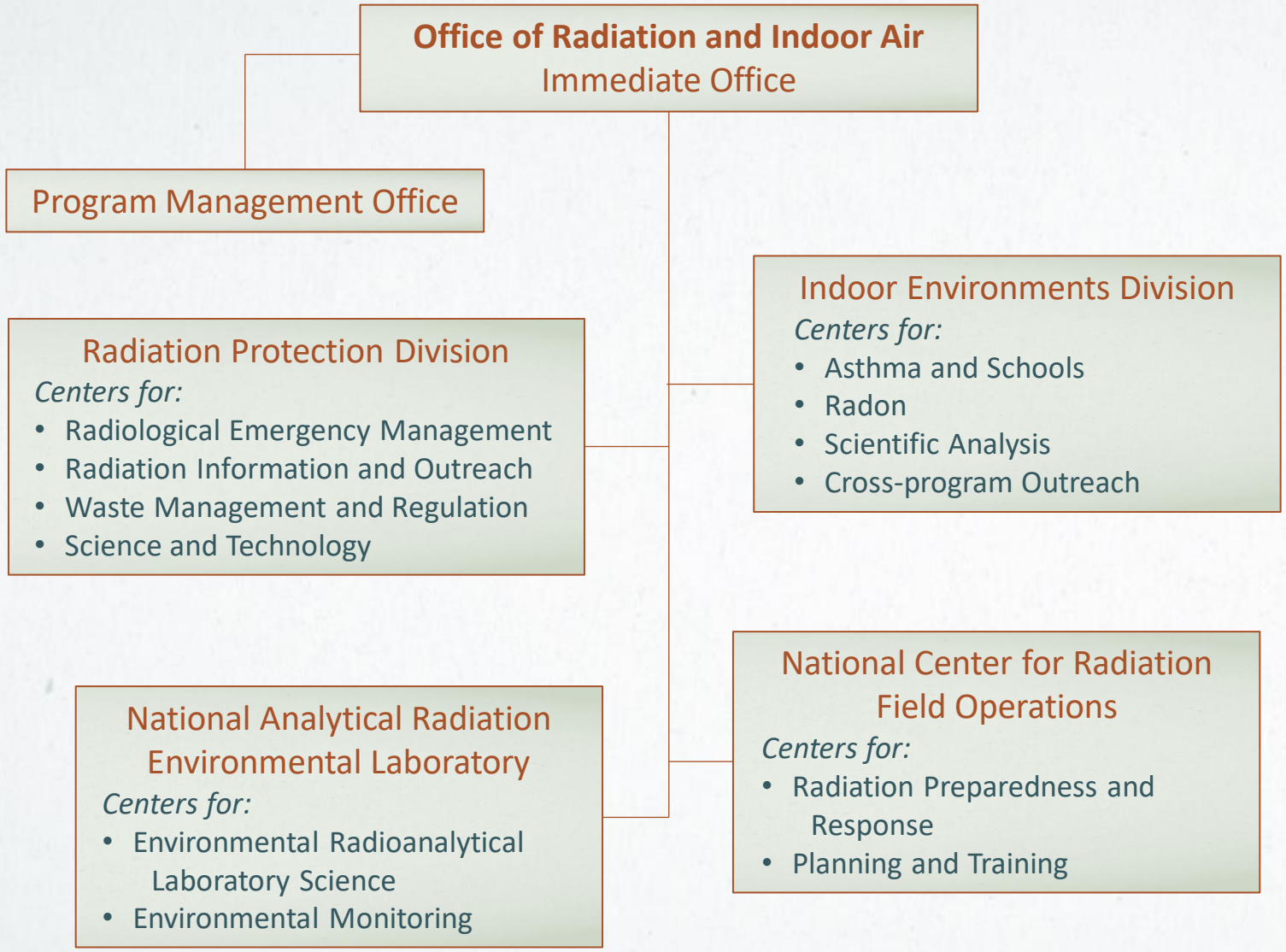
US EPA'S RADIATION EMERGENCY RESPONSE TEAM PROGRAM AND CAPABILITIES FOR RADIATION INCIDENTS

JON RICHARDS, US EPA REG4 RADIATION EXPERT, RERT MEMBER



OVERVIEW BRIEFING FOR THE ASSISTANT ADMINISTRATOR

OFFICE OF RADIATION & INDOOR AIR



MISSION

Protect the public and environment from radiation and indoor air pollution through technical assistance, guidance, outreach, and environmental standards.

WHAT WE DO

RADIATION PROTECTION PROGRAM

- Public Health Risk – ionizing radiation
- Protective Limits
  - Protective levels for exposure to radiation from uranium processing, nuclear power operations and waste disposal at energy and defense sites
- Assist/Educate
  - **Protective Action Guides (PAGs)**
  - Technical assistance in clean-up
  - Analytical methods; reference laboratory
- **Emergency Preparedness and Response**
  - **Communications (risk and emergency)**
  - **Monitoring; deployment**
  - **Comprehensive radiation laboratory services**
  - **Radiation dose assessment, scientific support for incident management**

