



GLOSSARY OF EXPOSURE ASSESSMENT-RELATED TERMS: A COMPILATION

**Prepared by the Exposure Terminology Subcommittee
of the
IPCS Exposure Assessment Planning Workgroup**

**for the
International Programme on Chemical Safety
Harmonization of Approaches to the Assessment of Risk from Exposure to Chemicals**

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Preamble

This is an unedited selection of exposure assessment related terms taken from a combination of 57 glossaries for exposure and related fields (references below). It has been prepared for the IPCS Exposure Terminology Subcommittee as a research paper for discussion purposes. It makes no pretense at being comprehensive; the 57 glossaries were those that were available to the Subcommittee when the project was in progress. Efforts to obtain several other glossaries were unsuccessful in the period when the work was being done. This compilation is being made available on the IPCS Harmonization website to aid researchers in finding differences in definitions for exposure-related terms, which is part of the original intent of the Exposure Terminology Subcommittee.

Selections of terms in this glossary were based on the IPCS Exposure Terminology Subcommittee's opinion of relevance to exposure assessment. Toxicological terms, risk-related terms, chemical names, procedural terms, and risk management terms were generally excluded from this list, as were terms clearly outside the risk assessment paradigm altogether.

The definitions are presented as they were worded in the references, with minor adjustments to reflect agreement among several definitions as to singular vs. plural definitions (e.g., source vs. sources).

The order in which the definitions are presented is alphabetical by reference, and should not imply order of importance or "correctness." Where several references give the same definition, the references are listed in order of dates, with oldest first.

The International Programme on Chemical Safety (IPCS)

Harmonization of Approaches to the Assessment of Risk from Exposure to Chemicals

GLOSSARY OF EXPOSURE ASSESSMENT-RELATED TERMS: A COMPILATION

Absorbed dose - **a.** See internal dose. [REAP, 1995: Residential Exposure Assessment Project][USEPA, 1992: GL for Exposure Assessment]; **b.** 1. The energy imparted to a unit mass of matter by ionizing radiation. The unit of absorbed dose is the rad. One rad equals 100 ergs per gram. 2. The amount of a substance absorbed into the body, usually per unit of time. The most common unit of dose is mg per kg body weight per day (mg/kg_{day}). [SRA, 1999: Glossary of Risk Analysis Terms, attributed to Stephen L. Brown]; **c.** Energy absorbed by matter from ionizing radiation per unit mass of irradiated material at the place of interest in that material. The absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 gray). [USDOE, 1998: Radiological Control Manual]; **d.** The energy imparted to a unit mass of matter by ionizing radiation. The unit of absorbed dose is the rad or gray. One rad equals 100 ergs per gram. The amount of a substance absorbed into the body, usually per unit of time. The most common unit of dose is mg per kg body weight per day (mg/kg_{day}). [USDOE, 2000: RAIS Glossary]; **e.** The amount of a substance penetrating across an absorption barrier (the exchange boundaries) of an organism, via either physical or biological processes. Sometimes called internal dose. [USEPA, 1992a: Dermal Exposure Assessment]; **f.** In exposure assessment, the amount of a substance that penetrates an exposed organism's absorption barriers (e.g., skin, lung tissue, gastrointestinal tract) through physical or biological processes. The term is synonymous with internal dose. [USEPA, 1997a: EPA Terms of Environment]; **g.** The amount of pesticide entering systemic circulation after crossing a specific absorption barrier (e.g., the exchange boundary of the skin, lung, or digestive tract); normally expressed as mass per unit body weight per unit time (e.g., mg/kg/day). Internal dose is a more general term denoting the amount absorbed with respect to specific absorption barriers or exchange boundaries [USEPA, 1998: Postapp. Exposure Test GL., attributed to USEPA, 1992]; **h.** Dose resulting from the agent crossing the contact boundary and diffusing through a resisting boundary layer [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts] [Cf. **internal dose**]

Absorption - **a.** The process of taking in, as when a sponge takes up water. Chemicals can be absorbed through the skin into the bloodstream and then transported to other organs. Chemicals can also be absorbed into the bloodstream after breathing or swallowing. [ATSDR, 1999: Online Glossary][New York Department of Health, 1999: Glossary of

Environmental Health Terms]; **b.** The penetration of a substance through a barrier (e.g., the skin, gut, or lungs). [REAP, 1995: Residential Exposure Assessment Project]; **c.** 1. The penetration of one substance into or through another. 2. Specifically, the penetration of a substance into the body from the skin, lungs, or digestive tract. [SRA, 1999: Glossary of Risk Analysis Terms, attributed to Stephen L. Brown][USDOE, 2000: RAIS Glossary]; **d.** The taking in of water and dissolved minerals and nutrients across cell membranes. Contrast with ingestion. [UCMP, 1998: Glossary of Ecological Terms]; **e.** A mode of entry of a toxic substance into the body in which the substance enters through the unbroken skin. [University of Kentucky, 1999: Glossary of Safety Terms]; **f.** The process by which a substance is transported across the skin permeability surface barrier and taken up into the living tissue of the body; generally synonymous with percutaneous absorption and with dermal uptake. [USEPA, 1992a: Dermal Exposure Assessment]; **g.** The uptake of water, other fluids, or dissolved chemicals by a cell or an organism (as tree roots absorb dissolved nutrients in soil.) [USEPA, 1997a: EPA Terms of Environment]

Absorption barrier - **a.** Any of the exchange barriers of the body that allow differential diffusion of various substances across a boundary. Examples of absorption barriers are the skin, lung tissue, and gastrointestinal tract wall. [USEPA, 1992: GL for Exposure Assessment][USEPA, 1992a: Dermal Exposure Assessment]; **b.** Any of the exchange sites of the body that permit uptake of various substances at different rates (e.g., skin, lung tissue, and gastrointestinal tract wall) [USEPA, 1997a: EPA Terms of Environment]

Absorption cross section - A measurement of an atom or molecule's ability to absorb light at a specified wavelength, measured in square cm/particle. [SHSU, 2000: Atmospheric Chemistry Glossary, attributed to Journal of Atmospheric Sciences **50**:941-950 (1994) and Journal of Chemical Education **71**:105-108 (1994)]

Absorption factor - The fraction of an agent (e.g., a chemical) making contact with an organism that is systemically distributed in the organism. [REAP, 1995: Residential Exposure Assessment Project]

Absorption fraction - The relative amount of a substance on the skin that penetrates through the epidermis into the body; reported as the

unitless fraction of the applied dose or as the percent absorbed. [USEPA, 1992a: Dermal Exposure Assessment]

Absorption percent - (percent absorbed) The relative amount of a substance that penetrates through a barrier into the body, reported as a unitless fraction. [USEPA, 1997b: Exposure Factors Handbook];

Absorption of radiation - The uptake of radiation by a solid body, liquid or gas. The absorbed energy may be transferred or re-emitted. [USEPA, 2000: Global Warming Glossary]

Acceptable daily intake (ADI) - **a.** The highest daily amount of a substance that may be consumed over a lifetime without adverse effects. [CARB, 2000: Glossary of Air Pollution Terms]; **b.** This is an estimate of the amount of a substance in food that can be ingested daily over a lifetime by humans without appreciable health risk. The concept of the ADI has been developed principally by WHO and FAO and is relevant to chemicals such as additives to foodstuffs, residues of pesticides and veterinary drugs in foods. ADIs are derived from laboratory toxicity data, and from human experiences of such chemicals when this is available, and incorporate a safety factor. The ADI is thus an estimate of the amount of a substance in food that can be ingested over a lifetime by humans without appreciable health risk (for contaminants in food and drinking water, Tolerable Intakes _ daily or weekly _ are used). See Tolerable Daily Intake. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]; **c.** The ADI of a chemical is the estimate of the amount of a substance in food and/or drinking water, expressed on a body-weight basis, that can be ingested daily over a lifetime without appreciable health risk to the consumer on the basis of all the known facts at the time of the evaluation. It is usually expressed in milligrams of the chemical per kilogram of body weight. [FAO/WHO, 1997: Food Consumption & Exp. Assessment of Chemicals]; **d.** The amount of a chemical a person can be exposed to on a daily basis over an extended period of time (usually a lifetime) without suffering deleterious effects. [IRIS, 1999: Glossary of IRIS Terms]; **e.** Same as "Reference Dose". Estimate of largest amount of exposure to an agent on a daily basis not expected to result in adverse effects. [REAP, 1995: Residential Exposure Assessment Project]; **f.** An estimate of the daily exposure dose that is likely to be without deleterious effect even if continued exposure occurs over a lifetime. [USDOE, 2000: RAIS Glossary]

Accumulation - Repeated doses of a chemical may result in its concentration in an organism, organ or tissue increasing progressively and the toxic effects may become more marked with successive doses. Factors involved in accumulation include selective binding of the chemical to tissue molecules, concentration of fat soluble chemicals in body fat, absent or slow metabolism, and slow excretion. Accumulation is a mass balance effect where input exceeds output. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]

Accuracy - **a.** The extent to which results of a calculation or the readings of an instrument approach the true values of the calculated or measured quantities, and are free from error. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** The degree to which a measurement, or an estimate based on measurements, represents the true value of the attribute that is being measured. [Last, 1983: A Dictionary of Epidemiology]; **c.** The degree of agreement between a measured value and the true value; usually expressed as +/- percent of full scale. [SRA, 1999: Glossary of Risk Analysis Terms][USDOE, 2000: RAIS Glossary]; **d.** The measure of the correctness of data, as given by the difference between the measured value and the true or standard value. [USEPA, 1992: GL for Exposure Assessment][USEPA, 1997b: Exposure Factors Handbook] [Cf. **precision**]

Activity - A specific action related to a task or behavior that may result in an exposure event (e.g., harvesting pesticide treated crops, crawling on pesticide treated lawn) [USEPA, 1998: Postapp. Exposure Test GL.]

Actual dermal exposure - The amount of pesticide coming into contact with bare (uncovered) skin and the fraction transferring through protective and work clothing or via seams to the underlying skin, and which is therefore available for percutaneous absorption. [OECD, 1997: Occupational Exposure to Pesticides]

Acute - **a.** Occurring over a short time, usually a few minutes or hours. An acute exposure can result in short-term or long-term health effects. An acute effect happens a short time (up to 1 year) after exposure. [ATSDR, 1999: Online Glossary]; **b.** Occurring over a short time, usually a few minutes or hours. An acute exposure can result in short term or long term health effects. An acute effect happens within a short time after exposure. [New York Department of Health, 1999: Glossary of Environmental Health Terms]; **c.** Acute_diseases or responses with short and generally severe course (often due to high

pollutant concentrations). [SRA, 1999: Glossary of Risk Analysis Terms]; **d.** A health effect that is the result of a short time exposure to a very high concentration of a toxic material. The effect is usually immediately seen, not more than several hours after the exposure. [University of Kentucky, 1999: Glossary of Safety Terms]; **e.** Diseases or responses with short and generally severe course (often due to high pollutant concentrations). [USDOE, 2000: RAIS Glossary]

Acute exposure - **a.** One or a series of short_term exposures generally lasting less than 24 hours. [CARB, 2000: Glossary of Air Pollution Terms]; **b.** One dose or multiple doses of short duration spanning less than or equal to 24 hours. [IRIS, 1999: Glossary of IRIS Terms]; **c.** A short-term exposure to a chemical, usually consisting of a single exposure or dose administered for a period of less than 24 hours. [OFA, 2000: Oxyfuels Glossary]; **d.** An exposure of short duration and/or rapid onset. An acute toxic effect is one that develops during or shortly after an acute exposure to a toxic substance. [REAP, 1995: Residential Exposure Assessment Project]; **e.** A single exposure to a toxic substance which may result in severe biological harm or death. Acute exposures are usually characterized as lasting no longer than a day, as compared to longer, continuing exposure over a period of time. [USEPA, 1997a: EPA Terms of Environment] [USDOE, 2000: RAIS Glossary]

Administered dose - **a.** The amount of a substance given to a test subject (human or animal) in determining dose-response relationships, especially through ingestion or inhalation. In exposure assessment, since exposure to chemicals is usually inadvertent, this quantity is called potential dose. [USEPA, 1992: GL for Exposure Assessment][REAP, 1995: Residential Exposure Assessment Project]; **b.** The amount of a substance given to a test animal in determining dose_response relationships, esp. through ingestion or inhalation. In exposure assessment, since exposure to chemicals is usually inadvertent, this quantity is called applied dose. [USEPA, 1992a: Dermal Exposure Assessment]; **c.** In exposure assessment, the amount of a substance given to a test subject (human or animal) to determine dose_response relationships. Since exposure to chemicals is usually inadvertent, this quantity is often called potential dose. [USEPA, 1997a: EPA Terms of Environment]

