

The Basics of Radiation Protection For Firefighters

Katharine McLellan Health Physicist November 2022



THE OF THE

Background Radiation

Ionizing Radiation Exposure to the Public



The above chart is taken from the National Council on Radiation Protection and Measurements (NCRP) Report No. 93, "Ionizing Radiation Exposure of the Population of the United States," 1987.

This chart shows that natural sources of radiation account for about 82% of all public exposure while man-made sources account for the remaining 18%.



Background Radiation

One Transcontinental round trip flight - 5 mRem





Radiation and Radioactivity

- Radiation
- Radioactivity
- Contamination
- Radioactive Decay and Half Life



What is Radiation?

- Atoms that contain too much energy become more stable by emitting their excess energy in the form of particles or electromagnetic waves.
 - The waves or particles are called radiation.
 - Cannot be detected by our senses.
 - We must use special instruments.





Atomic Structure

- All matter is made up of atoms
 - Protons
 - Neutrons
 - Electrons



- Not all atoms are stable
- Unstable atoms are known as radioactive atoms





Ionizing Radiation

- Ionizing Radiation
 - Energy that comes from a source and travels through space and may be able to penetrate various materials
- Non-ionizing radiation
 - Visible light/heat/radio waves/microwaves-does not have sufficient energy to cause ionization



Radiation Definitions

- Radioactivity= the average number of radioactive atoms that decay in a given unit of time.
- Contamination= radioactivity where it doesn't belong.
- Radioactive half-life= the time it takes for one half of the radioactive atoms present to decay





Types of Radiation

- Alpha Particles
- Beta Particles
- Gamma, X-Ray Radiation
- Neutron Radiation





Alpha Particle



- Is a hazard only if it gets into the body.
- Cannot penetrate the dead outer layer of the skin.
- Can travel only several inches in air
- Elements with high atomic numbers (>82) emit alpha radiation



Beta Particle



- Is both an external hazard (eyes, skin) and an internal hazard
- Originates in the nucleus
- Single particle with the mass of an electron
- Can travel between one inch to 20 feet in air depending on its energy

Gamma Rays and X-rays

- External hazard
- Originate in the nucleus
- Electromagnetic wave: no mass, no charge, (x-rays move at the speed of light)
- Can easily travel several hundred feet in air and easily penetrates the body
- Dense materials such as lead, tungsten and depleted uranium make effective shields



Neutron Particle



- Easily penetrates the body
- Is an external hazard
- Originates in the nucleus
- No charge
- Large size
- Range in air up to several hundred feet





Basics of Radiation Protection

CARDINAL RULES OF RADIATION PROTECTION







Shielding



10



Basics of Radiation Protection

• How do you stay safe?

RADIATION PROTECTION ACTIONS







Basics of Radiation Protection

- Internal pathways
 - Inhalation
 - Ingestion
 - Injection
 - Absorption







Fires with Radioactive Materials

• Off-site or Unexpected On-site Response

- Mutual aid or Haz Mat Response
- Commercial Delivery (UPS, FedEx)
- Terrorist Attack
- Tools we can use
 - Emergency Response Guide (ERG)
 - Safety Data Sheets
 - Documents that shipper may have



Fires with Radioactive Materials

- On Site
 - Laboratories
 - Accelerators
- Preparations
 - Pre-fire plans





 Building walk downs and coordination with occupants





Fires with Radiological Materials

- On-Site
 - Lab Equipment
 - Glove Box
 - Chemical Fume Hoods
 - Hot Cell



Photo credit NASA



Fires with Radiological Materials



Photo credit NIST



Fires with Radioactive Materials

- Waste Storage Areas
 - Buildings
 - Legacy Waste Burial sites
- Forest Fires and encroachment





Decontamination

- Firefighters
- Patients
- Severely Injured Patients
- Decontamination pool





Staying Safe at Your Site

- Environmental health and safety staff on site
- Other site fire departments sharing information
- Field & First Responders Sub-Committee
- Building site plans
- Training
- Call us at Headquarters for assistance



Education Classes

- Counter Terrorism Operations , NNSA
 - <u>www.ctosnnsa.org</u>
 - Nevada Test Site or mobile operations
- Radiation Emergency Assistance Center/Training Site
 - Oak Ridge, TN
 - <u>REAC/TS Continuing Medical Education Courses</u> -<u>ORISE (orau.gov)</u>



Thank you!
Katharine McLellan

Katharine.mclellan@hq.doe.gov

202-586-0183

