GLOSSARY OF TERMS

General Terms for Radiation Studies:

Dose Reconstruction
Epidemiology
Risk Assessment

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Absorbed dose (A measure of potential damage to tissue): The amount of energy deposited by ionizing radiation in a unit mass of tissue. Expressed in units of joule per kilogram (J/kg), which is given the special name Agray≅ (Gy). The traditional unit of absorbed dose is the rad (100 rad equal 1 Gy).

Alpha particle (ionizing radiation): A particle emitted from the nucleus of some radioactive atoms when they decay. An alpha particle is essentially a helium atom nucleus. It generally carries more energy than gamma or beta radiation, and deposits that energy very quickly while passing through tissue. Alpha particles cannot penetrate the outer, dead layer of skin. Therefore, they do not cause damage to living tissue when outside the body. When inhaled or ingested, however, alpha particles are especially damaging because they transfer relatively large amounts of ionizing energy to living cells.

Analytic study A type of epidemiological study conducted to determine whether an association exists between variables, such as between an exposure and a disease.

Association A relationship, generally demonstrated by statistical tests, between an exposure and a health effect. It does not necessarily imply cause and effect.

ATSDR (Agency for Toxic Substances and Disease Registry): ATSDR is part of the U.S. Department of Health and Human Services.

Background radiation The amount of ionizing radiation to which a person is exposed from natural sources, such as terrestrial radiation due to naturally occurring radionuclides in the soil or cosmic radiation originating in outer space.

Background rate of disease The rate of disease in a group of people in the absence of a specific hazard or exposure.

Becquerel (Bq) (a measure of the rate of radioactive decay): The Bq corresponds to one decay (disintegration) per second. It replaces the traditional unit activity, the Curie (Ci).

Beta particles (ionizing radiation) An electron (or positron) ejected from the nucleus of a decaying atom. Beta particles penetrate the dead skin layer. The beta particle is not stopped in tissue as quickly as an alpha particle, producing less damage per living cell. Beta particles may interact with living tissue by entering from the outside or by ingestion or inhalation.

Benign A general category of neoplasm that does not invade surrounding tissue. A benign tumor's characteristics generally include slow growth by expansion and enclosure in a fibrous capsule. Benign tumors are usually not referred to as cancer. (See "tumor").

Bias In epidemiology, this term does not refer to an opinion or point of view. Bias is the result of some systematic flaw in the design of a study, the collection of data, or in the analysis of data. Bias is not a chance occurrence.

Biological plausibility When study results are credible and believable in terms of current scientific biological knowledge.

Birth defect An abnormality of structure, function or body metabolism present at birth that may result in a physical and (or) mental disability or is fatal.

Cancer A collective term for malignant tumors. (See "tumor," and "malignant").

Carcinogen An agent or substance that can cause cancer.

Causal factor A factor whose reduction (or removal) leads to a change in the occurrence of a disease or health problem.

Case control study An epidemiologic study design in which the amount of past exposure in a group of individuals with a specific disease (cases) is compared to the amount of past exposure in one or more groups of individuals without disease (controls).

CDC (Centers for Disease Control and Prevention):
The CDC has 11 centers, offices and an institute. It is an agency of the Department of Health and Human Services. The CDC is a non-regulatory agency - its mission is to promote health and quality of life by preventing and controlling disease, injury and disability.

Chance A situation in which something happens unpredictably without discernable human intention or observable cause.

Cohort Study An epidemiologic study design where the level of disease that develops in a group of people after they have been exposed to a hazardous material (such as a radioactive material) is compared to the level of disease that develops in a group of people who were not exposed.

Computer Code A set of instructions that tells a computer to do something. A computer program consists of code. When a reference is made to the project software consisting of 60,000 lines of code, it refers to the commands contained in the computer programs used to estimate radiation doses or risks.

Confounder A variable that is associated with the disease under study and is also associated with the exposure under study in a study population. A confounder may mask a true exposure-disease relationship (false lack of association) or make it appear as if a relationship exists when it does not (false association).

Count   A measure of how many events (for example, the number of cases of disease or death) that happen within a certain period.

Cross-sectional study   A type of epidemiologic study design that examines the current exposure status and current disease status in a study population.

Curie (a measure of radioactive decay):   The traditional unit of measure used to express the amount of radioactive material present. One curie is 37 billion atoms undergoing radioactive decay each second.

Descriptive study   A type of epidemiological study that describes the distribution of variables such as a disease or an exposure. For example, summarizing disease occurrence by age, gender, place of residence, or time period.

Difference   A measure of association calculated by subtracting disease incidence, mortality, risk, or prevalence estimates in an unexposed population from estimates in an exposed population.

Disease registry   A surveillance system which collects, analyzes, and interprets data on all new cases of a specific disease or condition for a specified time period and population.

