Radioactivity Measurement

Curie (Ci)

1 Ci = 3.7×10^{10} Bq

(~Disintegrations per second in a gram of radium)

Becquerel (Bq) (SI Units)

1 Bq = one decay per second = 27 pCi

Disintegrations per minute (dpm)

60 dpm = 1 Bq

1 dpm ~ ½ pCi

Counts per minute (cpm)

Detector measurement
(multiply by a factor to get dpm)

Airborne

Picocurie per cubic meter (pCi/m^3)
Microcurie/milliliter (µCi/ml)
Derived Air Concentration (DAC)

Solid

Microcurie/gram (µCi/g)
Nanocurie/gram (nCi/g)
Picocurie per cubic meter (pCi/m^3)

Water

Picocurie/liter (pCi/l)

Surface contamination/swipe

Disintegrations per minute per 100 cm^2

DOE Radioactivity Area Control

Buffer Area

Area used to access controlled areas.

Radiation Area

Direct radiation dose

High Radiation Area

High radiation dose

Contaminated Areas

Some loose radioactive material

High Contamination Area

Extensive loose radioactive material

Airborne Contamination Area

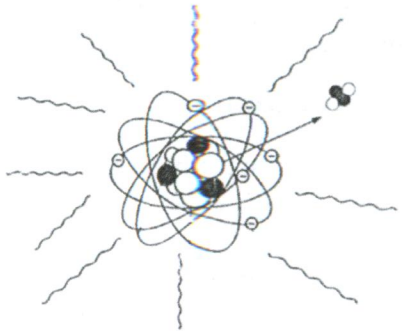
Potential for inhalation of radioactive material above limits

DAC value examples (10CFR835)

Am-241 – 5×10^{-12} µCi/ml (0.1 Bq/m^3)
Sr-90 – 7×10^{-9} µCi/ml (200 Bq/m^3)
Cs-137 – 8×10^{-8} µCi/ml (3,000 Bq/m^3)

Note: 2000 DAC-hours = 5 rem

Radiological Primer



Common Understanding of Terms

Health Safety Environmental Protection Committee

Hanford Advisory Board

April 2015

Radioactivity vs. Radiation

What is radioactivity?

Property exhibited by certain types of matter of emitting radiation spontaneously.

What is radiation?

Process by which energy is emitted from a source

Forms of ionizing radiation

Gamma (photons) Typical for Cesium (Cs)

Beta (electrons) Typical Strontium (Sr)

Alpha (helium nucleus) Typical for transuranics Americium (Am) or Plutonium (Pu)

Neutron (neutrons)

SI Unit Prefixes

10^{6} mega - M

10^{-3} milli - m

10^{-6} micro - μ

10^{-12} pico - p

Radiation Exposure Units

Radiation Energy/unit mass –
100 rad = 1 Gray (Gy)

Units reflecting radiation effect on humans

100 rem = 1 Sievert (Sv)
1 rem = 1,000 millirem (mrem)
100 mrem = 1 mSv
1 mrem = 1/1000 rem = 10 μSv

Background radiation
US average is 320 mrem/year (3.2 mSv)

Occupational and Medical –
US Average ~ 300 mrem/year (3.0 mSv)

Personal exposure source varies and is cumulative. Factors effecting dose:

- Terrestrial (5 – 100 mrem)
- Cosmic (altitude) (30 – 90 mrem)
- Radon (150 – 1,800+ mrem)
- Food (40 – 100 mrem)
- ✚ Air Travel (5 – 50+ mrem)
- ✚ Medical (1 – 5,000 mrem)
- ✚ Smoking (1,000 – ? mrem)

Online calculators links –

www.omsi.edu/exhibits/hanford/radiationquiz.htm

www.nrc.gov/about-nrc/radiation/around-us/calculator.html

Radiation Exposure Limits

As Low As Reasonably Achievable (ALARA)

Occupational limit –

5,000 mrem/year

DOE Administrative On-site Limits

Rad Worker = 500 mrem/year
General public/non-rad worker
= 100 mrem/year
Derived Concentration Standard
Water/Air (DCS) = 100 mrem/year
(1mSv/year)

Off-site limits

Washington State Clean Air Act
Ambient Air Standard = 10 mrem/year

Drinking Water = up to 36 mrem/year
Beta - 4 mrem/year (eg. Sr/tritium)
Alpha – 15 pCi/L (11 mrem/year*)
Radium – 5 pCi/L (20 mrem/year*)

* Based on DOE Standard

EPA "Rad Net" Data Base Link

http://iaspub.epa.gov/enviro/erams_query_v2.simple_query

http://lowdose.energy.gov/pdf/DoseRanges.pdf