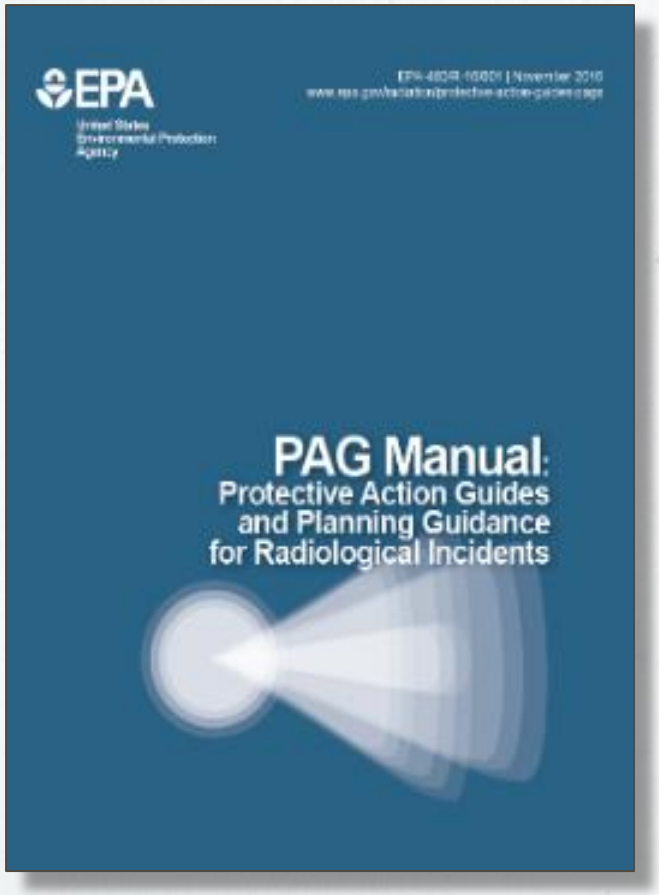
INDOOR AIR QUALITY (IAQ)

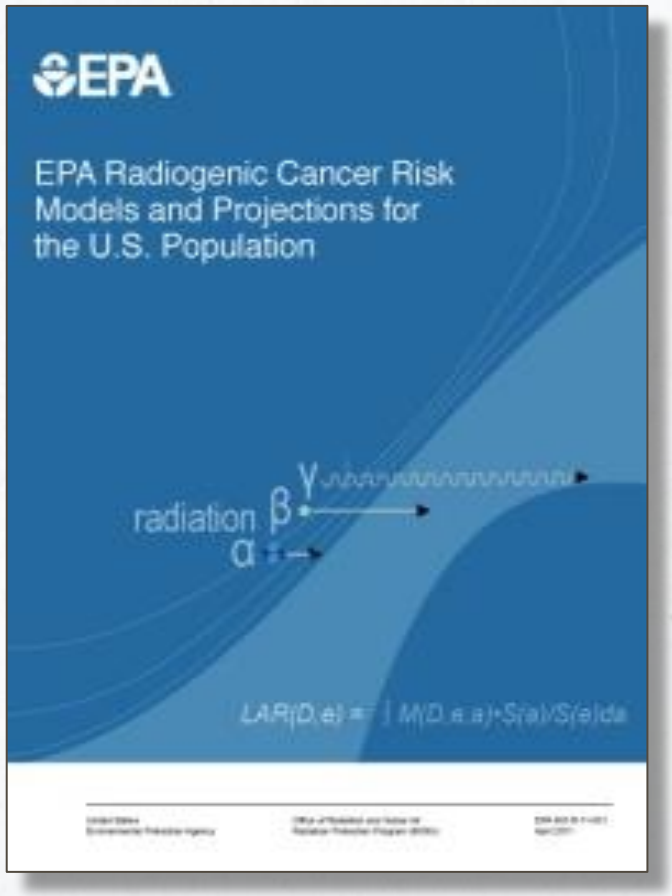
- Public Health Risk
  - Radon, asthma triggers, mold, second-hand smoke, VOCs, PM, other IAQ pollutants
- Public Action Guidance
  - Non-regulatory guidance for a range of IAQ pollutants/issues
  - Non-regulatory radon action level
- Technical Assistance
  - Promote healthy indoor air strategies, policies and interventions in homes/schools/commercial buildings through:
    - Technical guidance and tools
    - Partnerships
    - Grants to states, tribes and NGOs
    - Public information and education
    - Natural disaster preparedness and response

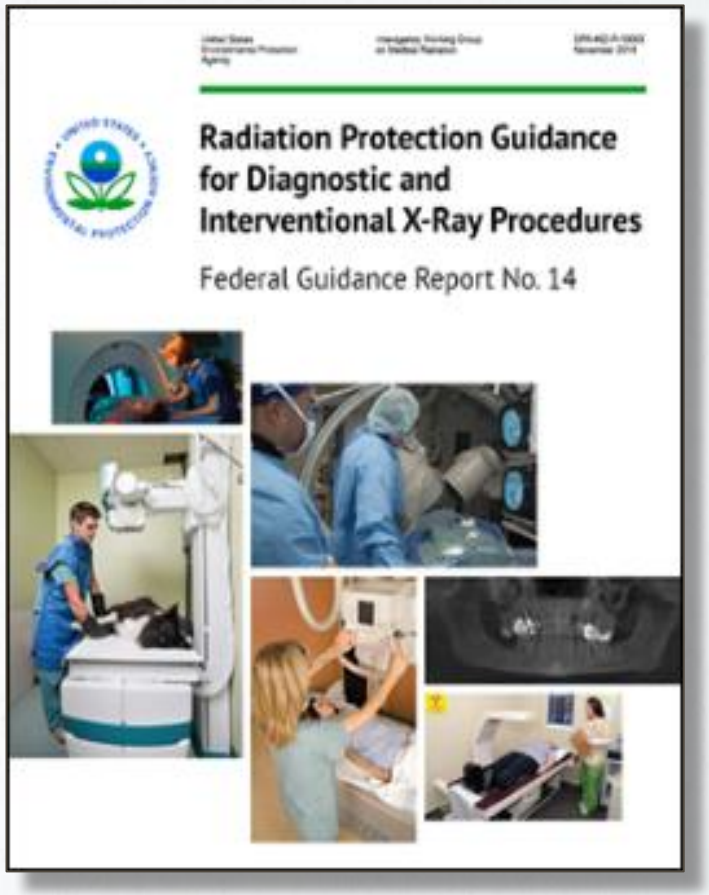
WHAT WE DO – RADIATION SCIENCE & EXPERTISE