Adsorption - **a.** The attachment of the molecules of a liquid or gaseous substance to the surface of a solid. [SRA, 1999: Glossary of Risk Analysis Terms]; **b.** The retention of a substance by soil particles. [USDOE, 2000:

RAIS Glossary]; **c.** Adherence of a solid or liquid to a surface without penetrating through the surface layer. Also, the adherence of ions or organic chemicals onto the surface layer of other materials without being incorporated into or absorbed by the surface of the material. [USEPA, 1992a: Dermal Exposure Assessment]; **d.** Removal of a pollutant from air or water by collecting the pollutant on the surface of a solid material; e.g., an advanced method of treating waste in which activated carbon removes organic matter from waste_water. [USEPA, 1997a: EPA Terms of Environment]

Advection - **a.** In meteorology, the transfer of heat, cold, or other atmospheric properties by the horizontal motion of an air mass; in oceanography, the process of transport of water, or of an aqueous property, solely by the mass motion of the oceans, most typically via horizontal currents. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** To transport or carry. In air quality, the rate at which particulate matter is transported. [SHSU, 2000: Atmospheric Chemistry Glossary, attributed to Journal of the Atmospheric Sciences 51:3109-3121 (1994) and Deep-Sea Research 41:243-261 (1994)]; **c.** Process of transport of an atmospheric property, or substance within the atmosphere, solely by the mass motion of the atmosphere. [SRA, 1999: Glossary of Risk Analysis Terms]

Aerodynamic diameter - **a.** The diameter of a sphere with unit density that has aerodynamic behavior identical to that of the particle in question; an expression of aerodynamic behavior of an irregularly shaped particle in terms of the diameter of an idealized particle. Particles having the same aerodynamic diameter may have different dimensions and shapes. [IRIS, 1999: Glossary of IRIS Terms]; **b.** Expression of aerodynamic behavior of an irregularly shaped particle in terms of the diameter of an idealized particle; that is, aerodynamic diameter is the diameter of a sphere of unit density that has aerodynamic behavior identical to that of the particle in question. Thus, particles having the same aerodynamic diameter may have different dimensions and shapes. [SRA, 1999: Glossary of Risk Analysis Terms]

Aerosol - **a.** Particles of solid or liquid matter that can remain suspended in air from a few minutes to many months depending on the particle size and weight. [CARB, 2000: Glossary of Air Pollution Terms]; **b.** This is a very broad term applied to any suspension of solid or liquid particles in a gas. Particle diameters may range from about 0.001 micrometres to about 100 micrometres. Mass

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concentrations may range from 10^{-9} to 10 grams per cubic metre of gas. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]; **c.** A suspension of liquid or solid particles in air. [IRIS, 1999: Glossary of IRIS Terms]; **d.** A suspension of microscopic solid or liquid particles in air. See also haze, particulate matter. [ODEQ, 1999: Air Quality Glossary]; **e.** System in which the dispersion medium is a gas and the dispersed phase (composed of solid particles or liquid droplet) does not settle out under the influence of gravity. [SRA, 1999: Glossary of Risk Analysis Terms]; **f.** 1. Small droplets or particles suspended in the atmosphere, typically containing sulfur. They are usually emitted naturally (e.g., in volcanic eruptions) and as the result of anthropogenic (human) activities such as burning fossil fuels. 2. The pressurized gas used to propel substances out of a container. 3. A finely divided material suspended in air or other gaseous environment. [USEPA, 1997a: EPA Terms of Environment]; **g.** [aerosols] Particles of matter, solid or liquid, larger than a molecule but small enough to remain suspended in the atmosphere. Natural sources include salt particles from sea spray and clay particles as a result of weathering of rocks, both of which are carried upward by the wind. Aerosols can also originate as a result of human activities and in this case are often considered pollutants. See also Sulfate Aerosols. [USEPA, 2000: Global Warming Glossary]

Aerosol particles - One of the components of an atmospheric air parcel, comprised of minute solids particles part of which is almost certainly water. [SHSU, 2000: Atmospheric Chemistry Glossary, attributed to *The Character and Origins of Smog Aerosols, Vol. 9 - Advances in Environmental Science and Technology Series*; Hidey, ed.; page 234 (1980) Wiley; New York, and *Environmental Particles, Vol. 1 - Environmental Analytical and Physical Chemistry Series*; pages 7, 30, 33 (1992)]; **b.** Solid particles $<10^{-6}$ m in diameter, dispersed in gas. [SRA, 1999: Glossary of Risk Analysis Terms]

Agent - a. A chemical, physical, mineralogical, or biological entity that may cause deleterious effects in an organism after the organism is exposed to it. [USEPA, 1992: GL for Exposure Assessment]; **b.** A chemical, radiological, mineralogical, or biological entity that may cause deleterious effects on an organism after the organism is exposed to it. [USEPA, 1992a: Dermal Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project] [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **c.** Suter et al. 1994 suggested it as an alternative for the term

stressor. It is considered to be more neutral than stressor, and is used in EPA's Guidelines for Exposure Assessment. [USEPA, 1997: Guidance on Cumulative Risk Assessment, Planning and Scoping]; **d.** Any physical, chemical, or biological entity that can be harmful to an organism (synonymous with stressor). [USEPA, 1997a: EPA Terms of Environment]; **e.** Any physical, chemical, or biological entity that can induce an adverse response (synonymous with stressor). [USEPA, 1998a: Guidelines for Ecological Risk Assessment]; **f.** A chemical, physical, mineralogical, or biological entity that may cause deleterious effects in a target after contacting the target [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts] [Cf. **stressor**]

Agent (of disease) - A factor, such as a microorganism, chemical substance, or form of radiation, whose presence, excessive presence, or (in deficiency diseases) relative absence is essential for the occurrence of a disease. A disease may have a single agent, a number of independent alternative agents (at least one of which must be present), or a complex of two or more factors whose combined presence is essential for the development of the disease. See also causality. [Last, 1983: A Dictionary of Epidemiology]

Aggregate exposure - The sum of exposures to pesticide chemical residues with a common mechanism of toxicity from multiple sources and multiple routes of exposure (Food Quality Protection Act, 1996). [USEPA, 1997: Guidance on Cumulative Risk Assessment, Planning and Scoping]

Air exchange rate - a. The rate at which outside air replaces indoor air in a given space. [USEPA, 1997a: EPA Terms of Environment]; **b.** Rate of air leakage through windows, doorways, intakes, exhausts, and "adventitious openings" (i.e. cracks and seams) that combine to form the leakage configuration of the building envelope plus natural and mechanical ventilation. [USEPA, 1997b: Exposure Factors Handbook]

ALARA - a. As Low As Reasonably Achievable; concept utilized in relation to intervention levels following the release of dangerous chemical or nuclear materials. [PDM, 2000: Disaster Terminology; from Debacker, et al., 1999]; **b.** An approach to radiological control to manage and control exposures (individual and collective) to the work force and to the general public at levels as low as is reasonable, taking into account social, technical, economic, practical and public policy considerations. As used in this Manual, ALARA is not a dose limit but a

process that has the objective of attaining doses as far below the applicable controlling limits as is reasonably achievable. [USDOE, 1998: Radiological Control Manual]; **c.** Acronym for "As Low As Reasonably Achievable," means making every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical, consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest. (see 10 CFR 20.1003). [USDOE, 2000: RAIS Glossary]

ALARA Committee - Multidisciplinary forum that reviews and advises management on improving progress toward minimizing radiation exposure and radiological releases. [USDOE, 1998: Radiological Control Manual]

Ambient measurement - a. A measurement (usually of the concentration of a chemical or pollutant) taken in an ambient medium, normally with the intent of relating the measured value to the exposure of an organism that contacts that medium. [USEPA, 1992: GL for Exposure Assessment]; **b.** A measurement of the concentration of a substance or pollutant within the immediate environs of an organism; taken to relate it to the amount of possible exposure. [USEPA, 1997a: EPA Terms of Environment]

Ambient monitoring - a. Monitoring that is done to determine existing environmental conditions, contaminant levels, rates, or species in the environment, against which future conditions can be compared. [NCSU, 1997: Watersheds Glossary]; **b.** A method of measuring the amount of a substance that is available for uptake: composed of environmental monitoring and personal monitoring. [OECD, 1997: Occupational Exposure to Pesticides]

Analysis of variance - A statistical technique that isolates and assesses the contribution of categorical factors to variation in the mean of a continuous outcome variable. The data are divided into categories based on their values for each of the independent variables, and the differences between the mean outcome values of these categories are tested for statistical significance. [Last, 1983: A Dictionary of Epidemiology]

Antagonism - a. When the adverse effect or risk from two or more chemicals interacting

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with each other is less than what it would be if each chemical was acting separately. [ED, 2000: Environmental Scorecard Glossary]; **b.** Opposite of synergism. The situation in which the combined effect of two or more factors is smaller than the solitary effect of any one of the factors. In bioassay, the term may be used to refer to the situation when a specified response is produced by exposure to either of two factors but not by exposure to both together. [Last, 1983: A Dictionary of Epidemiology]; **c.** Interference or inhibition of the effect of one chemical by the action of another. [USDOE, 2000: RAIS Glossary]; **d.** Interference or inhibition of the effect of one chemical by the action of another. [USEPA, 1997a: EPA Terms of Environment] [Cf. **synergism**]

Antagonistic effect - This is the consequence of one chemical (or group of chemicals) counteracting the effects of another: in other words, the situation where exposure to two chemicals together has less effect than the simple sum of their independent effects; such chemicals are said to show antagonism. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]

Applied dose - **a.** The amount of a substance in contact with the primary absorption boundaries of an organism (e.g., skin, lung, gastrointestinal tract) and available for absorption. [USEPA, 1992: GL for Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project]; **b.** In exposure assessment, the amount of a substance in contact with the primary absorption boundaries of an organism (e.g., skin, lung tissue, gastrointestinal tract) and available for absorption. [USEPA, 1997a: EPA Terms of Environment]; **c.** The amount of a substance presented to an absorption barrier (i.e., skin, lung, or digestive tract) and available for absorption, but not yet having crossed the outer boundary of an organism (U.S. EPA, 1992). [USEPA, 1998: Postapp. Exposure Test GL.]; **d.** The amount of a substance in contact with the primary absorption boundaries of an organism (e.g., skin, lung, gastrointestinal tract) and available for absorption. [USEPA, 1992a: Dermal Exposure Assessment]

Arithmetic mean - [also called simply the "mean"] **a.** The arithmetic average of all the values in the data set. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist] **b.** Average. [CARB, 2000: Glossary of Air Pollution Terms]; **c.** A measure of central tendency. It is computed by adding all the individual values together and dividing by the number in the group. [Last, 1983: A Dictionary of Epidemiology]; **d.** The

arithmetic average, or the sum of all the values divided by the number of values. [NIAID, 1997: HIV Vaccine Glossary] **e.** The sum of all the measurements in a data set divided by the number of measurements in the data set. [USEPA, 1992: GL for Exposure Assessment]

As consumed intake rates - Intake rates that are based on the weight of the food in the form that it is consumed. [USEPA, 1997b: Exposure Factors Handbook]

As low as reasonably achievable - see **ALARA**

Assessment - **a.** Survey of a real or potential disaster to estimate the actual or expected damages and to make recommendations for preparedness, mitigation and relief action [PDM, 2000: Disaster Terminology; from Gunn, 1990]; **b.** Evaluation or appraisal of a process, program or activity to estimate its acceptability. [USDOE, 1998: Radiological Control Manual]

Assessment of exposure - see **exposure assessment**

Atmospheric lifetime - see **lifetime**

Autocorrelation - The correlation between adjacent observations in time or space. [NCSU, 1997: Watershedds Glossary]

Average daily dose (ADD) - The average dose received on any given day during a period of exposure, expressed in mg/kg body weight/day. Ordinarily used in assessing noncancer risks. [REAP, 1995: Residential Exposure Assessment Project]; **b.** Dose rate averaged over a pathway specific period of exposure expressed as a daily dose on a per-unit-body-weight basis. The ADD is used for exposure to chemicals with non-carcinogenic, non-chronic effects. The ADD is usually expressed in terms of mg/kg-day or other mass/mass-time units. [USEPA, 1997b: Exposure Factors Handbook] [IRIS, 1999: Glossary of IRIS Terms]; **c.** Dose that is averaged over a specified time period taking into account the frequency, duration, and intensity of exposure during that time period. ADDs are usually expressed in units of mg/kg/day. [USEPA, 1998: Postapp. Exposure Test GL.]

