



Health and Safety Best Practices Guide

Radiation and Radioactive Material Responses

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Hazard Summary (See specific Safety Data Sheet (SDS) for more information)

Health Hazards: Continuous or intermittent exposure to radiation over a long period of time can cause cancer, benign tumors, cataracts, and potentially harmful genetic changes. Health hazards typically occur when the radiation dose was high and the radiation was able to reach internal organs.

Physical Hazards: Exposure to high dose radiation can cause skin and eye damage.

Signs and Symptoms of Exposure (See specific SDS for more information)

Short-term over-exposures: **Injury from short-term exposure is not a likely scenario for typical ERRPB activities.** Symptoms of exposure to high doses of radiation (Acute Radiation Sickness (ARS)) may include loss of appetite, fatigue, fever, nausea, vomiting, headache, and diarrhea. People who receive a high radiation dose also can have skin damage (Cutaneous Radiation Injury (CRI)). This damage can start to show within a few hours after exposure or it may be delayed for several days. It can include swelling, itching, and redness of the skin (like a bad sunburn) or may be more severe and include blisters or ulcers.

Long-term inhalation over-exposures: Continuous or intermittent exposure to radiation over a long period of time can cause cancer, benign tumors, cataracts, and potentially harmful genetic changes. Symptoms may include loss of appetite, fatigue, fever, nausea, vomiting, diarrhea, hair loss, seizures and coma.

Emergency Actions (See specific SDS for more information)

First-aid measures general: **If exposed or concerned seek medical advice/attention immediately.**

First-aid measures after inhalation: Remove to fresh air and keep in a position comfortable for breathing.

First-aid measures after skin contact: For minor/local skin contamination, wipe exposed area with cleaning wipes or moist towel and a mild surfactant. If contamination is still present, use duct tape on contaminated area to remove the radioactive contamination. For whole body contamination and/or mixed chemical and radioactive contamination, wash immediately in a decontamination shower. Attempt to contain the decon water.

First-aid measures after eye contact: Rinse immediately with water for 15 minutes. Hold eyes lids open while rinsing.

First-aid measures after ingestion: Rinse mouth, seek medical assistance.

Air Monitoring/Sampling Equipment

On-Site Monitoring	Deploy direct reading instruments on-site (Exclusion Zone, Command Post, Staging Areas, etc.) to ensure exposures are below Action Levels. Use data to guide PPE decisions, or the relocation of the command post/staging area.
Community Monitoring	<p>A combination of the following provides the best coverage for nearby residents and the highest quality data to drive recommendations and decisions.</p> <p>Fixed Locations –Fixed locations should be deployed near receptors and in an area where there is shore power to alleviate instrument battery maintenance. Location should be selected that are downwind. When using portable generators, assure that generator exhaust does not impact instruments. Fixed locations provide the best analysis of actual human exposure over time, but the data is limited to a small location.</p> <p>Roving Air Monitoring – Roving teams should identify areas downwind to drive through. Roving air monitoring provides coverage of large areas but is limited in its effectiveness to estimate actual human exposure over time. Roving air monitoring is best to deploy and monitor throughout neighborhoods with potential for exposure. Roving air monitoring teams allow flexibility to mobilize to sensitive areas (Schools, Day Care, Etc.) for immediate assessment of compounds of concern.</p>

Equipment (Linked to ERTG QSG)	Notes
Thermal Luminescence Dosimeter (TLD)	Passive personal radiation monitor worn during all field work that detects Beta (β), Gamma (γ), and X-Ray radiation. Must be sent to a laboratory for analysis.
Thermo Fisher Scientific Electronic Personal Dosimeter (EPD)	Personal radiation monitor that detects β , γ , and X-Ray radiation. Real-time monitor that alerts a user when total radiation dose and/or dose rate exceed alarm levels.
Ludlum 19 Gamma Detector	Detects γ Radiation. Instrument reads in $\mu\text{R/hr}$.
Ludlum 192 Gamma MicroR Survey Meter	Detects γ Radiation. Instrument reads in $\mu\text{R/hr}$.
Ludlum 2241 Digital Survey Meter	Contamination survey meter. Detects Alpha (α), β , γ , and X-Ray Radiation using the appropriate probe. Instrument reads in Counts per Minute (CPM)