- Develop federal guidance to help standardize radiation dose and risk assessment across federal and state agencies
- Set protective standards for radiation exposure based on quantitative risk assessment
- **Provide protective recommendations for all potentially significant exposure pathways in a radiation disaster; Protective Action Guides (PAGs)**
- Provide technical assistance in cleaning up sites contaminated with radioactive materials (e.g., Superfund, Brownfields sites)
- Provide WIPP Oversight

RADIATION SCIENCE & EXPERTISE – RESULTS







WHAT WE DO – FIELD OPERATIONS

- Coordinate and lead EPA radiological field operations
- **Serve key roles during response and recovery to radiological emergencies and incidents nationwide as the primary component of EPA's Radiological Emergency Response Team (RERT)**
- **Provide field and technical support to evaluate and assess sites contaminated with radioactive material**
- Develop and provide training on field radiological ER operations and other field techniques
- Operate the Tribal Air Monitoring Support (TAMS) Center to build tribal program capacity

FIELD OPERATIONS – RESULTS

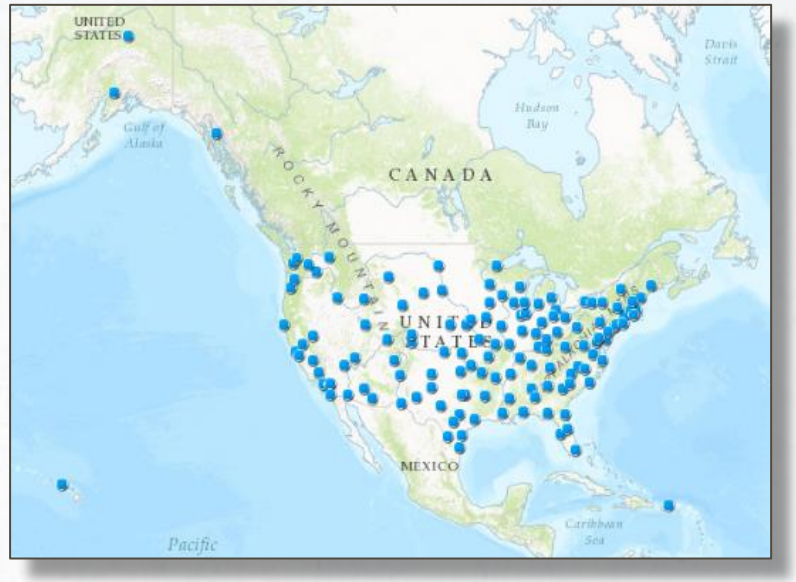
- **Training in radiation field activities for ER provided to states/partners**
- **Assistance to states in training for RDD response**
- Staff deployments to Puerto Rico and U.S. Virgin Islands to support non-radiation emergency response efforts
- Portable field scanning capability developed and placed into service
- Management and oversight of ORIA's radiological field assets
- Trained more than 1200 tribal environmental professionals
- Annually provide direct professional assistance and equipment loan services to tribes implementing air programs

RADIATION IS PART OF EPA'S ONLY PRIMARY MISSION ESSENTIAL FUNCTION

Prevent, limit, mitigate or contain chemical, oil, radiological, biological, and/or hazardous materials/agents during and in the aftermath of an accident and/or natural or man-made disaster in designated zones of the U.S. and provide environmental monitoring, assessment and reporting in support of overall domestic incident management.

WHAT WE DO – EMERGENCY PREPAREDNESS & RESPONSE

- Monitor and Assess
  - RadNet: real-time nationwide monitoring system
    - 139 fixed monitors; 40 deployable monitors
  - 1 Mobile Environmental Radiological Lab (MERL)
- Prepare and Respond
  - Train responders
  - Radiological Emergency Response Team (RERT)
  - **Member of federal advisory team** on site-specific recommendations during an actual emergency
  - Waste disposal following an incident
  - **Serve as members of the Federal Radiological Monitoring Assessment Center (FRMAC)**



EMERGENCY PREPAREDNESS & RESPONSE – RESULTS

- About 100 people are ready to respond to a radiological incident (25 NAREL, 20 NCRFO, 20 regional staff, and 30 HQ staff)
- RadNet typically maintains an operational level near 90% or better across the 139 monitor system (well above the defined 80% floor for RadNet system effectiveness)
- RadNet data is available during an emergency in 8 hours (performance measure)

RADNET IN ACTION

Air Monitors Capture Fukushima Nuclear Incident – 2011

- Additional field air monitors deployed to Hawaii, Alaska, Guam and Saipan
- Sample radiation detected well below levels of public health concern
- Public data stream of 606 monitoring samples from milk*, drinking water, precipitation