Average life expectancy - [expectation of life] The average number of years an individual is expected to live if current mortality trends continue to apply. A statistical abstraction based on existing, age-specific death rates. *Life expectancy at birth* (l_0): Average number of years a newborn baby can be expected to live if current mortality trends continue. Corresponds to the total number of years a

given birth cohort can be expected to live, divided by the number of children in the cohort. Life expectancy at birth is partly dependent on mortality in the first year of life and is lower in poor than in rich countries because of the higher infant mortality rates in the former. *Life expectancy at a given age*, age x (l_x): The average number of additional years a person age x would live if current mortality trends continue to apply, based on the age-specific death rates for a given year. Life expectancy is a hypothetical measure and indicator of current health and mortality conditions. It is not a rate. [Last, 1983: A Dictionary of Epidemiology]

Background level (or levels) - **a.** (1) **anthropogenic**: concentrations of chemicals that are present in the environment due to human-made, non-site sources; (2) **naturally occurring**: ambient concentrations of chemicals that are present in the environmental and have not been influenced by humans. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist, attributed to the Risk Assessment Guidance for Superfund, USEPA 1989]; **b.** A typical or average level of a chemical in the environment. Background often refers to naturally occurring or uncontaminated levels. [ATSDR, 1999: Online Glossary] [New York Department of Health, 1999: Glossary of Environmental Health Terms]; **c.** Two types of background levels may exist for chemical substances: (1) Naturally occurring levels: Ambient concentrations of substances present in the environment, without human influence; (2) Anthropogenic levels: Concentrations of substances present in the environment due to human-made, non-site sources (e.g., automobiles, industries). [IRIS, 1999: Glossary of IRIS Terms]; **d.** (1) In air pollution, the level of pollutants present in ambient air from natural sources. (2) More generally, the level of pollution present in any environmental medium attributable to natural or ubiquitous sources. [SRA, 1999: Glossary of Risk Analysis Terms, attributed to Stephen L. Brown] [USDOE, 2000: RAIS Glossary]; **e.** The concentration of substance in a defined control area during a fixed period of time before, during, or after a data-gathering operation. [USEPA, 1992: GL for Exposure Assessment]; **f.** (1) The concentration of a substance in an environmental media (air, water, or soil) that occurs naturally or is not the result of human activities. (2) In exposure assessment the concentration of a substance in a defined control area, during a fixed period of time before, during, or after a data-gathering operation.. [USEPA, 1997a: EPA Terms of Environment]

Benchmark dose (BMD) - **a.** A statistical

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lower confidence limit on the dose producing a predetermined, altered response for an effect. [USEPA, 1995: Benchmark Dose]; **b.** (also **benchmark concentration, BMC**) A statistical lower confidence limit on the dose that produces a predetermined change in response rate of an adverse effect (called the benchmark response or BMR) compared to background. [IRIS, 1999: Glossary of IRIS Terms]

Bias - **a.** A technical term for playing favorites in choosing study subjects or in assessing exposure. [FACS, 2000: Epidemiology for Journalists]; **b.** Any effect at any stage of investigation or inference tending to produce results that depart systematically from the true values (to be distinguished from *random error*). The term "bias" does not necessarily carry an imputation of prejudice or other subjective factor, such as the experimenter's desire for a particular outcome. This differs from conventional usage in which bias refers to a partisan point of view. Many varieties of bias have been described. [attributed to Sackett, D. L., Bias in analytic research, *J. Chron. Dis.* 32:51-53 (1979)]... **ascertainment bias** - Systematic error, arising from the kind of individuals or patients (e.g., slightly ill, moderately ill, acutely ill) that the individual observer is seeing. Also systematic error arising from the diagnostic process (which may be determined by the culture, customs, or individual idiosyncrasy of the person providing care for the patient)... **bias due to instrumental error** - Systematic error due to faulty calibration, inaccurate measuring instruments, contaminated reagents, incorrect dilution or mixing of reagents, etc.... **bias due to withdrawals** - A difference between the true value and that actually observed in a study due to the characteristics of those subjects who choose to withdraw.... **bias, in assumption** - (Syn: conceptual bias) Error arising from faulty logic or premises or mistaken beliefs on the part of the investigator. False conclusions about the explanation for associations between variables. Example: Having correctly deduced the mode of transmission of cholera, John Snow concluded that yellow fever was transmitted by similar means. In fact, the "miasma" theory would better fit the facts of yellow fever transmission.... **bias in autopsy series** - Systematic error resulting from the fact that autopsies represent a nonrandom sample of all deaths.... **bias in handling outliers** - Error arising from a failure to discard an unusual value occurring in a small sample, or due to exclusion of unusual values that should be included.... **bias in publication** - An editorial predilection for publishing particular findings, e.g., positive results, which leads to the failure of authors to submit negative findings for publication. This can

distort the general belief about what has been demonstrated in a particular situation.... **bias in the presentation of data** - Error due to irregularities produced by digit preference, incomplete data, poor techniques of measurement, or technically poor laboratory standards.... **bias of interpretation** - Error arising from inference and speculation. Sources of the error include (1) failure of the investigator to consider every interpretation consistent with the facts and to assess the credentials of each, and (2) mishandling of cases that constitute exceptions to some general conclusion.... **design bias** - The difference between a true value and that actually obtained, occurring as a result of faulty design of a study. Some examples are (1) uncontrolled studies where the effects of two processes cannot be separated (confounding), (2) controlled studies where observations are based on a poorly defined population, and (3) nonsimultaneous comparisons.... **detection bias** - Due to systematic error(s) in methods of ascertainment, diagnosis, or verification of cases in an epidemiologic survey, study, or investigation. Example: Verification of diagnosis by laboratory tests in hospital cases, but failure to apply the same tests to cases outside hospital.... **information bias** - (Syn: observational bias) A flaw in measuring exposure or outcome that results in differential quality (accuracy) of information between compared groups.... **interviewer bias** - Systematic error due to interviewers' subconscious or even conscious gathering of selective data.... **length bias** - A systematic error due to the selection of a disproportionate number of long-duration cases (cases who survive longest) in one group and not in the other. Can occur when prevalent cases, rather than incident cases, are included in a case control study.... **"lead time" bias** - A systematic error arising when follow-up of two groups does not begin at strictly comparable times. Occurs especially when one group has been diagnosed earlier in the natural history of the disease than the other group.... **measurement bias** - Systematic error arising from inaccurate measurement (or classification) of subjects on the study variables.... **observer bias** - Systematic difference between a true value and that actually observed due to observer variation. Observer variation may be due to differences among observers (interobserver variation) or to variation in readings by the same observer on separate occasions (intraobserver variation)... **recall bias** - Systematic error due to differences in accuracy or completeness of recall to memory of prior events or experiences. Example: Mothers whose children have had or have died of leukemia are more likely than mothers of healthy living children

to remember details of diagnostic x-ray examinations to which these children were exposed *in utero*.... **reporting bias** - Selective suppression or revealing of information such as past history of sexually transmitted disease.... **response bias** - Systematic error due to difference in characteristics between those who choose or volunteer to participate in a study and those who do not.... **sampling bias** - Unless the sampling method ensures that all members of the "universe" or reference population have a known chance of selection in the sample, bias is possible. The best way to ensure a known chance of selection for all is to use a probability sampling method such as a table of random numbers.... **selection bias (Berkson's bias)** - Error due to systematic differences in characteristics between those who are selected for study and those who are not. Examples include hospital cases or cases under a physician's care, excluding those who die before admission to hospital because the course of their disease is so acute, those not sick enough to require hospital care, or those excluded by distance, cost, or other factors. Selection bias also invalidates generalizable conclusions from surveys which would include only volunteers from a healthy population. A special example is Berkson's Bias, which Berkson characterized as the set of selective factors that lead hospital cases and controls in a case control study to be systematically different from one another. This occurs when the combination of exposure and disease under study increases the risk of hospital admission, thus leading to a systematically higher exposure rate among the hospital cases than the hospital controls. This in turn results in systematic distortion of the odds ratio. [from Berkson, J., Limitations of the application of fourfold table analysis to hospital data, *Biometrics Bull.* 2:47-53, 1946.] [Last, 1983: A Dictionary of Epidemiology]; **c.** An inclination that influences judgment. The term "bias" may be used in a merely descriptive way to mean an inclination, but more often it is used as a term of evaluation to mean an inclination that influences judgment and ought not to. "Prejudice" is a synonym for bias in this pejorative sense. However, bias that cannot be completely eliminated in the work of scientific investigators, in contrast to bias or prejudice that can and should be eliminated, is also an important topic in research ethics. For example, the way disciplinary training inclines people to interpret the results of an experiment in terms of the established categories of that discipline is a feature of research, and one that must be taken into account in assessing responsible behavior in research. Since undertaking research requires undergoing advanced training in a discipline, it is impossible to eliminate all preconceptions from one's interpretation of the data. Of

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course, researchers may hold disciplinary biases and still be unbiased in other respects. For example, they may be impartial on the question of the truth or falsity of a particular research hypothesis. [OECEs, 1998: Online Ethics Glossary]; **d.** Any difference between the true value and that actually obtained due to all causes other than sampling variability. [SRA, 1999: Glossary of Risk Analysis Terms]; **e.** Any difference between the true value and that actually obtained due to all causes other than sampling variability. [USDOE, 2000: RAIS Glossary]; **f.** A systematic error inherent in a method or caused by some feature of the measurement system. [USEPA, 1992: GL for Exposure Assessment]

Bimodal distribution - A distribution with two regions of high frequency separated by a region of low frequency of observations. A two_peak distribution. [Last, 1983: A Dictionary of Epidemiology]

Bioaccumulants - Substances that increase in concentration in living organisms as they take in contaminated air, water, or food because the substances are very slowly metabolized or excreted. (See: biological magnification.) [USEPA, 1997a: EPA Terms of Environment]

Bioaccumulation - a. In ecology, the accumulation of toxic chemicals in living things through the consumption of food or water. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** Bioaccumulation is the process by which chemicals concentrate in an organism. For example, DDT concentrates in fish and birds that eat fish. This concentration effect is expressed as the ratio of the concentration of the chemical in an organism (like a fish) to its concentration in the surrounding medium (usually water). Bioaccumulation refers to the uptake of chemicals both from water (bioconcentration) and from ingested food and sediment. [ED, 2000: Environmental Scorecard Glossary]; **c.** The process by which a contaminant accumulates in the tissues of an organism. [NCSU, 1997: Watersheds Glossary]; **d.** The process whereby certain toxic substances collect in living tissues, thus posing a substantial hazard to human health or the environment. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]

Bioavailability - a. The state of being capable of being absorbed and available to interact with the metabolic processes of an organism. Typically a function of chemical properties, physical state of the material to which an organism is exposed, and the ability of the individual organism to physiologically

take up the chemical. Also, the term used for the fraction of the total chemical in the environmental which is available for uptake by organisms. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist, attributed to USEPA 1992a]; **b.** The degree to which a substance becomes available to the target tissue after administration or exposure. [IRIS, 1999: Glossary of IRIS Terms]; **c.** The state of being capable of being absorbed and available to interact with the metabolic processes of an organism. Bioavailability is typically a function of properties of agents, physical state of the material to which an organism is exposed, and the ability of the individual organism to physiologically take up the agent. [REAP, 1995: Residential Exposure Assessment Project]; **d.** The state of being capable of being absorbed and available to interact with the metabolic processes of an organism. Bioavailability is typically a function of chemical properties, physical state of the material to which an organism is exposed, and the ability of the individual organism to physiologically take up the chemical. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment]; **e.** Degree of ability to be absorbed and ready to interact in organism metabolism. [USEPA, 1997a: EPA Terms of Environment]

Bioconcentration - a. The tendency of a chemical to accumulate in a living organism to levels in excess of the concentration in its surrounding environment. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** The accumulation of a chemical in tissues of a fish or other organism to levels greater than in the surrounding medium. [USEPA, 1997a: EPA Terms of Environment]

Bioconcentration factor (BCF) - provides a measure of the extent of chemical partitioning at equilibrium between a biological medium such as fish tissue or plant tissue and an external medium such as water. The higher the BCF, the greater the likely accumulation in living tissue. (Source: RAGS, 1989) [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]

Biodegradation - decomposition [by living organisms], especially by bacterial action. One of the most important degradation pathways for chemicals in the soil or aqueous environments. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]

Bioindicators - Organisms that are used to detect changes in environmental pollutant levels. [NCSU, 1997: Watersheds Glossary]