DOE (U.S. Department of Energy):   The DOE is responsible for developing and producing nuclear weapons and for the sites at which weapons materials have been produced and handled.

Dose   When radiation enters a person=s body, that person receives a radiation dose. Several different terms describe these radiation doses. The *rad or gray* expresses the concentration (amount of energy divided by the tissue mass) of energy deposited by radiation in the body. The rad is the most basic unit of radiation dose, but its use is limited because different types of radiation have different effects on the cells in the body. The *rem or sievert* is a unit of radiation dose that takes these different effects into account. It puts different types of radiation on an equivalent basis in terms of their potential impact on human cells. A third measure of dose, effective dose is used to account for the fact that a rem of radiation dose to one part of the body does not have the same potential health effect as a rem to another part. The effective dose allows estimation of dose to the entire body from individual organ doses.   To help people interpret these radiation doses, it may be helpful to compare them with other radiation doses people typically receive in daily life. This is called background radiation. Each year the average American receives an effective dose of about 0.3 rem (300 millirem) from background radiation. This radiation is from naturally occurring sources, such as the sun, air, soil and radon gas. Manmade sources such as medical x rays add about 60 millirem per year to the average person=s dose.

Dose Reconstruction   A scientific study that estimates doses to people from releases of radioactivity or other pollutants.   The reconstruction is done by determining how much material was released, how people came in contact with it and the amount absorbed by their bodies.

Dose-response effect   The observation that the amount of disease increases as the dose or level of exposure increases.

Dosimetry   Dosimetry involves methods developed to measure the radiation doses to people or objects exposed to ionizing radiation. Such methods may range, for example, from badges worn by the people potentially exposed to radiation, to external gamma radiation measurements taken by hand held counting devices, to chemical and radionuclide analyses of urine samples to determine the amount of intake of radionuclides such as tritium or plutonium.

Environmental epidemiology   The study of the effects of environmental factors (physical, chemical, and biological) on the distribution of disease in human populations.

Environmental exposure   The exposure to substances through the environment.

EPA (U.S. Environmental Protection Agency):   The EPA is a federal regulatory agency responsible for protecting and enhancing the quality of the nation's environment. One of EPA's many roles is to work with other health agencies to establish federal standards limiting the exposures individuals receive from chemical or toxic substances, to include radioactive materials.

Epidemiology   The study of the distribution of and the factors that contribute to disease. By studying the connection between environmental exposures, other risk factors and disease, epidemiology serves as a valuable tool in the prevention and control of disease.

Equivalent dose   A quantity used in radiation protection to place all radiation on a common scale for calculating tissue damage. Equivalent dose is the product of the absorbed dose in grays and the radiation weighting factor. The radiation weighting factor accounts for differences in radiation effects caused by different types of ionizing radiation. Some radiation, including alpha particles, cause a greater amount of damage per unit absorbed dose than other radiation. The sievert (Sv) is the unit used to measure equivalent dose. The sievert replaces the rem, the traditional unit (1 Sv equals 100 rem).

Exposure pathways   The means by which humans are exposed to toxic substances. The key exposure pathways are air and water, with most exposures via inhalation, drinking water, crops, eating other foods and direct radiation.

Gamma radiation (ionizing radiation):   A high energy electromagnetic radiation emitted from a decaying atomic nucleus. Gamma rays are similar to medical x-rays, but are emitted at very specific energies characteristic of their decaying atoms.   They penetrate tissue farther than beta or alpha particles, but leave a lower concentration of ions in their path to potentially cause cell damage.

Genetic effects   The result of exposure to substances (such as radiation) that cause damage to the genes of a reproductive cell (sperm or egg).

Gray (Gy) (a measure of the amount of energy absorbed by the body):   The unit of absorbed dose that replaces the traditional unit; the rad (1 Gy equals 100 rads).

Half-life   The length of time in which any radioactive substance will lose one half of its radioactivity. The half-life determines how long a substance will remain radioactive.

Health data   A type of information collected about health conditions, reproductive outcomes, causes of death, and quality of life.

Health Effect   The result of exposure to substances (such as radiation) that cause harm to a person's health — including cancers, birth and genetic effects, and other diseases.

Health Physics   An interdisciplinary science focused on the radiation protection of humans and the environment. Health Physics combines the elements of physics, biology, chemistry, statistics, and electronic instrumentation to protect individuals from the effects of radiation.

Incidence   A measure of the number of new cases (in the form of a count or rate) of a disease or condition that occur in a specified population within a certain period.

Information bias   A type of bias (error) which occurs when the measurement of information (such as exposure or disease) is different between study groups.

– **Memory or recall bias –**   A type of information bias which occurs when there are differences in how exposure groups or disease groups remember or recall needed information.

Ingestion   The process of radionuclides or chemicals taken into the body by eating or drinking.

Inhalation   The process of radionuclides or chemicals taken into the body by breathing.