Socrata

Sorted RadNet Laboratory Analysis

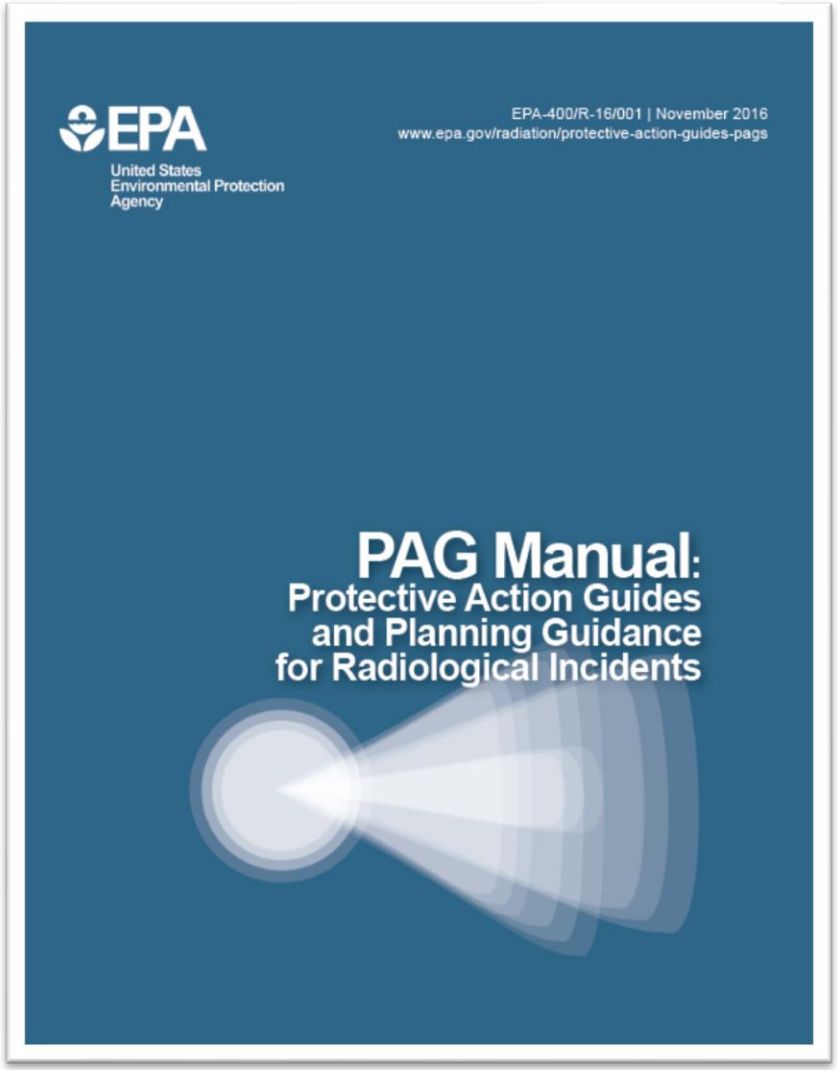
	State	Location	Date Posted	Date Collected	Sample Type			
586	WA	Olympia	05/03/2011	04/18/2011	Precipitation			
587	WA	Olympia	04/25/2011	04/14/2011	Precipitation			
588	WA	Olympia	04/15/2011	04/07/2011	Precipitation			
589	WA	Olympia	04/13/2011	04/04/2011	Precipitation			
590	WA	Olympia	04/13/2011	03/29/2011	Precipitation			
591	WA	Olympia	04/13/2011	03/31/2011	Precipitation			
592	WA	Olympia	04/04/2011	03/24/2011	Precipitation	pCi/l	Non-detect	Non-de

*Milk samples no longer collected

PROTECTION ACTIONS

What is a Protective Action Guide (PAG)?

- A dose guideline that triggers public safety measures
  - Based on avoiding additional dose for a given situation
  - Examples include evacuation, sheltering-in-place, food embargo, alternative water, and relocation
- Non-regulatory guidance
- Functionally equivalent to IAEA's Operational Intervention Levels (OILs)

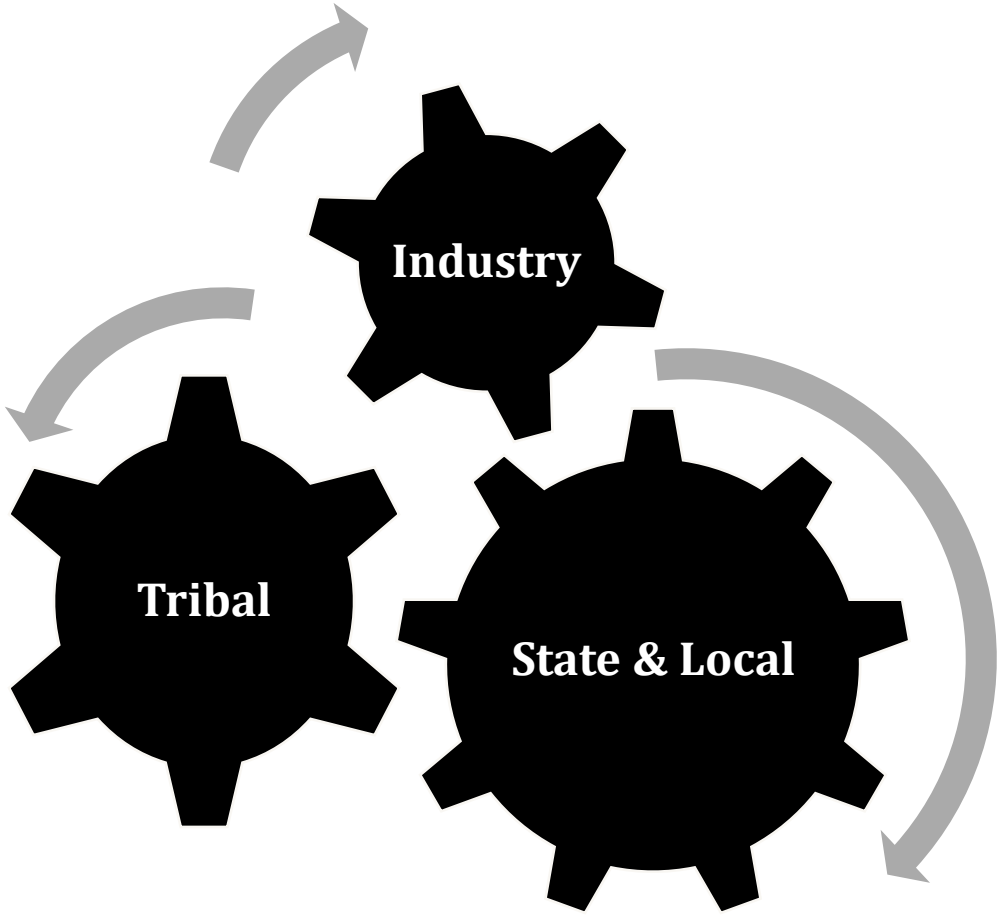


https://www.epa.gov/radiation/protective-action-guides-

PROTECTIVE ACTIONS

Who Uses PAGs?