Biological half life (t1/2) - a. The term which is used for the time required for the amount of a particular substance in a biological system to be reduced to one half of its value by biological processes when the rate of removal is approximately exponential. Substances with a long biological half life will tend to accumulate in the body and are, therefore, particularly to be avoided. Substances with a short biological half life may accumulate if some becomes tightly bound, even if most is cleared from the body rapidly. There is also the possibility of cumulative effects of chemicals which have a short residence time in the body. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]; **b.** The time required for a biological system (such as a human or animal) to eliminate, by natural processes, half the amount of a substance (such as a radioactive material) that has been absorbed into that system. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary] [cf. half-life]

Biomagnification (biological magnification) - a. The process by which impurities found in water are concentrated in lower forms of life and reconcentrated substantially during their movement through the food chain. Due also to uptake of food which has progressively bioconcentrated that chemical in its environment. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** This is a general term applied to the sequence of processes in an ecosystem by which higher concentrations are attained in organisms of higher trophic level, i.e., of higher levels in the food chain. The process by which xenobiotics increase in body concentration in organisms through a series of prey-predator relationships from primary producers to ultimate predators, often human beings. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]; **c.** An increase in the concentration of a substance in each progressive link of the food chain. [NCSU, 1997: Watersheds Glossary]; **d.** The concentration of certain substances up a food chain. A very important mechanism in concentrating pesticides and heavy metals in organisms such as fish. [SRA, 1999: Glossary of Risk Analysis Terms]; **e.** Refers to the process whereby certain substances such as pesticides or heavy metals move up the food chain, work their way into rivers or lakes, and are eaten by aquatic organisms such as fish, which in turn are eaten by large birds, animals or humans. The substances become concentrated in tissues or internal organs as they move up the chain. [USDOE, 2000: RAIS Glossary]; **f.** Refers to the process whereby certain substances such as pesticides or heavy metals move up the food chain, work

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their way into rivers or lakes, and are eaten by aquatic organisms such as fish, which in turn are eaten by large birds, animals or humans. The substances become concentrated in tissues or internal organs as they move up the chain. (See: bioaccumulants.) [USEPA, 1997a: EPA Terms of Environment]

Biological marker (biomarker) - Indicators of changes or events in human biological systems. Biological markers of exposure refer to cellular, biochemical, or molecular measures that are obtained from biological media such as human tissues, cells, or fluids and are indicative of exposure to environmental contaminants. [NRC, 1991: Human Exp. for Airborne Pollutants]

Biological marker (biomarker) of exposure - Exogenous chemicals, their metabolites, or products of interactions between a xenobiotic chemical and some target molecule or cell that is measured in a compartment within an organism. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment] [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]

Biological measurement - a. A measurement taken in a biological medium. For the purpose of exposure assessment via reconstruction of dose, the measurement is usually of the concentration of a chemical/metabolite or the status of a biomarker, normally with the intent of relating the measured value to the internal dose of a chemical at some time in the past. (Biological measurements are also taken for purposes of monitoring health status and predicting effects of exposure.) (See also ambient measurement) [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment]; **b.** A measurement taken in a biological medium. For exposure assessment, it is related to the measurement is taken to related it to the established internal dose of a compound. [USEPA, 1997a: EPA Terms of Environment]

Biological medium - a. One of the major categories of material within an organism, e.g., blood, adipose tissue, or breath, through which chemicals can move, be stored, or be biologically, physically, or chemically transformed. (See also ambient medium, environmental medium) [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment]; **b.** One of the major component of an organism; e.g., blood, fatty tissue, lymph nodes or breath, in which chemicals can be stored or transformed. (See: ambient medium, environmental medium.) [USEPA, 1997a: EPA Terms of Environment]

Biological monitoring (biomonitoring) - a. Measuring chemicals in biological materials (blood, urine, breath, etc.) to determine whether chemical exposure in humans, animals, or plants has occurred. [ATSDR, 1999: Online Glossary] [New York Department of Health, 1999: Glossary of Environmental Health Terms]; **b.** This is a procedure of periodic examination of biological specimens for the purposes of monitoring. It is usually applied to exposure monitoring but can also apply to effect monitoring. Analysis of the amounts of potentially toxic substances or their metabolites present in body tissues and fluids, as a means of assessing exposure to these substances and aiding timely action to prevent adverse effects. The term is also used to mean assessment of the biological status of populations and communities of organisms at risk, in order to protect them and to have early warning of possible hazards to human health. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]; **c.** A method of assessing the absorption of chemicals by measuring the parent compound or its metabolites in body fluids, usually blood, urine or exhaled breath. Woollen (1993) refined this term in the context of pesticides and assessment of absorbed dose for risk assessment: Measurement of a pesticide or its metabolites in the body fluids of exposed persons and conversion to an equivalent absorbed dose of the pesticide based on a knowledge of its human metabolism and pharmacokinetics. [OECD, 1997: Occupational Exposure to Pesticides]; **d.** 1. The use of living organisms to test the suitability of effluents for discharge into receiving waters and to test the quality of such waters downstream from the discharge. 2. Analysis of blood, urine, tissues, etc., to measure chemical exposure in humans. [USEPA, 1997a: EPA Terms of Environment]

Biological stressor - a. As used in this report, synonymous with non-indigenous species - a species introduced (intentionally or unintentionally) beyond its natural range or natural zone of potential dispersal. Biological stressors may also include genetically engineered organisms. [CENR, 1999: Ecorisk in the Federal Government]; **b.** [biological stressors] Organisms accidentally or intentionally dropped into habitats in which they do not evolve naturally; e.g. gypsy moths, Dutch elm disease, certain types of algae, and bacteria. [USEPA, 1997a: EPA Terms of Environment]

Biological uptake - The transfer of hazardous substances from the environment to plants, animals, and humans. This may be evaluated

through environmental measurements, such as measurement of the amount of the substance in an organ known to be susceptible to that substance. More commonly, biological dose measurements are used to determine whether exposure has occurred. The presence of a contaminant, or its metabolite, in human biologic specimens, such as blood, hair, or urine, is used to confirm exposure and can be an independent variable in evaluating the relationship between the exposure and any observed adverse health effects. [ATSDR, 1999: Online Glossary]

Biologically Based Dose Response (BBDR) model - A predictive tool used to estimate potential human health risks by describing and quantifying the key steps in the cellular, tissue and organismal responses as a result of chemical exposure. [IRIS, 1999: Glossary of IRIS Terms]

Biologically effective dose - a. The amount of the deposited or absorbed contaminant that reaches the cells or target site where an adverse effect occurs or where an interaction of that contaminant with a membrane surface occurs. [NRC, 1991: Human Exp. for Airborne Pollutants]; **b.** The amount of a deposited or absorbed chemical that reaches the cells or target site where an adverse effect occurs, or where that chemical interacts with a membrane surface. [USEPA, 1992: GL for Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project] [USEPA, 1997a: EPA Terms of Environment]

Biomarker - see **biological marker**

Biomonitoring - see **biological monitoring**

Biosensor - Analytical device comprising a biological recognition element (e.g., enzyme, receptor, DNA, antibody, or microorganism) in intimate contact with an electrochemical, optical, thermal, or acoustic signal transducer that together permit analyses of chemical properties or quantities. Shows potential development in some areas, including environmental monitoring. [USEPA, 1997a: EPA Terms of Environment]

Biotransformation - a. The transformation of chemical compounds within a living system. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** In this process, a chemical is modified by a living organism in contrast to abiotic processes referred to earlier. The enzyme-mediated transformation of xenobiotics, frequently involving phase 1 and phase 2 reactions. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]; **c.** Conversion of a substance into other

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compounds by organisms; includes biodegradation. [USEPA, 1997a: EPA Terms of Environment]

Body burden - **a.** The amount of a particular chemical stored in the body at a particular time, especially a potentially toxic chemical in the body as a result of exposure. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** The total amount of a chemical in the body. Some chemicals build up in the body because they are stored in fat or bone or are eliminated very slowly. [ATSDR, 1999: Online Glossary]; **c.** The total amount of a chemical in the body. Some chemicals build up in the body because they are stored in body organs like fat or bone or are eliminated very slowly. [New York Department of Health, 1999: Glossary of Environmental Health Terms]; **d.** The amount of a substance stored in the body a particular time, in the body as a result of exposure. Body burdens can be the result of long term or short term storage, for example, the amount of metal in bone, the amount of a lipophilic substance such as PCB is adipose tissue, or the amount of carbon monoxide (as carboxyhemoglobin) in the blood. [REAP, 1995: Residential Exposure Assessment Project]; **e.** The total amount of a specific substance (for example, lead) in an organism, including the amount stored, the amount that is mobile, and the amount absorbed. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]; **f.** The amount of a particular chemical stored in the body at a particular time, especially a potentially toxic chemical in the body as a result of exposure. Body burdens can be the result of long-term or short-term storage, for example, the amount of a metal in bone, the amount of a lipophilic substance such as PCB in adipose tissue, or the amount of carbon monoxide (as carboxyhemoglobin) in the blood. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment]; **g.** The amount of a chemical stored in the body at a given time, especially a potential toxin in the body as the result of exposure. [USEPA, 1997a: EPA Terms of Environment]

Bounding estimate - An estimate of exposure, dose, or risk that is higher than that incurred by the person in the population with the highest exposure, dose, or risk. Bounding estimates are useful in developing statements that exposures, doses, or risks are "not greater than" the estimated value. [USEPA, 1992: GL for Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project] [USEPA, 1997a: EPA Terms of Environment]

Breathing zone - **a.** The area around the nose and mouth from which air is inhaled. [OECD,

1997: Occupational Exposure to Pesticides]; **b.** A zone of air in the vicinity of an organism from which respired air is drawn. Personal monitors are often used to measure pollutants in the breathing zone. [USEPA, 1992: GL for Exposure Assessment]; **c.** Area of air in which an organism inhales. [USEPA, 1997a: EPA Terms of Environment]

Characterization of exposure - **a.** A portion of the analysis phase of ecological risk assessment that evaluates the interaction of the stressor with one or more ecological entities. Exposure can be expressed as co-occurrence or contact, depending on the stressor and ecological component involved. [CENR, 1999: Ecorisk in the Federal Government]; **b.** A portion of the analysis phase of ecological risk assessment that evaluates the interaction of the stressor with one or more ecological entities. Exposure can be expressed as co-occurrence or contact, depending on the stressor and ecological component involved. [USEPA, 1998a: Guidelines for Ecological Risk Assessment]; **c.** Portion of an ecological risk assessment that evaluates interaction of a stressor with one or more ecological entities. [USEPA, 1997a: EPA Terms of Environment]

Chemical stressors - Chemicals released to the environment through industrial waste, auto emissions, pesticides, and other human activity that can cause illnesses and even death in plants and animals. [USEPA, 1997a: EPA Terms of Environment]

Chronic - **a.** Occurring over a long period of time (more than 1 year). [ATSDR, 1999: Online Glossary]; **b.** Occurring over a long period of time, several weeks, months or years. [New York Department of Health, 1999: Glossary of Environmental Health Terms]; **c.** Having a persistent, recurring or long-term nature. As distinguished from acute. [SRA, 1999: Glossary of Risk Analysis Terms]; **d.** A toxic effect that occurs only after exposure to a material for a long time, usually months or years. The amount of exposure is usually very low, and often symptoms are not immediately noticeable. [University of Kentucky, 1999: Glossary of Safety Terms]; **e.** Having a persistent, recurring or long-term nature. As distinguished from acute. [USDOE, 2000: RAIS Glossary]; **f.** A disease or condition that has been present for several weeks or longer. [WSU, 1999: Definitions and Abbreviations of Veterinary Terms]

Chronic daily intake - see *intake, chronic daily*. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]

Chronic exposure - **a.** Long-term exposure, usually lasting one year to a lifetime. [CARB,

2000: Glossary of Air Pollution Terms]; **b.** Multiple exposures occurring over an extended period of time, or a significant fraction of the animal's or the individual's lifetime. [IRIS, 1999: Glossary of IRIS Terms]; **c.** A long-term exposure to a chemical for a period of one year or more in animals and more than seven years in humans. [OFA, 2000: Oxyfuels Glossary]; **d.** A persistent, recurring, or long-term exposure, as distinguished from acute. Chronic exposure may result in health effects (such as cancer) that are delayed in onset, occurring long after exposure has ceased. [REAP, 1995: Residential Exposure Assessment Project]; **e.** Multiple exposures occurring over an extended period of time, or a significant fraction of the animal's or the individual's life-time. [USDOE, 2000: RAIS Glossary]; **f.** Long-term exposure usually lasting 6 months to a lifetime. [USEPA, 1995: Benchmark Dose]; **g.** Multiple exposures occurring over an extended period of time or over a significant fraction of an animal's or human's lifetime (Usually seven years to a lifetime.) [USEPA, 1997a: EPA Terms of Environment]; **h.** Exposure to the poison occurs over a period of weeks, months, or years; onset of signs may be sudden and dramatic, or can be insidious like a slow loss in body condition or reduced productivity. [WSU, 1999: Definitions and Abbreviations of Veterinary Terms]