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RADeCo High Volume Air Sampler	Specialized high volume air sampler used for grab sampler with an air volume totalizer which will automatically shut off the unit when a specified volume of air has been sampled.
Ludlum 3030 Alpha/Beta Sample Counter	Analyzes wipe samples for total α and β Radiation contamination
SAM 940 Gamma Spectrometer and Radiation Survey Meter	Identifies γ Isotopes. Cannot identify α or β emitting isotopes, but will likely identify γ emitting daughter products of α and β isotopes.

Note: There are other radiation detection equipment available in the Regional Readiness Center (RRC) and through the Environment Response Team (ERT). Contact the Branch Radiation OSC for more information.

Occupational Exposure Limits (Summary)*

Agency	Annual Dose Limits	Quarterly Dose Limits	Special Dose Limits
EPA SHEM Guideline 38 ⁶	500 mrem/yr, whole body dose	50 mrem/qtr, whole body dose	5000 mrem/yr, whole body dose with special approval/waiver from management and Regional Safety Manager.
ACGIH ⁸	50 millisievert (mSv) single year 20 mSv/yr averaged over 5 years (0.01 mSv = 1 mrem)		150 mSv/yr lens of eye, annual dose 500 mSv/yr skin, hands, feet, annual dose 0.5 mSv/month embryo/fetus
OSHA ⁹	5000 mrem/year whole body dose	3000 mrem/qtr whole body dose	18.75 rem/qtr hands and forearms, feet and ankles 7.5 rem/qtr skin of whole body

*Contact the Regional Radiation Safety Officer (RSO) or Regional Safety Manager for the complete details on ionizing radiation exposure limits and/or if you have questions or concerns regarding pregnancy and occupational exposure to radiation.

Action Levels:

Contaminant/Hazard	Action
2 to 3 times natural background	Implement contamination control techniques (see Special Considerations). Don Level D+ Protection (at a minimum). Perform a more detailed radiation survey for α , β , and γ contamination with the Ludlum 2241 or other appropriate radiation detector. Contact the Branch Radiation OSC for guidance.
>100 μR/hr	Stop, contact the Branch Radiation OSC for guidance.
<ul style="list-style-type: none"> >200 CPM/100 cm² α Surface Contamination >400 CPM/100cm² β Surface Contamination 	Must don Level C or B protection. Must consult with a Health Physicist or Radiation Safety Officer.
1.5 R/hr	STOP, EXIT THE EXCLUSION ZONE. Deny Entry. Request a Health Physicist or Radiation Safety Officer.

Personal Protection Equipment

Level D:	Safety Toe/Shank Work Boots, Disposable Boot Covers, Safety Glasses, Nitrile Gloves, Work Gloves (as needed), Hard Hat (as needed), High-Vis Vest (as needed), Hearing Protection (as needed).
Level D+:	Safety Toe/Shank Work Boots, Paper Tyvek Suits, Disposable Boot Covers, Safety Glasses, Nitrile Gloves, Work Gloves (as needed), Hard Hat (as needed), High-Vis Vest (as needed), Hearing Protection (as needed).
Level C:	Safety Toe/Shank Work Boots or HAZMAT Boots, Saranex (Tychem SL)/Polyethylene Coated (Tychem QC)/Paper Tyvek Suits, Full Face APR with Hg Cartridges, Nitrile Gloves, Work Gloves (as needed), Hard Hat (as needed), High-Vis Vest (as needed), Hearing Protection (as needed).
Level B:	HAZMAT Boots, Saranex (Tychem SL)/Polyethylene Coated (Tychem QC), SCBA/SAR, Nitrile Gloves, Work Gloves (as needed), Hard Hat (as needed), High-Vis Vest (as needed), Hearing Protection (as needed).