- Developed by EPA, in consultation with other Federal partners
- Implemented by
  - Local emergency response officials
  - State and territorial radiation and emergency management groups
  - Tribal governments
  - Industry



PROTECTIVE ACTIONS

Why PAGs?

- Nuclear Power Plant Incidents
  - Three Mile Island (1979)
  - Chernobyl (1986)
  - Fukushima (2011)
- Terrorism
  - Radiological Dispersal Device (RDD), also known as “dirty bomb”
- Improvised Nuclear Device (IND)
  - Release from a contaminated site
  - Nuclear weapon
  - Waste management

PROTECTIVE ACTIONS

PAGs for Different Stages of a Response

1. **Early Phase**
2. **Intermediate Phase**
3. **Late Phase**

PROTECTIVE ACTIONS

PAGs for Early Phase

- Implement PAGs immediately following an incident
- This phase may last from hours to days
- PAG decision examples:
  - Evacuation/shelter: 10 – 50 mSv
  - Supplementary protective action: 50 mSv child thyroid dose
  - Emergency worker exposure limits: 50, 100, 250+ mSv

Units: in the U.S. we mostly use rem. 1 rem = 1 mSv

PROTECTIVE ACTIONS

PAGs for Intermediate Phase

- Starts after source and release brought under control
- This phase may last from weeks to months
- PAG decision examples:
  - Relocate population
    - ≥ 20mSv projected dose in the first year; 5 mSv/year projected in subsequent years
  - Food interdiction
    - Most limiting of 5 mSv whole body or 50 mSv to most exposed organ or tissue
  - Drinking water: Two level approach
    - 1 mSv projected annual dose for sensitive populations (children and pregnant/nursing women)
    - 5 mSv projected annual dose for general population

PROTECTIVE ACTIONS

Why is there a need for a PAG when there are regulations for drinking water?

- Lifetime Protection
  - In the U.S. we set Maximum Contaminant Levels (MCL) for contaminants in drinking water, including radioactive materials, based on lifetime exposure criteria, which are tested for on a regular basis.
- Emergency Conditions
  - The PAGs provide a numerical threshold to use during an emergency, over which protective actions should be taken
    - Prioritize potentially scarce water resources for those at most risk
    - Return to compliance with regulatory levels as soon as practical

PROTECTIVE ACTIONS

Practical Considerations for Drinking Water Protection

- Options available to local jurisdictions for providing an alternate source of drinking water may include:
  - Bottled water
  - Altering the source water (such as switching from surface water to ground water)
  - Interconnection between systems
  - Combination of all of these actions
- Radioactive material concentrations present in a water supply decline at rates determined by the half-lives of individual nuclides
- Concentration may decline by dilution with uncontaminated water or increase with rainfall due to surface water runoff

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PROTECTIVE ACTIONS

PAGs for the Late Phase: Cleanup

- Begins when strategic focus shifts to reducing longer-term exposure and improving living conditions
  - Additional planning time for stakeholder involvement
- Response may extend from months to years
- Cleanup process should be based on the societal objectives for expected land use
- Numeric PAG levels are not applicable for long-term cleanup
- Community members should be included in long-term cleanup discussions

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PROTECTIVE ACTIONS

Late Phase: Waste Management

- Waste may overwhelm existing radioactive waste disposal capacity in the U.S.
- Primary responsibility for waste management decisions falls to state, local, tribal and territorial officials.
- Safely managing and disposing of radioactive waste will require advance planning at all levels of government and careful coordination with stakeholders at all stages of the decision-making process.

DECONTAMINATION AND CLEAN-UP OPERATIONS

Emergency Support Function 10 – Oil and Hazardous Materials

- EPA is the federal go-to agency for clean up of large scale releases on land of oil and/or hazardous substances, pollutants or contaminants
- US environmental protection laws allow regulatory authority and resources to be used in emergencies that require clean-up of contaminated homes, buildings, landscapes and other materials
- ESF-10 is an emergency phase capacity EPA uses to respond with resources it already has for cleaning up releases of the materials it regulates.
  - Useful for emergencies involving public exposure

