INSTITUTE FOR ENERGY AND ENVIRONMENTAL RESEARCH

6935 Laurel Avenue, Suite 201
Takoma Park, MD 20912

Phone: (301) 270-5500
FAX: (301) 270-3029
e-mail: ieer@ieer.org
http://www.ieer.org

Fact Sheet

# Radiation and Human Health

Radiation exposure is measured by the amount of energy deposited in people's bodies.

## Terms

**Rad** (radiation absorbed dose): A unit of absorbed dose of radiation, in other words, a measure of the amount of energy deposited in a given tissue (100 ergs/gram).

**Gray** (Gy): A unit of absorbed radiation dose equal to 100 rad.

**Rem** (radiation equivalent man): A measure of the biological damage of a given absorbed dose of radiation. The rem takes into account the varying ways in which ionizing radiations transfer their energy to human tissue. Rems are derived from rads by mutiplying rads by the "quality factor" of the type of radiation in question. For gamma and most beta radiation, the quality factor is one; in other words, rems equals rads. For alpha radiation, the quality factor is 20, that is, rems equal 20 times rads. Neutron radiation quality factors vary according to neutron energy.

**Sievert** (Sv): A unit of equivalent absorbed dose equal to 100 rem. A person-sievert is a unit for population dose, as distinct from individual dose, and expresses the sum of individual doses in a defined population.

1 Sv = 100 rem
1 Gy = 100 rad
Milli = one-thousandth (symbol m)
Micro= one-millionth (symbol: μ)

High dose (10 rad or more in a short time (minutes) could affect some workers in accident situations.

Early symptoms of radiation sickness hours to one week (more that 1 gray or 100 rads): nausea and vomiting, diarrhea. Later symptoms of radiation sickness: dizziness and disorientation, hair loss, bloody vomit and stools, infections, poor wound healing, low blood pressure. (http://www.mayoclinic.com/health/radiation-sickness/DS00432/DSECTION=symptoms)

Low dose (less than 10 rad) and low dose rate radiation (less than a few tens of rad per hour).

High doses produce immediate effects (see above) and low doses and dose rates increase the risk of cancer, birth defects, with some risks of other problems as well.

Collective population exposure is expressed as **person-rem** or **person-Sv**, which is the sum of all individual exposures in a population.

From an estimate of collective dose, one can apply a risk factor to get a statistical estimate of the number of additional **cancers** that would result from the dose.

Suppose time is involved? Then we are talking about dose rate, or dose per unit time. A common unit for dose rate is **millirem per hour** (mrem/h).

**U.S. annual dose limit** from nuclear fuel cycle facilities (including reactors): 25 millirem per year = 0.25 millisievert/year (40 CFR 190)

**Natural background radiation**: 0.1 rem/year

Radiation rates measured at various times at or around the Daiichi plant: less than 1 mSv/hour to 4,000 mSv/hour

**Fatal cancer risk**: 1 fatal cancer per 17 Sv (1,700 rem) EPA Federal Guidance Report 13, 1999

**Cancer occurrence risk**: 1 per 9 Sv (900 rem) BEIR VII Report

**Relative risks**

Females have a greater overall risk of cancer than males for the same dose and children have a greater risk than adults for the same dose. The average cancer occurrence risk for females is 0.14 cancers per Sv and for men it is 0.09 cancers per Sv (BEIR VII). Remember 1 Sv = 100 rem.

**Some Radionuclides of Concern**

The following is a list of some of the radionuclides that were reported to have been, or could be expected to be, released from the damaged nuclear facilities in Japan.

**Iodine-131** is a short-lived radionuclide with a half-life of 8 days. Primary risk of exposure is thyroid cancer; children are more at risk than adults. For more information see the Argonne National Laboratory Human Health Fact Sheet at http://www.evs.anl.gov/pub/doc/Iodine.pdf.

**Cesium-137** is a long-lived radionuclide with a half-life of 30 years. Exposure increases cancer risk. For more information see the Argonne National Laboratory Human Health Fact Sheet at http://www.evs.anl.gov/pub/doc/cesium.pdf.

**Strontium-90** is a long-lived radionuclide with a half-life of 29 years. Because it behaves like calcium and concentrates in the bones, the primary health concerns of strontium-90 exposure are bone tumors and leukemia. For more information see the Argonne National Laboratory Human Health Fact Sheet at http://www.evs.anl.gov/pub/doc/strontium.pdf.

**Tritium** (aka Hydrogen-3) is a long-lived radionuclide with a half-life of 12 years. Ingested or inhaled tritium increases risk of cancer. Tritium can cross the placenta and in sufficient doses cause miscarriage or birth defects to the embryo/fetus. For more information see the Argonne National Laboratory Human Health Fact Sheet at http://www.evs.anl.gov/pub/doc/tritium.pdf and *Science for Democratic Action* vol. 14 no. 4 (IEER: February 2007) at http://www.ieer.org/sdafiles/14-4.pdf

*References*


National Academies BEIR VII report (2006) at http://www.nap.edu/openbook.php?record_id=11340&page=1

EPA Federal Guidance Report 13, 1999, at http://www.epa.gov/radiation/docs/federal/402-r-99-001.pdf

Mayo Clinic Staff, Radiation Sickness at http://www.mayoclinic.com/health/radiation-sickness/DS00432/DSECTION=symptoms (for high levels of radiation)

IEER materials:

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