Chronic intake - The long term period over which a substance crosses the outer boundary of an organism without passing an absorption barrier. [USEPA, 1997b: Exposure Factors Handbook]

Climate model - A quantitative way of representing the interactions of the atmosphere, oceans, land surface, and ice. Models can range from relatively simple to quite comprehensive. Also see General Circulation Model. [USEPA, 2000: Global Warming Glossary]

Climate modeling - The simulation of the climate using computer-based models. Also see General Circulation Model. [USEPA, 2000: Global Warming Glossary]

Coefficient of variation - The ratio of the standard deviation to the mean. This is meaningful only if the variable is measured on a ratio scale. [Last, 1983: A Dictionary of Epidemiology]

Collective dose - **a.** The sum of the total effective dose equivalent values for all individuals in a specified population. Collective dose is expressed in units of person-rem (or person-sievert). [USDOE, 1998: Radiological Control Manual]; **b.** The sum

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of the individual doses received on a given period of time by a specified population from exposure to a specified source of radiation. [USDOE, 2000: RAIS Glossary]

Composite sample - a. A sample of water, soil or other medium which is made by combining samples from two or more locations. [New York Department of Health, 1999: Glossary of Environmental Health Terms]; **b.** A series of water samples taken over a given period of time and weighted by flow rate. Or a soil sample that consists of soil taken from various depths or various locations. [USDOE, 2000: RAIS Glossary]; **c.** A series of water samples taken over a given period of time and weighted by flow rate. [USEPA, 1997a: EPA Terms of Environment]

Concentration - a. The amount of one substance dissolved or contained in a given amount of another. For example, sea water contains a higher concentration of salt than fresh water. [ATSDR, 1999: Online Glossary] [New York Department of Health, 1999: Glossary of Environmental Health Terms]; **b.** The amount of material in the air, eg., 50 parts per million. May also refer to the amount of a substance in a mixture, eg., 10% ammonia in water. [University of Kentucky, 1999: Glossary of Safety Terms]; **c.** The relative amount of a substance mixed with another substance. An example is five ppm of carbon monoxide in air or 1 mg/l of iron in water. [USEPA, 1997a: EPA Terms of Environment]; **d.** Amount of agent per unit volume [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Concentration_effect curve - This is a graph produced to show the relationship between the exposure concentration of a drug or xenobiotic and the magnitude of graded effect that it produces. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]

Concentration ratio - The ratio of the concentration of a compound or radionuclide in an organism or its tissues to the concentration in the surrounding under equilibrium, or steady_state conditions. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]

Concentration_response curve- This is a graph produced to show the relation between the exposure concentration of a drug or xenobiotic and the degree of response it produces, as measured by the percentage of the exposed population showing a defined, often quantal, effect. If the effect determined is death, the curve may be used to estimate an LC50 value. [Duffus, 2000: Univ. Edinburgh

Med School On-line Chemical Safety Glossary]

Conceptual model - a. The conceptual model describes a series of working hypotheses of how the stressor might affect ecological entities. The conceptual model also describes the ecosystem potentially at risk, the relationship between measures of effect and assessment endpoints, and exposure scenarios. [CENR, 1999: Ecorisk in the Federal Government]; **b.** A diagram or written description of the predicted key relationships between the stressor(s) and the assessment endpoint(s) for a risk assessment. [USEPA, 1997: Guidance on Cumulative Risk Assessment, Planning and Scoping]; **c.** A conceptual model in problem formulation is a written description and visual representation of predicted relationships between ecological entities and the stressors to which they may be exposed. [USEPA, 1998a: Guidelines for Ecological Risk Assessment]

Confidence interval - a. A range of values which bracket a *point estimate*; e.g., there is a 95% probability that the true value is contained in the 95% confidence interval. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** A range of values ($a_1 < a < a_2$) determined from a sample of definite rules so chosen that, in repeated random samples from the hypothesized population, an arbitrarily fixed proportion of that range will include the true value, x , of an estimated parameter. The limits, a_1 and a_2 , are called confidence limits; the relative frequency with which these limits include a is called the confidence coefficient; and the complementary probability is called the confidence level. As with significance levels, confidence levels are commonly chosen as 0.05 or 0.01, the corresponding confidence coefficients being 0.95 or 0.99. Confidence intervals should not be interpreted as implying that the parameter itself has a range of values; it has only one value, a . On the other hand, the confidence limits (a_1 , a_2) being derived from a sample, are random variables, the values of which on a particular sample either do or do not include the true value a of the parameter. However, in repeated samples, a certain proportion of these intervals will include a provided that the actual population satisfied the initial hypothesis. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]

Confidence limit - A confidence interval for a parameter is a range of values that has a specified probability (e.g., 95 percent) of containing the parameter. The confidence limit refers to the upper or lower value of the range (e.g., upper confidence limit). [USEPA, 1995: Benchmark Dose]

Contact boundary - a surface in space containing at least one exposure point on the target of interest [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Contact boundary element - Surface element of a contact boundary [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Contact, direct - see **direct contact**

Contact, indirect - see **indirect contact**

Contact rate - a. Amount of medium (water, soil) contacted per unit of time or event. (Source: RAGS, 1989) [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** The rate at which susceptibles meet infecteds. Usually measured as individuals per unit time. [Swinton, 1999: A Dictionary of Epidemiology]

Contact zone - a volume adjoining a contact boundary in which agent has a high probability of contacting the contact boundary in the time interval of interest [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Contact zone element - Volume element that contains only one type of carrier medium (e.g., air, liquid, soil, particles) and is contained in a contact zone [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Contact zone thickness - The distance (from the contact boundary) in which a particle of agent has at least a pre-specified probability p of intersecting the contact boundary within a pre-specified time interval t [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Continuous sample - a. A flow of water from a particular place in a plant to the location where samples are collected for testing; may be used to obtain grab or composite samples. [USDOE, 2000: RAIS Glossary]; **b.** A flow of water, waste or other material from a particular place in a plant to the location where samples are collected for testing. May be used to obtain grab or composite samples. [USEPA, 1997a: EPA Terms of Environment]

Continuous time model - A model in which the system changes continuously over time. Derivatives (e.g. dY/dt) are the mathematical formalism for describing such continuous change. The differential equation which embodies a model provides the values of these derivatives at any particular time point; calculus or a computer can then be used to move the state of the model forwards in time. Continuous models have the advantage over

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discrete time models in that they are more amenable to algebraic manipulation, although they are slightly harder to implement on a computer. The same as a differential equation model. [Swinton, 1999: A Dictionary of Epidemiology]

Correlation - relationship that results when a change in one variable is consistently associated with a change in another one [EDVCB, 2000: Environmental Economics Glossary]

Correlation coefficient - A measure of association that indicates the degree to which two or more sets of observations fit a linear relationship. This coefficient, represented by the letter r , can vary between +1 and -1. If $r = +1$, there is a perfect linear relationship in which one variable varies directly with the other. If $r = -1$, there is again a perfect linear association, but one variable varies inversely with the other. [Last, 1983: A Dictionary of Epidemiology]

Cumulative distribution function (CDF) - Cumulative distribution functions are particularly useful for describing the likelihood that a variable will fall within different ranges of x . $F(x)$ (i.e., the value of y at x in a CDF plot) is the probability that a variable will have a value less than or equal to x . *Note: the original has a sample CDF plot that is not reproduced here.* [USEPA, 1998a: Guidelines for Ecological Risk Assessment]

Cumulative dose - The total dose resulting from repeated exposures of ionizing radiation to an occupationally exposed worker to the same portion of the body, or to the whole body, over a period of time (see 10 CFR 20.1003). [USDOE, 2000: RAIS Glossary]

Cumulative exposure - The sum of exposures of an organism to a pollutant over a period of time. [USEPA, 1997a: EPA Terms of Environment]

Cutaneous - Of, relating to, or affecting the skin. [USEPA, 1992a: Dermal Exposure Assessment]

Delivered dose - The amount of a chemical available for interaction by any particular organ or cell (U.S. EPA, 1992). [USEPA, 1998: Postapp. Exposure Test GL.]

Demography - **a.** The study of populations, especially with reference to size and density, fertility, mortality, growth, age distribution, migration, and VITAL STATISTICS, and the interaction of all these with social and economic conditions. [Last, 1983: A Dictionary of Epidemiology]; **b.** The rate of

growth and the age structure of populations, and the processes that determine these properties. [WRI, 1992: Biodiversity Glossary of Terms]

Dermal - Referring to the skin. Dermal absorption means absorption through the skin. [ATSDR, 1999: Online Glossary] [ED, 2000: Environmental Scorecard Glossary] [New York Department of Health, 1999: Glossary of Environmental Health Terms]

Dermal absorption (dermal penetration) - **a.** The transfer of contaminant across the skin, and subsequent incorporation into the body. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** Movement of a pesticide into and through the skin; includes that taken up into the systemic circulation and that retained in the skin compartment. [OECD, 1997: Occupational Exposure to Pesticides]; **c.** Process by which a chemical penetrates the skin and enters the body as an internal dose. [USEPA, 1997a: EPA Terms of Environment]

Dermal adherence capacity - The maximum amount of a specified matrix that can be contained on the skin. [USEPA, 1992a: Dermal Exposure Assessment]

Dermal adsorption - The process by which materials come in contact with the skin surface, but are then retained and adhered to the permeability barrier without being taken into the body. [USEPA, 1992a: Dermal Exposure Assessment]

Dermal exposure - **a.** Contact with the skin by any medium containing chemicals, quantified as the amount on the skin and available for adsorption and possible absorption. [USEPA, 1992a: Dermal Exposure Assessment]; **b.** Contact between a chemical and the skin. [USEPA, 1997a: EPA Terms of Environment] [USDOE, 2000: RAIS Glossary]; **c.** This term refers to a quantifiable measure of the amount of residue deposited on skin; normally expressed as a density, or mass per unit time, deposited on a defined skin surface area (e.g., mg/hr hand exposure); equivalent to potential dose for the dermal route. [USEPA, 1998: Postapp. Exposure Test GL.]

Dermally absorbed dose - The amount of the applied material (the dose) which becomes absorbed into the body. [USEPA, 1992a: Dermal Exposure Assessment]

Deterministic analysis - Calculation and expression of health risks as single numerical values or "single point" estimates of risk. In risk assessments, the uncertainty and variability are discussed in a qualitative manner. [USEPA, 1999: Superfund Risk

Assessment Glossary]

Deterministic model - A mathematical model in which the parameters and variables are not subject to random fluctuations, so that the system is at any time entirely defined by the initial conditions chosen. Contrast with a stochastic model. [Swinton, 1999: A Dictionary of Epidemiology]

Diary study - Survey in which individuals are asked to record food intake activities, or other factors in a diary which is later used to evaluate exposure factors associated with specific populations. [USEPA, 1997b: Exposure Factors Handbook]

Direct contact - A mode of transmission of infection between an infected host and susceptible host. Direct contact occurs when skin or mucous surfaces touch, as in shaking hands, kissing, and sexual intercourse. [Last, 1983: A Dictionary of Epidemiology]

Direct exposure - Exposure to a subject who comes into contact with an agent via the medium in which it was initially released to the environment. Examples include exposures mediated by cosmetics, other consumer products, some food and beverage additives, medical devices, over-the-counter drugs, and single-medium environmental exposures. [REAP, 1995: Residential Exposure Assessment Project]

Dislodgeable residue - **a.** Residue of an applied pesticide that may be removed from a treated or untreated surface by solvent rinse. [OECD, 1997: Occupational Exposure to Pesticides]; **b.** The amount of chemical residues deposited onto the leaf surface that have not been absorbed into the leaf or dissipated from the surface, and that can be dislodged by shaking leaf samples in a detergent solution (g/cm^2). [USEPA, 1998: Postapp. Exposure Test GL.]

