FACT SHEET

Radiation Measurement

When scientists measure radiation, they use different terms depending on whether they are discussing radiation coming from a radioactive source, the radiation dose absorbed by a person, or the risk that a person will suffer health effects (biological risk) from exposure to radiation. This fact sheet explains some of the terminology used to discuss radiation measurement.

Units of Measure

Most scientists in the international community measure radiation using the System Internationale (SI), a uniform system of weights and measures that evolved from the metric system. In the United States, however, the conventional system of measurement is still widely used.

Different units of measure are used depending on what aspect of radiation is being measured. For example, the amount of radiation being given off, or emitted, by a radioactive material is measured using the conventional unit **curie** (Ci), named for the famed scientist Marie Curie, or the SI unit **becquerel** (Bq). The radiation dose absorbed by a person (that is, the amount of energy deposited in human tissue by radiation) is measured using the conventional unit **rad** or the SI unit **gray** (Gy). The biological risk of exposure to radiation is measured using the conventional unit **rem** or the SI unit **sievert** (Sv).

Measuring Emitted Radiation

When the amount of radiation being emitted or given off is discussed, the unit of measure used is the conventional unit Ci or the SI unit Bq.

A radioactive atom gives off or emits radioactivity because the nucleus has too many particles, too much energy, or too much mass to be stable. The nucleus breaks down, or disintegrates, in an attempt to reach a nonradioactive (stable) state. As the nucleus disintegrates, energy is released in the form of radiation.

The Ci or Bq is used to express the number of disintegrations of radioactive atoms in a radioactive material over a period of time. For example, one Ci is equal to 37 billion (37×10^9) disintegrations per second. The Ci is being replaced by the Bq. Since one Bq is equal to one disintegration per second, one Ci is equal to 37 billion (37×10^9) Bq.

Ci or Bq may be used to refer to the amount of radioactive materials released into the environment. For example, during the Chernobyl power plant accident that took place in the former Soviet Union, an estimated total of 81 million Ci of radioactive cesium (a type of radioactive material) was released.

Measuring Radiation Dose

When a person is exposed to radiation, energy is deposited in the tissues of the body. The amount of energy deposited per unit of weight of human tissue is called the absorbed dose. Absorbed dose is measured using the conventional **rad** or the SI **Gy**.

The rad, which stands for radiation absorbed dose, was the conventional unit of measurement, but it has been replaced by the **Gy**. One Gy is equal to 100 rad.

Measuring Biological Risk

A person's biological risk (that is, the risk that a person will suffer health effects from an exposure to radiation) is measured using the conventional unit **rem** or the SI unit **Sv**.

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Radiation Measurement

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To determine a person's biological risk, scientists have assigned a number to each type of ionizing radiation (alpha and beta particles, gamma rays, and x-rays) depending on that type's ability to transfer energy to the cells of the body. This number is known as the Quality Factor (Q).

When a person is exposed to radiation, scientists can multiply the dose in rad by the quality factor for the type of radiation present and estimate a person's biological risk in rems. Thus, risk in **rem** = rad X Q.

The rem has been replaced by the Sv. One Sv is equal to 100 rem.

Abbreviations for Radiation Measurements

When the amounts of radiation being measured are less than 1, prefixes are attached to the unit of measure as a type of shorthand. This is called scientific notation and is used in many scientific fields, not just for measuring radiation. The table below shows the prefixes for radiation measurement and their associated numeric notations.

Prefix	Equal to	Which is this much	Abbreviation	Example
atto-	1×10^{-18}	.000000000000000001	a	aCi
femto-	1×10^{-15}	.000000000000001	f	fCi
pico-	1×10^{-12}	.000000000001	p	pCi
nano-	1×10^{-9}	.000000001	n	nCi
micro-	1×10^{-6}	.000001	μ	μCi
milli-	1×10^{-3}	.001	m	mCi
centi-	1×10^{-2}	.01	c	cGy

When the amount to be measured is 1000 (that is, 1 X 103) or higher, prefixes are attached to the unit of measure to shorten very large numbers (also scientific notation). The table below shows the prefixes used in radiation measurement and their associated numeric notations.

Prefix	Equal to	Which is this much	Abbreviation	Example
kilo-	1×10^{3}	1,000	k	kCi
mega-	1×10^{6}	1,000,000	M	MCi
giga-	1×10^{9}	1,000,000,000	G	GBq
tetra-	1×10^{12}	1,000,000,000,000	T	TBq
peta-	1×10^{15}	1,000,000,000,000,000	P	PBq
exa-	1×10^{18}	1,000,000,000,000,000,000	E	EBq

Common Radiation Exposures

People are exposed to radiation daily from different sources, such as naturally occurring radioactive materials in the soil and cosmic rays from outer space (of which we receive more when we fly in an airplane). Some common ways that people are exposed to radiation and the associated doses are shown in the table below.

Source of exposure	Dose in rem	Dose in sievert (Sv)
Exposure to cosmic rays during a roundtrip airplane flight from New York to Los Angeles	3 mrem	0.03 mSv
One dental x-ray	4–15 mrem	0.04–0.15 mSv
One chest x-ray	10 mrem	0.1 mSv
One mammogram	70 mrem	0.7 mSv
One year of exposure to natural radiation (from soil, cosmic rays, etc.)	300 mrem	3 mSv

For More Information

For more information about radiation measurement, you may visit the website for the Health Physics Society at www.hps.org, or the Environmental Protection Agency's "Radiation Topics" at www.epa.gov/radiation/topics.htm.

For more information about radiation, see CDC's Radiation Emergencies website at www.bt.cdc.gov/radiation and "Radiation and Health Effects" at www.bt.cdc.gov/radiation/healthfacts.asp. You may also call the CDC public response hotline at 800-CDC-INFO or 888-232-6348 (TTY).

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