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Decontamination

- The goal is to not become contaminated or allow a piece of equipment to become contaminated. Practice standard contamination control techniques (see Special Considerations). Contact the Branch Radiation OSC for guidance and assistance.
- The Radiation Personnel Decontamination Standard Operating Guidelines is found at: https://www.epaosc.org/sites/3482/files/SOGD102_Rad_DECON_01072015.pdf.
- All equipment used at a radiation site must be screened for radiation contamination prior to leaving the site. This includes, but is not limited to, trailers, tents, benches, boots, inside of vehicles, and equipment cases. Recommend that wipes samples are taken on equipment used in the exclusion zone and scanned in the Ludlum 3030 prior to demobilization for documentation purposes.
- Radiation contamination can be removed with a surfactant (simple green, RAD-Con DECON Spray, Dish Soap). If possible, do not generate a liquid waste. Based on the specific isotope, it may be possible to allow the contaminated equipment to go through a number of half-lives as opposed to decontamination. Contact the Branch Radiation OSC for guidance and assistance.

Special Considerations

- A radiation survey/assessment must be conducted at all emergency response and removal sites. You should have an increased index of suspicion that a radiation hazard may be present at drum sites, T&D facilities, laboratories, hospitals, scrap yards, etc.
- Standard Contamination Control Techniques:
 - During pre-entry safety/OPS briefs, discuss measures that will help reduce or prevent contamination spread.
 - Establish an appropriate decontamination line/contamination reduction zone prior to conducting entries.
 - Use Step-Off-Pads to transition from contaminated areas to non-contaminated areas.
 - Pre-stage areas to prevent contamination spread from work activities. Lay down clean poly sheeting in the exclusion zone to stage clean equipment and monitoring equipment. Secure the poly sheeting properly if personnel will use it as a walking surface.
 - Cover/tape tools or equipment used during the job to minimize decontamination after the entry.
 - Assign “clean” and “dirty” roles to entry team members. The “clean” personnel should handle the monitoring equipment and the equipment that will leave the exclusion zone.
 - Change out gloves or protective gear frequently to prevent cross-contamination of equipment.
 - Control, minimize, and screen all material taken into or out of contaminated areas.
- Specific signage and a “Radiation Work Permit” may be required for high contamination areas or airborne contamination areas. Work with a Radiation Safety Officer/Technical Specialist to determine if these conditions exist.
- Oftentimes, the Radiation Safety Officer/Technical Specialist will provide clearance levels in Disintegrations per Minute (DPM).
CPM to DPM Conversion: $DPM = CPM - \text{background/probe efficiency}$

Resources/References:

1. Safety Data Sheets:
 - a. http://hpschapters.org/northcarolina/nuclide_information_library.php3
 - b. <http://nuclearsafety.gc.ca/eng/resources/radiation/radiation-safety-data-sheets/index.cfm>
 - c. <http://web.stanford.edu/dept/EHS/prod/researchlab/radlaser/RSDS.html>
2. [Emergency Response and Removal Operations Job Hazard Analysis](#)
3. [Emergency Response, Removal and Prevention Health and Safety Standard Operating Guidelines](#)
4. [ERTG Radiological Response Guidelines](#)
5. [Emergency Responder Health and Safety Manual](#)
6. [Safety, Health, and Environmental Management \(SHEM\) Guideline 38 - Radiation Safety and Health Protection Program](#)
7. [NIOSH Pocket Guide to Chemical Hazards](#)
8. [American Conference of Governmental Industrial Hygienist TLVs and BEIs](#)
9. [29 CFR 1910.1096 – Ionizing Radiation](#)
10. [Online Radiation Unit Conversion Calculator](#)
11. [SCOTT Safety SureLife Cartridge Calculator](#)
12. [MSA Emergency Response Application \(Respirator Cartridge Calculator\)](#)