Dispersion model - See air quality simulation model above. [CARB, 2000: Glossary of Air Pollution Terms]

Distribution - **a.** This is a general term for the dispersal of a xenobiotic and its derivatives throughout an organism or environmental system. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]; **b.** The complete summary of the frequencies of the values or categories of a measurement made on a group of persons. The distribution tells either how many or what proportion of the group were found to have each value (or each range of values) out of all the possible values that the quantitative measure can have. [Last, 1983: A Dictionary of Epidemiology];

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c. The pattern by which parasite numbers are partitioned amongst available hosts. If the fraction of the population who have *i* parasites is *p*(*i*) then the distribution is the set of numbers *p*(0), *p*(1), *p*(2), Summary statistics of this distribution include prevalence ($1 - p(0)$) and mean intensity ($p(1) + 2p(2) + 3p(3) + \dots$). Useful distributions include the Poisson and negative binomial. [Swinton, 1999: A Dictionary of Epidemiology]; **d.** A set of values derived from a specific population or set of measurements that represents the range and array of data for the factor being studied. [USEPA, 1997b: Exposure Factors Handbook]

Distribution free method - (Syn: nonparametric method) A method of testing a hypothesis or of setting up a confidence interval that does not depend on the form of the underlying distribution; in particular, it does not depend upon the variable following a normal distribution. [Last, 1983: A Dictionary of Epidemiology]

Domestic waste - see **household waste**

Dosage - see **dose rate**

Dose - **a.** (1) **absorbed**: amount of a substance penetrating the exchange boundaries of an organism after contact. Calculated from intake and absorption efficiency, and expressed as mg/kg-day. (2) **administered**: mass of a substance given to an organism and in contact with an exchange boundary, expressed as mg/kg-day. (3) **applied**: amount of a substance given to an organism, especially through dermal contact. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist, attributed to USEPA RAGS, 1989]; **b.** The amount of substance to which a person is exposed. Dose often takes body weight into account. [ATSDR, 1999: Online Glossary]; **c.** The amount of a pollutant that is absorbed. A level of exposure which is a function of a pollutant's concentration, the length of time a subject is exposed, and the amount of the pollutant that is absorbed. The concentration of the pollutant and the length of time that the subject is exposed to that pollutant determine dose. [CARB, 2000: Glossary of Air Pollution Terms]; **d.** (1) *pharmacology*. A quantity to be administered at one time, such as a specified amount of medication. (2) *radiobiology*. A general term denoting the quantity of radiation or energy absorbed. For special purposes it must be appropriately qualified. If unqualified, it refers to absorbed dose. Unit of absorbed dose is the rad. The SI unit is the gray ($1 \text{ Gy} = 1 \text{ J kg}^{-1} = 100 \text{ R}$). Origin: Gr. Dosis = a giving [Graham, 1998: The On Line Medical Dictionary]; **e.** The amount of substance to which a person is

exposed. Dose often takes body weight into account. For example, to receive equivalent doses of medicine, children are given smaller amounts than adults. [New York Department of Health, 1999: Glossary of Environmental Health Terms]; **f.** The amount of a contaminant that is absorbed or deposited in the body of an exposed organism for an increment of time—usually from a single medium. Total dose is the sum of doses received by a person from a contaminant in a given interval resulting from interaction with all environmental media that contain the contaminant. Units of dose and total dose (mass) are often converted to units of mass per volume of physiological fluid or mass of tissue. [NRC, 1991: Human Exp. for Airborne Pollutants]; **g.** The amount of a pesticide systemically available. [OECD, 1997: Occupational Exposure to Pesticides]; **h.** The amount of substance available for interaction with metabolic processes or biologically significant receptors after crossing the outer boundary of an organism (see potential dose, applied dose, and internal dose definitions). The amount of the agent available for interaction by any particular organ or cell is termed the delivered dose for that organ or cell. [REAP, 1995: Residential Exposure Assessment Project]; **i.** The amount or concentration of undesired matter or energy deposited at the site of effect. See also absorbed dose. [SRA, 1999: Glossary of Risk Analysis Terms]; **j.** The amount of a substance that enters the body. The amount depends on the rate at which the substance enters the body and the length of time the substance continues to enter the body, e.g., a worker may inhale 10 milligrams of dust per day for 10 days. The total dose is 100 milligrams. Not all of the substance may remain in the body; some is eliminated, possibly as fast as it enters. [University of Kentucky, 1999: Glossary of Safety Terms]; **k.** The amount of energy deposited in body tissue due to radiation exposure. Various technical terms, such as dose equivalent, effective dose equivalent and collective dose, are used to evaluate the amount of radiation an exposed worker receives. These terms are used to describe the differing interactions of radiation with tissue as well as to assist in the management of personnel exposure to radiation. Some types of radiation, such as neutron and alpha, deposit their energy more densely in affected tissue than gamma radiation and thereby causing more damage to tissue. The term dose equivalent, measured in units of rem, is used to take into account this difference in tissue damage. Therefore 1 rem from gamma radiation causes damage equivalent to 1 rem from alpha radiation. However, it takes one-twentieth as much energy from alpha radiation, as compared with

gamma radiation, to produce this 1 rem dose equivalent. Definitions for dose terms necessary for various exposure calculations and recordkeeping purposes include the following: [USDOE, 1998: Radiological Control Manual]; **l.** The absorbed dose, given in rads (or the international system of units, grays), that represents the energy absorbed from the radiation in a gram of any material. Furthermore, the biological dose or dose equivalent, given in rem or sieverts, is a measure of the biological damage to living tissue from the radiation exposure. [USDOE, 2000: RAIS Glossary]; **m.** The amount of a substance available for interaction with metabolic processes or biologically significant receptors after crossing the outer boundary of an organism. The *potential dose* is the amount ingested, inhaled, or applied to the skin. The *applied dose* is the amount of a substance presented to an absorption barrier and available for absorption (although not necessarily having yet crossed the outer boundary of the organism). The *absorbed dose* is the amount crossing a specific absorption barrier (e.g., the exchange boundaries of skin, lung, and digestive tract) through uptake processes. *Internal dose* is a more general term denoting the amount absorbed without respect to specific absorption barriers or exchange boundaries. The amount of the chemical available for interaction by any particular organ or cell is termed the *delivered dose* for that organ or cell. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1997b: Exposure Factors Handbook]; **n.** The amount of a substance available for interaction with metabolic processes after crossing the outer boundary of an organism. The applied dose is the amount of a substance presented to an absorption barrier and available for absorption (although not necessarily having yet crossed the outer boundary of the organism). The internal dose is the amount crossing an absorption barrier (e.g., the exchange boundaries of skin, lung, and digestive tract) through uptake processes. The amount of the chemical available for interaction by any particular organ or cell is termed the delivered dose for that organ or cell. [USEPA, 1992a: Dermal Exposure Assessment]; **o.** (1) The actual quantity of a chemical administered to an organism or to which it is exposed. (2) The amount of a substance that reaches a specific tissue (e.g., the liver). (3) The amount of a substance available for interaction with metabolic processes after crossing the outer boundary of an organism. [USEPA, 1997a: EPA Terms of Environment]; **p.** A term referring generically to the amount of chemical to which an organism is exposed by any of several routes. Specifying the routes within the environmental context and especially the point

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of measurement is made possible via subcategories of dose (see Potential Dose, Applied Dose, Absorbed Dose, Internal Dose, and Delivered Dose). Dose is normally expressed as a mass per unit body weight per unit time and is frequently expressed in units of mg/kg/day. [USEPA, 1998: Postapp. Exposure Test GL.]; **q.** The amount of agent that enters the target over a specified time interval by crossing a contact boundary [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Dose adjustment - Modification of doses used in animal experimentation to equivalent levels for human beings. The usual method is to calculate the ratio of body weights raised to some power, which is roughly equivalent to the ratio of surface areas; a simple ratio of body weights has also been used. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]

Dose assessment - Process of determining radiological dose and uncertainty included in the dose estimate, through the use of exposure scenarios, bioassay results, monitoring data, source term information and pathway analysis. [USDOE, 1998: Radiological Control Manual]

Dose effect - The relationship between dose (usually an estimate of dose) and the gradation of the effect in a population, that is a biological change measured on a graded scale of severity, although at other times one may only be able to describe a qualitative effect that occurs within some range of exposure levels. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]

Dose effect curve - This is a graph drawn to show the relationship between the dose of a drug or xenobiotic and the magnitude of the graded effect that it produces. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]

Dose equivalent - **a.** The product of the absorbed dose from ionizing radiation and such factors as account for differences in biological effectiveness due to the type of radiation and its distribution in the body as specified by the International Commission on Radiological Units and Measurements (ICRU). [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]; **b.** The product of the absorbed dose (D) (in rad or gray) in tissue, a quality factor (Q), and all other modifying factors (N). Dose equivalent is expressed in units of rem (or sievert) (1 rem = 0.01 sievert). [USDOE, 1998: Radiological Control Manual]; **c.** The product of the absorbed dose from ionizing radiation and such factors as account for biological

differences due to the type of radiation and its distribution in the body in the body. [USEPA, 1997a: EPA Terms of Environment]

Dose membrane - A barrier which offers resistance to flow of the agent after it crosses a contact boundary [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Dose rate - **a.** Dose per unit time, for example in mg/day, sometimes also called dosage. Dose rates are often expressed on a per-unit-body-weight basis, yielding units such as mg/kg/day (mg/kg-day). They are also often expressed as averages over some time period, for example a lifetime. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project]; **b.** In exposure assessment, dose per time unit (e.g., mg/day), sometimes also called dosage. [USEPA, 1997a: EPA Terms of Environment]; **c.** The rate at which the agent passes through a unit area of the contact boundary [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Dose response - **a.** The relationship between the dose of a pollutant and the response (or effect) it produces on a biological system. [CARB, 2000: Glossary of Air Pollution Terms]; **b.** The relationship between the dose of a pollutant and its effect on a biological system [ODEQ, 1999: Air Quality Glossary]; **c.** A dose response is a mathematical model that describes how a response variable—a biological measurement or epidemiologic population statistic—depends on the level of radiation dose. The dose response model tells whether the level of response increases or decreases with dose and how rapidly it changes as a function of dose. [RERF, 1999: Radiation Effects Research Foundation Glossary]; **d.** A correlation between a quantified exposure (dose) and the proportion of a population that demonstrates a specific effect (response). [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]; **e.** Shifts in toxicological responses of an individual (such as alterations in severity) or populations (such as alterations in incidence) that are related to changes in the dose of any given substance. [USEPA, 1997a: EPA Terms of Environment]

Dose response assessment - **a.** The amount of a chemical that an organism (such as a person) is exposed to is called the dose, and the severity of the effect of that exposure is called the response. A dose response assessment is a scientific study to determine the relationship between dose and response, and how much dose is correlated with how much response. [ED, 2000: Environmental Scorecard Glossary]; **b.** A determination of the

relationship between the magnitude of an administered, applied, or internal dose and a specific biological response. Response can be expressed as measured or observed incidence, percent response in groups of subjects (or populations), or as the probability of occurrence within a population. [IRIS, 1999: Glossary of IRIS Terms]; **c.** The process of characterizing the relation between the dose of an agent administered or received and the incidence of an adverse health effect in exposed populations and estimating the incidence of the effect as a function of human exposure to the agent. It takes account of intensity of exposure, age pattern of exposure, and possibly other variables that might affect response, such as sex, lifestyle, and other modifying factors. A dose response assessment usually requires extrapolation from high to low dose and extrapolation from animals to humans. A dose response assessment should describe and justify the methods of extrapolation used to predict incidence and should characterize the statistical and biologic uncertainties in these methods. [NRC 1983: Risk Assessment in the Federal Government]; **d.** The second step in the assessment of risks to humans from potentially toxic agents, in which the relationship between the dose levels to which animals or humans are exposed and the health-effect responses at each dose level are characterized quantitatively. Often the close-response assessment is based on high-dose experimental animal studies and applied to humans who are exposed at much lower doses. (See risk assessment.) [OFA, 2000: Oxyfuels Glossary]; **e.** The process of characterizing the relation between the dose of an agent administered or received and the incidence of an adverse health effect in exposed populations and estimating the incidence of the effect as a function of human exposure to the agent. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]; **f.** The determination of the relationship between the magnitude of administered, applied, or internal dose and a specific biological response. Response can be expressed as measured or observed incidence, percent response in groups of subjects (or populations), or the probability of occurrence of a response in a population. [USEPA, 1992: GL for Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project]; **g.** The determination of the relationship between the magnitude of administered, applied, or internal dose and the probability of occurrence of the health effects in question. [USEPA, 1992a: Dermal Exposure Assessment]; **h.** (1) Estimating the potency of a chemical. (2) In exposure assessment, the process of determining the relationship between the dose of a stressor and a specific biological response.