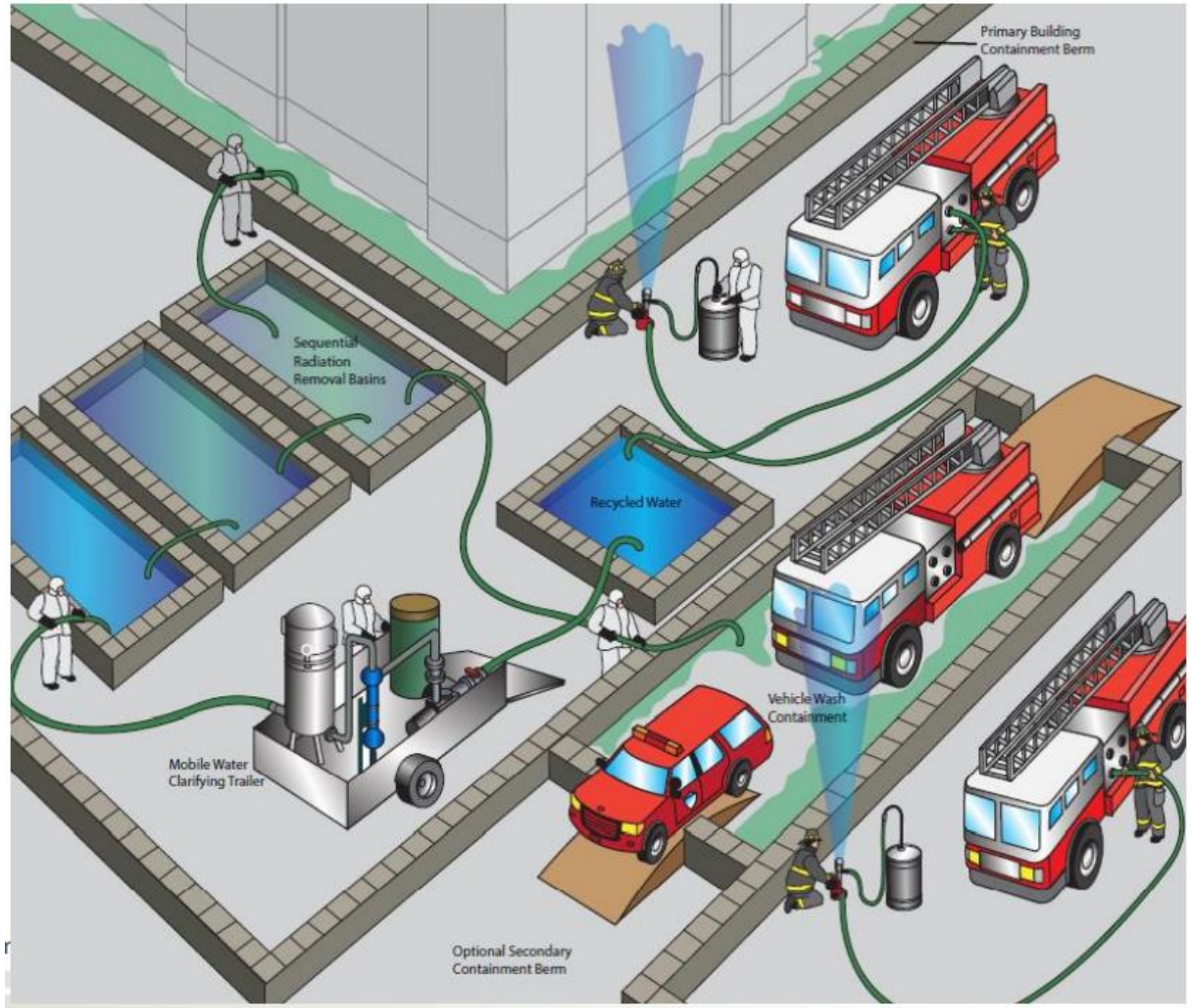
THE AFFECTED LOCATION

Removal of contaminated materials

- The area affected by a successful RDD detonation will almost certainly need to be decontaminated
  - Physical removal methods
  - Low levels of contamination
  - Disposal concerns
- The majority of the removed material will be only slightly contaminated and can be disposed of in local landfills that are authorized to accept hazardous wastes
  - Public acceptance
  - Mixed wastes
  - Liquids

HANDLING THE CONTAMINATED WASTE

Washing and water



Decontaminating the surfaces of an urban location will require large volumes of water that must be collected:

- Collection systems
- Bladders or tanks
- Treatment and storage
- Transportation

Irreversible Wash-Aid, Treatment, and Emergency Reuse System (IWATERS): Ad-Hoc Systems for On-site Treatment of CBRN Contaminants from Wash Waters

DOSE MANAGEMENT AND PPE

Keeping workers safe

- All response personnel must be able to work as safely as possible during the response.
- Personal protective equipment and dose measurement devices
  - Real-time dosimetry / EPDs
  - Level C PPE if no airborne contaminants
  - Level B (supplied air) if airborne hazards exist
- EPA limits most of its workers to 500 millirems (5 milliSieverts) per year
  - Higher levels can be authorized
- Must also consider other hazards that might be present: materials, moving vehicles, security concerns

WHEN ARE WE DONE?

Not obvious

- Possible definitions of success:
  - “Indistinguishable from background”
  - Some fraction of an acceptable limit (4 mrem, 15 mrem, 100 mrem, ...)
  - Value chosen or defined by the affected groups (stakeholders) or by the gov’t
- EPA sites have been cleaned to many different targets, often concentration levels (i.e., < 5 pCi/gm in top 6 inches of soil)
- Clean-up goals are sometimes chosen below naturally occuring levels or below the hazard from other radioactive materials that are present.