Ionizing radiation   A type of radiation that has enough energy to create ions (ionized atoms which are chemically active) inside living cells. These ions can damage key substances in cells, including the DNA within the cell nucleus. Such damage can lead to cancer or other defects.

Late effects   A health effect that does not become apparent for years, or decades, after the exposure occurs.

Latency period   The term often applied to the time interval between exposure and disease manifestation.

Malformation   A birth defect caused by abnormal growth of an organ. Examples include cleft palate and spina bifida.

Malignant   A general category of neoplasm that invades surrounding tissue. A malignant tumor generally is unencapsulated, grows by invasion, and is able to metastasize via lymphatic and blood systems to distant tissue sites.

Mathematical Model   A collection of mathematical formulas used to characterize a relationship or process. For example, mathematical formulas are used in Environmental Dose Reconstruction Projects to model, or mimic, how radionuclides released from former weapons facilities traveled through the environment and were taken up by the body. Models such as this can also estimate the risk of health effects that result from exposures.

MCL (Maximum contaminant level):   A standard for drinking water established by the U.S. Environmental Protection Agency under the Safe Drinking Water Act. It is the permissible level of a chemical in the water delivered to any user of a public water system.

Median   The middle value in a distribution, above and below which lie an equal number of values.

Milli- *Abbr.*   Indicates 1/1,000 of a unit.

Modeling   When determining the risks to humans from past operations of nuclear weapons facilities, it is rare to find actual measurements of offsite dose. In such cases, doses from past releases must be estimated using mathematical models. For example, models are used to simulate environmental movements of radionuclides and chemicals released from a facility=s stacks. Models calculate how materials disperse as they move with the winds, how they deposit on food crops, how they are inhaled, or ingested by people, and the resulting doses. Some models are complex, requiring information such as weather conditions, crops, and eating habits. Other models are relatively simple.

Mortality   A measure of the number of people who die (in the form of a count or rate) of a disease or condition within a specified population in a certain period.

Mutagen   An agent or substance that changes the DNA in a person's cells. Only changes to DNA in reproductive cells (egg or sperm) can be passed on to a person's children.

NAS (National Academy of Sciences):   The NAS is a private, non-profit, self-perpetuating society of distinguished scholars engaged in scientific research. Upon the authority of the charter granted to it by Congress in 1863, the NAS has a mandate that requires it to advise the federal government on scientific and technical matters.

NCEH (National Center for Environmental Health):   One of CDC=s "centers."

NCRP (National Council on Radiation Protection and Measurements):   The NCRP produces recommendations concerning all aspects of radiation protection, including many reports defining recommended methods for performing key aspects of dose reconstruction.

Neoplasm   An abnormal mass of tissue, the growth of which exceeds and is uncoordinated with that of normal tissues. A "tumor" is a neoplastic mass. (See "tumor")

NIOSH (National Institute for Occupational Safety and Health): NIOSH is a ACenter≅ within CDC.

NRC (National Research Council):   The NRC is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering to serve the government and other organizations.

Odds   A measure of the likelihood that an event will occur. For example, the odds of developing a certain disease.

Odds ratio A measure of association used in a case-control study; the ratio of the odds of being exposed among diseased individuals divided by the odds of being exposed among non-diseased individuals.

Organ dose Among the factors to consider in measuring radiation dose is whether a person received a radiation dose to a single organ or to the whole body.

Plume The concentration profile of an airborne or waterborne release of materials as it spreads from its source. A plume from a coal-fired power plant, for example, may be visible for some distance from its stack, with the concentration of its components decreasing with distance from the stack and from the centerline of the plume. After the plume becomes invisible because of dilution, it continues to be diluted with increasing time and distance. Atmospheric dispersion models of this process predict concentrations within a plume far downwind and far beyond the point at which a plume becomes invisible. Similar modeling for releases from nuclear facilities can estimate the impacts of releases long past, reconstructing exposure and dose estimates.

Population at risk Those persons who are susceptible to developing the disease being studied.

Power The probability that a study can distinguish a true exposure to disease relationship from coincidence. The power of a study depends on the size of a study population, the amount of radiation exposure and the number of cases of the disease under investigation.

Prevalence The proportion of people who have a disease at a specified point in time.

Program A complete set of computer code. A sequence of related statements which instruct a computer to perform a certain function.

Public health activities Activities conducted to protect, promote or restore public health. The activities can include a number of programs and campaigns such as surveillance of disease, epidemiological studies, disease registries, collection of vital statistics, disease prevention programs, public and provider education, health inspections, and quality assurance activities.

Rad (a measure of the amount of energy absorbed by the body): The rad is the traditional unit of absorbed dose, equal to 100 ergs/gram in any medium; now replaced by the gray (1 gray equals 100 rad).