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(3) Evaluating the quantitative relationship between dose and toxicological responses. [USEPA, 1997a: EPA Terms of Environment]

Dose-response curve - a. A mathematical relationship between the dose administered or received and the incidence of adverse health effects in the exposed population; *toxicity values* are derived from this relationship. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** This is a graph to show the relation between the dose of a drug or xenobiotic and the degree of response it produces, as measured by the percentage of the exposed population showing a defined, often quantal, effect. If the effect determined is death, such a curve may be used to estimate an LD50 value. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]; **c.** A graphical representation of the quantitative relationship between potential, applied or internal dose of an agent, and a specific biological response to that agent. [REAP, 1995: Residential Exposure Assessment Project]; **d.** A graphical representation of the quantitative relationship between administered, applied, or internal dose of a chemical or agent, and a specific biological response to that chemical or agent. [USEPA, 1992: GL for Exposure Assessment]; **e.** A quantitative relationship between administered, applied, or internal dose and probability of occurrence of a health effect or effects. Results are usually expressed in units of incidence per unit dose. [USEPA, 1992a: Dermal Exposure Assessment]; **f.** Graphical representation of the relationship between the dose of a stressor and the biological response thereto. [USEPA, 1997a: EPA Terms of Environment]

Dose response, linear - A linear dose response is a relationship between dose and biological response that is a straight line. In other words, the rate of change (slope) in the response is the same at any dose. A linear dose response is written mathematically as follows: if Y represents the expected, or average response and D represents dose, then $Y = aD$ where a is the slope, also called the linear coefficient. [RERF, 1999: Radiation Effects Research Foundation Glossary]

Dose response, linear quadratic - A linear quadratic dose response is a relationship between dose and biological response that is curved. This implies that the rate of change in response is different at different doses. The response may change slowly at low doses, for example, but rapidly at high doses. A linear quadratic dose response is written mathematically as follows: if Y represents the expected, or average response and D represents dose, then $Y = aD +$

bD^2 where a is the linear coefficient (or slope) and b is the quadratic coefficient (or curvature). [RERF, 1999: Radiation Effects Research Foundation Glossary]

Dose response relationship - a. A relationship in which a change in amount, intensity duration of exposure is associated with a change—either an increase or a decrease—in risk of a specified outcome. [Last, 1983: A Dictionary of Epidemiology]; **b.** The relationship between the dose of a vaccine and an immune or physiologic response. In vaccine research, a dose response effect means that as the dose of the vaccine increases, so does the level of the immune response (antibodies and CTL activity). [NIAID, 1997: HIV Vaccine Glossary]; **c.** The resulting biological responses in an organ or organism expressed as a function of a series of different doses. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1997b: Exposure Factors Handbook]; **d.** A relationship between (1) the dose, either "administered dose" (i.e., exposure) or absorbed dose, and (2) the extent of toxic injury produced by that chemical. Response can be expressed either as the severity of injury or proportion of exposed subjects affected. A dose response assessment is one of the four steps in a risk assessment. [USEPA, 1995: Benchmark Dose]; **e.** The quantitative relationship between the amount of exposure to a substance and the extent of toxic injury or disease produced. [USEPA, 1997a: EPA Terms of Environment] [USDOE, 2000: RAIS Glossary]; **f.** The relationship between a quantified exposure (dose), and the proportion of subjects demonstrating specific, biological changes (response). [IRIS, 1999: Glossary of IRIS Terms]

Dose, threshold - A threshold dose is a dose level below which there is no effect of radiation on the biological response. It is often difficult to distinguish between a threshold and a linear quadratic dose response where the response changes only slightly at low doses. A threshold model postulates that radiation does not cause the effect at any level below the threshold. Radiation thresholds are generally thought to be limited to acute (short term) effects that are called deterministic, because they require depletion of certain cells in the body to below a critical number in a given organ or tissue. These effects include radiation sickness (nausea and vomiting), infection and bleeding, and loss of hair. [RERF, 1999: Radiation Effects Research Foundation Glossary]

Dose-response evaluation - quantitative evaluation of toxicity information and characterization of the relationship between the

dose administered or received and the incidence of adverse health effects in the exposed population. (Source: RAGS, 1989) [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]

Dosimeter - a. Instrument to measure dose; many so-called dosimeters actually measure exposure rather than dose. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment]; **b.** An instrument to measure dosage; many so-called dosimeters actually measure exposure rather than dosage. Dosimetry is the process or technology of measuring and/or estimating dosage. [USEPA, 1997a: EPA Terms of Environment]

Dosimetry - a. The theory and application of the principles and techniques involved in the measurement and recording of ionizing radiation doses. [USDOE, 2000: RAIS Glossary]; **b.** Process of measuring or estimating dose. [USEPA, 1992: GL for Exposure Assessment]; **c.** Process of measuring dose. [USEPA, 1992a: Dermal Exposure Assessment]

Drinking water exposure - Intake of a chemical into the body through the ingestion of drinking water. [OFA, 2000: Oxyfuels Glossary]

Dry weight intake rates - Intake rates that are based on the weight of the food consumed after the moisture content has been removed. [USEPA, 1997b: Exposure Factors Handbook]

Duration: - A measure of the length of time the ground shaking exceeds a given threshold of shaking, such as 5 % of the force of gravity. Also, a description of the length of time between the onset and the departure of a natural hazard. [PDM, 2000: Disaster Terminology]

Duration of exposure - see **exposure duration**

Effective dose equivalent (HE) - The summation of the products of the dose equivalent received by specified tissues of the body (HT) and the appropriate weighting factors (WT) - that is ($HE = \sum WTHT$). It includes the dose from radiation sources internal and/or external to the body. The effective dose equivalent is expressed in units of rem (or sievert). [USDOE, 1998: Radiological Control Manual]

Effective Dose (ED10) - The dose corresponding to a 10% increase in an adverse effect, relative to the control response. [IRIS, 1999: Glossary of IRIS Terms]

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Effective half life - The time required for a radionuclide contained in a biological system, such as a human or an animal, to reduce its activity by one_half as a combined result of radioactive decay and biological elimination. [USDOE, 2000: RAIS Glossary]

Effluent - **a.** Treated or untreated liquid waste material that is discharged into the environment from a point source, such as a wastewater treatment plant or an industrial facility. [NCSU, 1997: Watersheds Glossary]; **b.** Waste material discharged into the environment, treated or untreated. Generally refers to water pollution. [SRA, 1999: Glossary of Risk Analysis Terms]; **c.** Waste material discharged into the environment, treated or untreated. Generally refers to surface water pollution. [USDOE, 2000: RAIS Glossary]; **d.** Waste material being discharged into the environment, either treated or untreated. Effluent generally is used to describe water discharges to the environment, although it can refer to stack emissions or other material flowing into the environment. [USEPA, 1992: GL for Exposure Assessment]; **e.** Wastewater__treated or untreated__that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes discharged into surface waters. [USEPA, 1997a: EPA Terms of Environment]

Emission - **a.** The release or giving out of a gas, light or heat. An automobile releases uncombusted or partially oxidized hydrocarbon emissions from its tailpipe when the engine is running. Atoms in an excited state often emit light in order to reach a lower energy state. These emissions can be used to determine the presence of the atoms in a sample. [SHSU, 2000: Atmospheric Chemistry Glossary, attributed to JJournal of Environmental Economics and Management 25:177-195 (1993) and Science 26:1255-1257 (1994)]; **b.** Like effluent but used in regard to air pollution. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]; **c.** Pollution discharged into the atmosphere from smokestacks, other vents, and surface areas of commercial or industrial facilities; from residential chimneys; and from motor vehicle, locomotive, or aircraft exhausts. [USEPA, 1997a: EPA Terms of Environment]

Emissions - **a.** Release of pollutants into the air from a source [ODEQ, 1999: Air Quality Glossary]; **b.** Pollutants released into the air or waterways from industrial processes, households or transportation vehicles. Air emissions pertain to atmospheric air pollution; water emissions refer to pollutants released into waterways. [RFF, 2000: Glossary of

Terms and Concepts]; **c.** The release of a substance (usually a gas when referring to the subject of climate change) into the atmosphere. [USEPA, 2000: Global Warming Glossary]

Emission rate - **a.** The weight of a pollutant emitted per unit of time (e.g., tons/year). [CARB, 2000: Glossary of Air Pollution Terms]; **b.** The amount of pollutant emitted per unit of time. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]

Employer tenure - The length of time a worker has been with the same employer. [USEPA, 1997b: Exposure Factors Handbook]

Endangerment assessment - A study to determine the nature and extent of contamination at a site on the National Priorities List and the risks posed to public health or the environment. EPA or the state conducts the study when a legal action is to be taken to direct potentially responsible parties to clean up a site or pay for it. An endangerment assessment supplements a remedial investigation. [USEPA, 1997a: EPA Terms of Environment] [USDOE, 2000: RAIS Glossary]

Environmental assessment - An environmental analysis prepared pursuant to the National Environmental Policy Act to determine whether a federal action would significantly affect the environment and thus require a more detailed environmental impact statement. [USEPA, 1997a: EPA Terms of Environment] [USDOE, 2000: RAIS Glossary]

Environmental exposure - Human exposure to pollutants originating from facility emissions. Threshold levels are not necessarily surpassed, but low_level chronic pollutant exposure is one of the most common forms of environmental exposure [USEPA, 1997a: EPA Terms of Environment] [USDOE, 2000: RAIS Glossary]

Environmental fate - **a.** Where a substance ends up after it is released into the environment. Environmental fate depends on many factors, including transport (e.g., wind, runoff) and transformation processes (e.g., degradation). [ED, 2000: Environmental Scorecard Glossary]; **b.** The destiny of a chemical or biological pollutant after release into the environment. Environmental fate involves temporal and spatial considerations of transport, transfer, storage, and transformation. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment]; **c.** The destiny of a chemical or biological pollutant after release into the environment. [USEPA, 1997a: EPA Terms of

Environment]

Environmental fate model - In the context of exposure assessment, any mathematical abstraction of a physical system used to predict the concentration of specific chemicals as a function of space and time subject to transport, intermedia transfer, storage, and degradation in the environment. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment]

Environmental monitoring - A method of measuring the amount of a pesticide present in an environmental medium. [OECD, 1997: Occupational Exposure to Pesticides]

Environmental pathway - 1. All routes of transport by which a toxicant can travel from its release site to human populations including air, food chain, and water. 2. The connected set of environmental media through which a potentially harmful substance travels from source to receptor. [SRA, 1999: Glossary of Risk Analysis Terms, attributed to Stephen L. Brown] [USDOE, 2000: RAIS Glossary]

Error - **a.** Any discrepancy between a computed, observed, or measured quantity and the true, specified, or theoretically correct value of that quantity. (1) **random error** - in statistics, an error that can be predicted only on a statistical basis; (2) **systematic error** - in statistics, an error which results from some bias in the measurement process and is not due to chance, in contrast to random error. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** (1) A false or mistaken result obtained in a study or experiment. Several kinds of error can occur in epidemiology, for example, due to bias. (2) **Random error (sampling error)** is that due to chance, when the result obtained in the sample differs from the result that would be obtained if the entire population ("universe") were studied. Two varieties of sampling error are type I, or alpha error, and type II, or beta error. In an experiment, if the experimental procedure does not in reality have any effect, an apparent difference between experimental and control groups may nevertheless be observed by chance, a phenomenon known as type I error. Another possibility is that the treatment is effective but by chance the difference is not detected on statistical analysis—type II error. In the theory of testing hypotheses, rejecting a null hypothesis when it is actually true is called "type I error." Accepting a null hypothesis when it is incorrect is called "type II error." (3) **Systematic error** is that due to factors other than chance, such as faulty measuring instruments. It is further considered in bias.