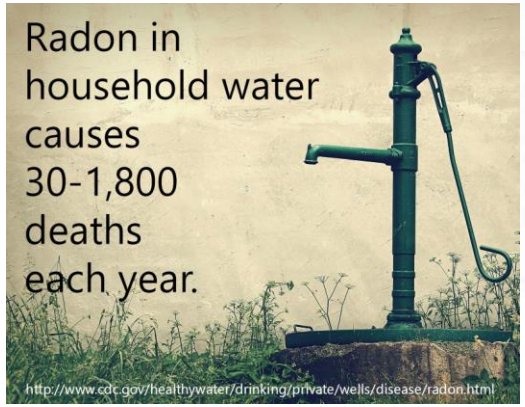
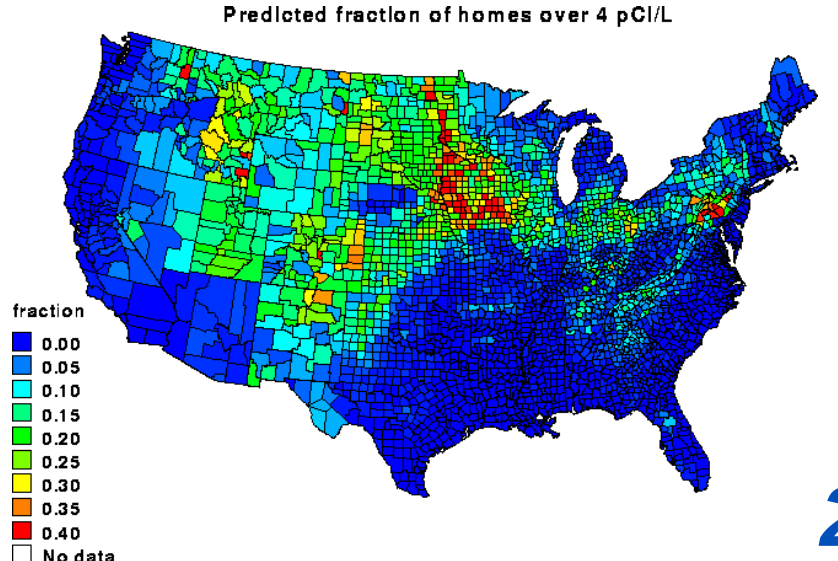


Table 2: Comparison of Soil Sample Results to Site-Specific Preliminary Remedial Goals

Soil Sample Results Compared to EPA Unrestricted Use Criteria[A] All units in pCi/g				
Sample ID	Thorium 230 + 232	Radium 226 + 228	Total Uranium	Lead-210
EPA Unrestricted Use value	7.9	7.9	54.5	No value established
WLL20151104-S01	3.1	2.3	1.8*	1.07
WLL20151104-S02	5.8	6.0	5.7*	3.28
WLL20151104-S02B	2.6	3.2	1.7*	1.59
WLL20151104-S02C (FD)	2.9	3.4	1.6*	1.48
WLL20151105-S03	3.8	3.4	1.8*	1.60
WLL20151105-S04	4.3	1.7*	1.6*	1.23
WLL20151104-S05	2.7	3.3	2.0*	1.12
WLL20151105-S06	1.7	2.4	1.6*	ND
WLL20151106-S08	3.7	3.7	1.8*	ND
WLL20151105-S09	9.2	3.6	1.9*	1.46
WLL20151104-S10	24.6	3.8*	2.0*	2.47

* Indicates one result was non-detect
[A] Reference value based on EPA Unrestricted Use Criteria
ND = Non-detect



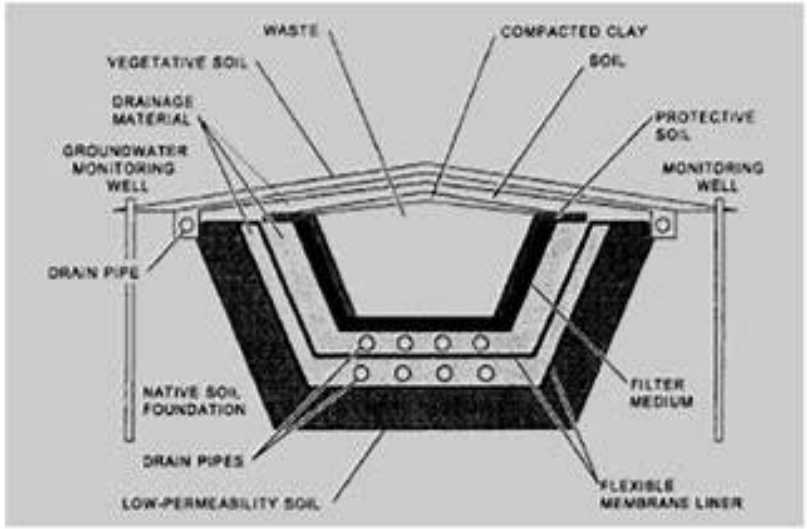
WHERE DOES THE WASTE GO?

Not far, for most of it

Vast majority – low concentration

- Local landfills that accept some hazardous materials
- On-site, built for purpose landfill

An RCRA Subtitle C hazardous waste landfill is planned with the cross section shown in the figure below.