Radiation Energy moving in a form of particles or waves. Familiar radiations are heat, light, radio waves and microwaves. Ionizing radiation is a very high energy form of electromagnetic radiation. It is invisible and cannot be sensed without the use of detection equipment. Ionizing radiation creates ionization within tissue; these ions can cause cell damage.

Radioactive contamination Radioactive materials distributed over an area, equipment or an individual.

Radioactive materials Materials that contain unstable (radioactive) atoms that give off radiation as they decay. Radioactive materials produce radiation when they decay.

Radioactivity Spontaneous transformation of an unstable atom, often resulting in the emission of radiation. This process is referred to as decay or disintegration of an atom.

Radiological Related to radioactive materials or radiation. The radiological sciences focus on the measurement and effects of radiation.

Radionuclide A radioactive element, for example, uranium 235.

Rate A measure of the frequency of occurrence of disease or death related to a specific population base. Rates (rather than raw numbers) are needed to compare the disease experience of populations at different times, different places, or among different groups of people.

Ratio A measure of association calculated by dividing one amount by another.

Rate ratio The ratio of the incidence of disease or death in an exposed population compared to the incidence in an unexposed group. When the risk of disease is small the rate ratio approximates the relative risk.

Receptors Persons, bodies of water, food, plants or animals potentially affected by release of a hazardous material.

Relative risk (or risk ratio) A ratio comparison of two risk estimates. Relative risk indicates the increased or decreased degree of risk among exposed subjects compared with unexposed persons. A relative risk of 1 indicates no association between the exposure and the disease. A relative risk of 2 indicates that the exposed group is twice as likely as the unexposed group to experience the health effect being studied. The term relative risk is frequently used to refer to the rate ratio and odds ratio when the risk of disease is small.

Rem (roentgen equivalent, man): The traditional unit of equivalent dose; replaced by the sievert (Sv) (1Sv = 100 rem). The rem measures the damage to a human from radiation exposure. It is determined by multiplying the number of rads by a number reflecting the potential damage caused by the particular type of radiation.

Reproducibility When repeated studies produce similar results, it is more likely that a risk factor caused the disease being studied.

Risk The probability of developing a given disease over a specified time period. Risk can be influenced by a variety of factors in addition to exposure to toxic materials— such as: being a smoker or non-smoker; genetic susceptibility; and exposure to other harmful materials. Because many of these factors are not exactly measurable, risk estimates are always uncertain.

Risk factor   An aspect of personal behavior or lifestyle, an environmental exposure, or an inborn or inherited characteristic that is known from scientific evidence to be associated with a health effect.

Sample size   The number of participants in a research study; the larger the sample size in a research study, the more power the study has to detect an association between exposure and health effect.

Selection bias   A type of bias (error) which occurs when there are differences in how people are selected within one study.

– **Response bias**   A type of selection bias which occurs when there are differences between how people in different study groups (for example, exposed or unexposed) participate in a study.

Sievert (Sv)   The unit of equivalent dose of any ionizing radiation that produces the same biological effect as a unit of absorbed dose of ordinary x-rays (1 sievert = 100 rem).

Source term   The quantity of radioactive materials or chemicals released from identified sources or from incidents at a facility. It is usually specified as a rate (quantity released over time, such as, curies per year).

Statistical significance   The probability of seeing an association between exposure and disease risk when no association really exists.

Statistical testing   The assessment of the extent to which a study's results may be accounted for by chance.

Strength of association   Generally refers to the size of the relative risk (or odds ratio). For example, a relative risk of 10 for the association between an exposure and a disease is a stronger association than a relative risk of 2.

Surveillance   The ongoing systematic collection, analysis, interpretation, and reporting of health data. Surveillance data is needed to evaluate public health activities.

Teratogen   An agent or substance that can cause abnormalities in an embryo or fetus.

Tumor   A tumor or "neoplasm" is an abnormal mass of tissue. Tumors are usually classified as either malignant or benign. A malignant tumor is invasive, i.e., it infiltrates the surrounding normal tissue. It usually metastasizes or spreads to other sites in the body. Cancer is the common term for all malignant tumors. A benign tumor does not invade the surrounding normal tissue, it does not spread to other sites, and is not referred to as cancer.

Uncertainty   The term used to describe the lack of precise knowledge in a given estimate based on the amount and quality of the evidence or data available. All estimates contain uncertainty.

Uptake   The absorption by a tissue of some substance and its permanent or temporary retention.

Uranium (U)   The heaviest natural element. Uranium-235, one of the uranium isotopes, can be made to fission through the capture of neutrons. Neutrons produced during fission can in turn fission other U-235 atoms, leading to a chain reaction under certain conditions.

Vital statistics   The recording of births, deaths, marriages, and divorces within a group of people.

Whole-body dose   Radiation exposure to gamma rays from outside the body can give a radiation dose to the entire body, and each organ receives approximately the same dose.