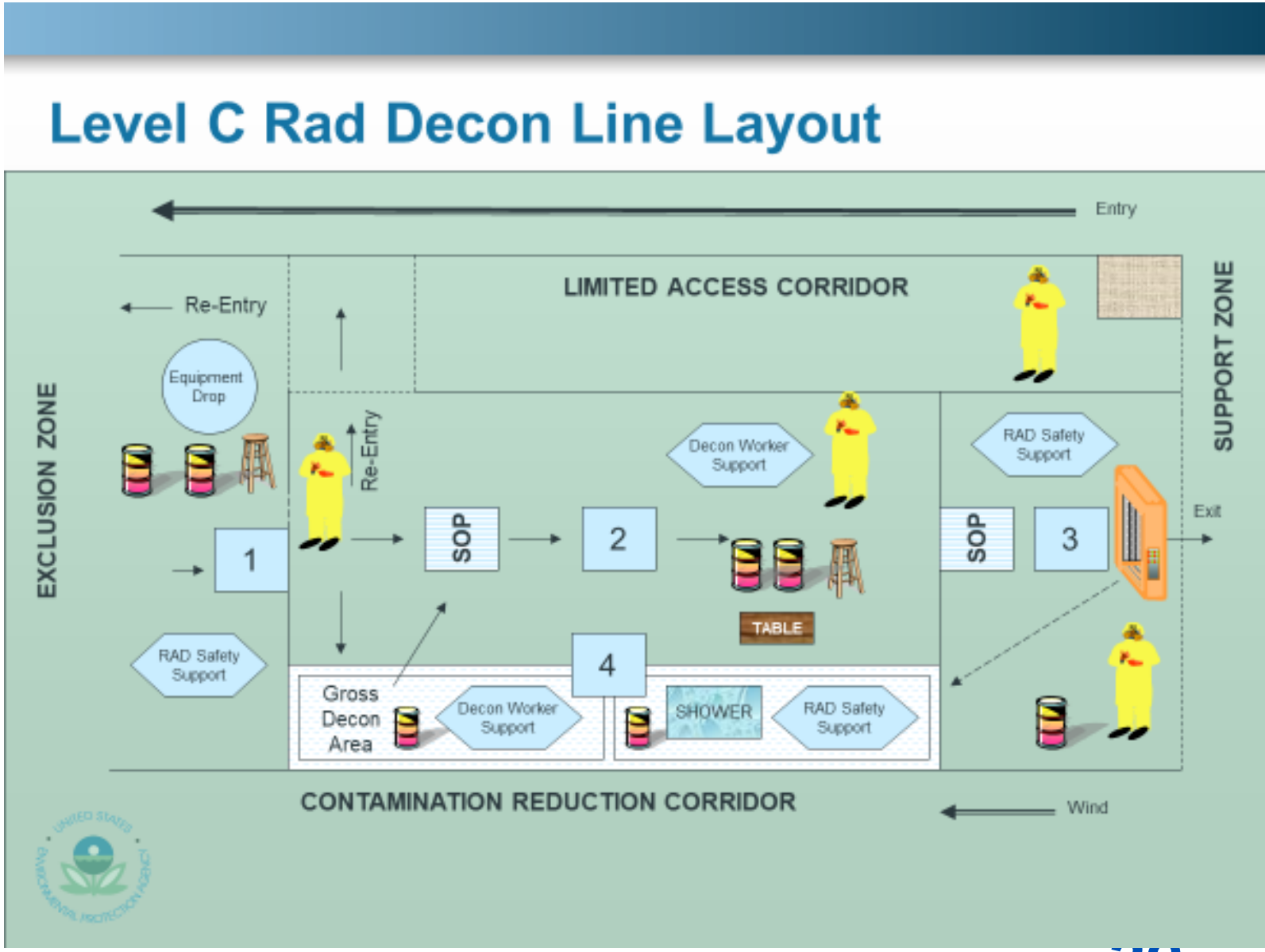


Highest activity waste – small volume

- One of 4 US radioactive waste facilities
  - High transport costs
  - Permitting concerns
  - Acceptance criteria and waste class limits

WHAT ABOUT PEOPLE?

- EPA does not conduct decon operations for members of the public
- Local community or public health responsibility
- We do provide decon for workers and responders during the cleanup



RAD INCIDENT RESPONSE SUPPORT

Environmental Characterization and Fate and Transport

Environmental Sampling and Analytical Methods (ESAM) Program

- Rapid Radiochemical Methods for Sampling and Analysis

Summary of the Transport of Cesium in the Environment

- Cesium emissions from laboratory fires
- Particle Transport of Radionuclides Following a Radiological Incident
- Fate of Radiological Dispersal Device (RDD) Material on Urban Surfaces: Impact of Rain on Removal of Cesium
- Radiological Dispersal Device Outdoor Simulation Test: Cesium Chloride Particle Characteristics
- Modeling radionuclide transport in urban overland flow

RAD INCIDENT RESPONSE SUPPORT

Environmental Cleanup

Urban Surface Decontamination

- Radiological Decontamination Query Tool
- Hot Spot Calculator
- Municipal and Commercial Equipment for Radiological Response and Recovery in an Urban Environment

Self Help

- Evaluation of Low-Tech Indoor Remediation Methods Following Wide Area Radiological/Nuclear Incidents
- Assessment of the Fate of RDD Contamination after Laundering of Soft Porous Materials

Containment and Wastewater Treatment

- Wide Area Stabilization of Radiological Particulate Contamination
- Technologies for preventing secondary transport of soluble and particulate radiological contamination from roadways, roadside vegetation, and adjacent soils
- Irreversible Wash-Aid, Treatment, and Emergency Reuse System (IWATERS)

RAD INCIDENT RESPONSE SUPPORT

Waste Management

- Incident Waste Decision Support Tool for planning how to handle, transport, treat, and dispose of contaminated waste and debris.
- Waste Estimation Support Tool for estimating waste generated from remediation and cleanup activities.
- Waste Storage and Staging Tool for identification and prioritization of locations of staging and storing waste.
- Waste Logistics Tool for optimal routes for transporting large volumes of waste from a disaster response area to waste management facilities.

RAD INCIDENT RESPONSE SUPPORT

Drinking Water and Wastewater Infrastructure

Persistence

- Radiological Contaminant Persistence and Decontamination in Drinking Water Pipes
- Persistence of Surrogate Radionuclides on Wastewater Collection System Infrastructure

Monitoring

- Distribution System Water Quality Monitoring: Sensor Technology Evaluation Methodology And Results
- On-line Water Quality Monitoring in Drinking Water Distribution Systems: A Summary Report of U.S. EPA Research and Best Practices
- Testing Contamination Source Identification Methods for Water Distribution Networks
- EPA's Water Security Modeling and Simulation Research

Decontamination

- Decontamination of Radiological Agents from Drinking Water Infrastructure: A Literature Review and Summary
- Decontamination of Drinking Water Infrastructure: A Literature Review and Summary

CONTACTS AND QUESTIONS?

- Jon Richards
- US EPA R4
- 61 Forsyth ST, SW
- Atlanta, GA 30303
- Richards.jon@epa.gov
- 404-431-1340