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[Last, 1983: A Dictionary of Epidemiology]

Errors - Deviation between estimated value and true value. (1) **False positive**: in Superfund risk assessment, a conclusion that contaminant concentrations in onsite soil are higher than background soil concentrations when in fact they are not; could result in unnecessary remediation; (2) **False negative**: a conclusion that onsite contaminant concentrations are not higher than background concentrations when in fact they are; could result in failure to clean up a site when such action is necessary. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]

Estimated Exposure Dose (EED) - The measured or calculated dose to which humans are likely to be exposed considering all sources and routes of exposure. [IRIS, 1999: Glossary of IRIS Terms]

Exposed - In epidemiology, the exposed group (or simply, *the exposed*) is often used to connote a group whose members have been exposed to a supposed cause of a disease or health state of interest, or possess a characteristic that is a determinant of the health outcome of interest. [Last, 1983: A Dictionary of Epidemiology]

Exposure - **a.** Contact of an organism with a chemical or physical agent, quantified as the amount of chemical available at the exchange boundaries of the organism and available for absorption. Usually calculated as the mean exposure, and some measure of maximum exposure. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist, attributed to USEPA RAGS, 1989]; **b.** Contact with a chemical by swallowing, by breathing, or by direct contact (such as through the skin or eyes). Exposure may be short term (acute) or long term (chronic). [ATSDR, 1999: Online Glossary] [New York Department of Health, 1999: Glossary of Environmental Health Terms]; **c.** The concentration of the pollutant in the air multiplied by the population exposed to that concentration over a specified time period. [CARB, 2000: Glossary of Air Pollution Terms]; **d.** Normally external exposure: the amount of substance ingested, the amount in contact with the skin or either the amount inhaled or the concentration of the substance in the atmosphere (as appropriate). [EC, 1996: Risk Assessment for New Notified Subs]; **e.** *radiobiology*. A quantitative measure of x or gamma radiation at a certain place, based on its ability to produce ionisation in air. The former special unit of exposure was the roentgen (R). $1R = 2.58 \times 10^{-4} C/kg$. In the international system (SI unit), the special unit

is coulomb per kilogram. (Exposure also is frequently used as a synonym for irradiation). [Graham, 1998: The On Line Medical Dictionary]; **f.** Contact made between a chemical, physical, or biological agent and the outer boundary of an organism. Exposure is quantified as the amount of an agent available at the exchange boundaries of the organism (e.g., skin, lungs, gut). [IRIS, 1999: Glossary of IRIS Terms]; **g.** An event that occurs when there is contact at a boundary between a human and the environment with a contaminant of a specific concentration for an interval of time; the units of exposure are concentration multiplied by time. [NRC, 1991: Human Exp. for Airborne Pollutants]; **h.** Occurs when a person comes into contact with a chemical in their environment. May involve oral ingestion, inhalation, and absorption through the skin or the mucus membranes of the eyes, nose, or mouth. [NRDC, 1998: Trouble on the Farm]; **i.** A condition of oral, dermal, respiratory or ocular contact between a person and a pesticide. [OECD, 1997: Occupational Exposure to Pesticides]; **j.** (1) The time integral of the concentration of a toxicant which is in the immediate vicinity of various ports of entry (such as lung, GI tract and skin). (2) Qualitatively, contact between a potentially harmful agent and a receptor (e.g., a human or other organism) that could be affected. [SRA, 1999: Glossary of Risk Analysis Terms, attributed to Stephen L. Brown]; **k.** Similar to dose. The combination of concentration of a substance in air and the amount of time a worker is exposed to that concentration gives the total exposure or dose. [University of Kentucky, 1999: Glossary of Safety Terms]; **l.** Contact of an organism with a chemical, radiological, or physical agent. Exposure is quantified as the amount of the agent available at the exchange boundaries of the organism (e.g., skin, lungs, gut) and available for absorption. [USDOE, 2000: RAIS Glossary]; **m.** Contact of a chemical, physical, or biological agent with the outer boundary of an organism. Exposure is quantified as the concentration of the agent in the medium in contact integrated over the time duration of that contact. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project] [USEPA, 1997b: Exposure Factors Handbook]; **n.** The contact or co-occurrence of a stressor with a receptor. [USEPA, 1997: Guidance on Cumulative Risk Assessment, Planning and Scoping] [USEPA, 1998a: Guidelines for Ecological Risk Assessment] [CENR, 1999: Ecorisk in the Federal Government]; **o.** The amount of radiation or pollutant present in a given environment that represents a potential health threat to living organisms. [USEPA, 1997a: EPA Terms of

Environment]; **p.** A measure of the environment leading to a dose. Exposure is quantified as the concentration of the agent in the medium in contact, integrated over the duration of the contact [USEPA, 1998: Postapp. Exposure Test GL.]; **q.** Exposure does not equal poisoning, it is the dose. If you smell ammonia you have been exposed but you have not been poisoned with ammonia gas. [WSU, 1999: Definitions and Abbreviations of Veterinary Terms]; **r.** Contact between an agent and a target [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Exposure assessment - **a.** Measurement or estimation of the magnitude, frequency, duration and route of exposure to a substance for the populations of interest. [CARB, 2000: Glossary of Air Pollution Terms]; **b.** Identifying the ways in which chemicals may reach individuals (e.g., by breathing); estimating how much of a chemical an individual is likely to be exposed to; and estimating the number of individuals likely to be exposed. [ED, 2000: Environmental Scorecard Glossary]; **c.** The qualitative and/or quantitative evaluation of the likely intake of biological, chemical or physical agents via food as well as exposure from other sources if relevant. [FAO/WHO, 1997: Food Consumption & Exp. Assessment of Chemicals]; **d.** An identification and evaluation of the human population exposed to a toxic agent, describing its composition and size, as well as the type, magnitude, frequency, route and duration of exposure. [IRIS, 1999: Glossary of IRIS Terms]; **e.** An estimate of the number of people who will be exposed to a chemical, along with the concentration, duration and terms of the exposure. [JHU, 1999: Altweb Glossary]; **f.** A process that estimates the amount of a chemical that enters or comes into contact with people. An exposure assessment also describes the length of time and the nature and size of a population exposed to a chemical. [New York Department of Health, 1999: Glossary of Environmental Health Terms]; **g.** The process of measuring or estimating the intensity, frequency, and duration of human exposures to an agent currently present in the environment or of estimating hypothetical exposure that might arise from the release of new chemicals into the environment. In its most complete form, it describes the magnitude, duration, schedule, and route of exposures; the size, nature, and classes of the human populations exposed; and the uncertainties in all estimates. Exposure assessment is often used to identify feasible prospective control options and to predict the effects of available control technologies on exposure. [NRC 1983: Risk Assessment in the

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Federal Government]; **h.** Involves numerous techniques to identify the contaminant, contaminant sources, environmental media of exposure, transport through each medium, chemical and physical transformations, routes of entry to the body, intensity and frequency of contact, and spatial and temporal concentration patterns of the contaminant. An array of techniques can be employed, ranging from estimating the number of people exposed and contaminant concentrations to sophisticated methodology employing contaminant monitoring, modeling, and human biological marker measurement. [NRC, 1991: Human Exp. for Airborne Pollutants]; **i.** The third step in the assessment of risks to humans from potentially toxic agents, in which the nature and size of the human population exposed to a toxic agent, and the magnitude and duration of these exposures are described. Exposure assessment can include both current and anticipated future exposures. Factors important in exposure assessment include: (1) numbers of potentially exposed individuals, (2) route, frequency and duration of exposure, and (3) distribution of age, gender, and unique conditions such as pregnancy, childhood, old age, pre-existing illnesses, and lifestyle within the population of interest. [OFA, 2000: Oxyfuels Glossary]; **j.** The process of measuring or estimating the intensity, frequency, and duration of human exposures to an agent currently present in the environment or of estimating hypothetical exposures that might arise from the release of new chemicals into the environment. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]; **k.** The determination or estimation (qualitative or quantitative) of the magnitude, frequency, duration, and route of exposure. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project] [USEPA, 1997b: Exposure Factors Handbook] [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **l.** Identifying the pathways by which toxicants may reach individuals, estimating how much of a chemical an individual is likely to be exposed to, and estimating the number likely to be exposed. [USEPA, 1997a: EPA Terms of Environment]

Exposure concentration - a. The concentration of a chemical or other pollutant representing a health threat in a given environment. [USEPA, 1997a: EPA Terms of Environment] [USDOE, 2000: RAIS Glossary]; **b.** The concentration of a chemical in its transport or carrier medium at the point of contact. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1997b: Exposure Factors Handbook]

Exposure dose reconstruction - An approach that uses computational models and other approximation techniques to estimate cumulative amounts of hazardous substances internalized by people at presumed or actual risk from contact with substances associated with hazardous waste sites. [ATSDR, 1999: Online Glossary: ATSDR-specific term]

Exposure duration - a. Toxicologically, there are three categories describing duration of exposure: acute (one-time), subchronic (repeated, for a fraction of a lifetime), and chronic (repeated, for nearly a lifetime). [REAP, 1995: Residential Exposure Assessment Project]; **b.** (1) Length of time over which contact with the contaminant lasts; (2) Total time an individual is exposed to the chemical being evaluated. [USEPA, 1997b: Exposure Factors Handbook]

Exposure event - an incident of contact with a chemical or physical agent; can be defined by time or by incident. (Source: RAGS, 1989) [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]

Exposure frequency - The number of times an exposure occurs in a given period; exposure may be continuous, discontinuous but regular (e.g., once daily), or intermittent (e.g., less than daily, with no standard quantitative definition). [REAP, 1995: Residential Exposure Assessment Project]

Exposure indicator - A characteristic of the environment measured to provide evidence of the occurrence or magnitude of a response indicator's exposure to a chemical or biological stress. [USEPA, 1997a: EPA Terms of Environment] [USDOE, 2000: RAIS Glossary]

Exposure level - The amount (concentration) of a chemical at the absorptive surfaces of an organism. [USEPA, 1997a: EPA Terms of Environment] [USDOE, 2000: RAIS Glossary]

Exposure limits - Suggested or mandatory restrictions placed upon exposure typically established to assure that exposure below these levels will result in no or minimal adverse effects. [REAP, 1995: Residential Exposure Assessment Project]

Exposure medium - The contaminated environmental medium to which an individual is exposed. Includes the transfer of contaminants from one medium to another. [USEPA, 1999: Superfund Risk Assessment Glossary]

Exposure monitoring - To keep track of,

regulate, or control exposure (see Exposure). Frequently conducted relative to a reference exposure limit. See Exposure Limits. [REAP, 1995: Residential Exposure Assessment Project]

Exposure pathway - a. The path a chemical or physical agent takes from source to exposed organism; consists of (1) source or release, (2) transport medium (possible), (3) exposure point, and (4) exposure route. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist, attributed to USEPA RAGS, 1989]; **b.** The physical course a chemical or pollutant takes from the source to the organism exposed. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project] [USEPA, 1997a: EPA Terms of Environment] [USEPA, 1997b: Exposure Factors Handbook] [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **c.** The path from sources of pollutants via, soil, water, or food to man and other species or settings. [USEPA, 1997a: EPA Terms of Environment]; **d.** The course a chemical takes from the source to the exposed individual. An exposure pathway analysis links the sources, locations, and types of environmental releases with population locations and activity patterns to determine the significant pathways of human exposure. [USEPA, 1999: Superfund Risk Assessment Glossary]

Exposure point - a. Location of potential contact between an organism and a chemical or physical agent. (Source: RAGS, 1989) [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** An exact location of potential contact between a person and a chemical within an exposure medium. [USEPA, 1999: Superfund Risk Assessment Glossary]; **c.** The point on a contact boundary at which contact with an agent occurs [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Exposure point concentration - The value that represents a conservative estimate of the chemical concentration available from a particular medium or route of exposure. See definitions for Medium EPC and Route EPC, which follow. Exposure Route The way a chemical comes in contact with a person (e.g., by ingestion, inhalation, dermal contact). [USEPA, 1999: Superfund Risk Assessment Glossary]

Exposure potential - An estimate of the total dose of a chemical received by an exposed organism (e.g., a person) or by a population,

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not just via one pathway or medium but from all likely pathways. [ED, 2000: Environmental Scorecard Glossary]

Exposure profile - The product of characterization of exposure in the analysis phase of ecological risk assessment. The exposure profile summarizes the magnitude and spatial and temporal patterns of exposure for the scenarios described in the conceptual model. [USEPA, 1998a: Guidelines for Ecological Risk Assessment] [CENR, 1999: Ecorisk in the Federal Government]

Exposure_response relationship - **a.** The connection between the amount of a chemical administered and a specific toxic effect in the organism, also called the dose_response relationship. [JHU, 1999: Altweb Glossary]; **b.** The relationship between exposure level and the incidence of adverse effects. [USEPA, 1997a: EPA Terms of Environment]

Exposure route - [also **route, route of exposure**] **a.** The way an organism comes into contact with a chemical or physical agent; ingestion, inhalation, dermal contact, etc. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist, attributed to USEPA RAGS 1989]; **b.** The way in which a person may contact a chemical substance. For example, drinking (ingestion) and bathing (skin contact) are two different routes of exposure to contaminants that may be found in water. [ATSDR, 1999: Online Glossary]; **c.** The avenue by which a chemical comes into contact with an organism (such as a person). Possible routes include inhalation, ingestion, and dermal contact. [ED, 2000: Environmental Scorecard Glossary]; **d.** The way in which a person may contact a chemical substance. For example, drinking (ingestion) and bathing (skin contact) are two different routes of exposure to contaminants that may be found in water. [New York Department of Health, 1999: Glossary of Environmental Health Terms]; **e.** The way an agent enters an organism after contact (*e.g.*, by ingestion, inhalation, or dermal absorption). [REAP, 1995: Residential Exposure Assessment Project]; **f.** The way a chemical or pollutant enters an organism after contact, *e.g.*, by ingestion, inhalation, or dermal absorption. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment] [USEPA, 1997a: EPA Terms of Environment] [USEPA, 1997b: Exposure Factors Handbook]; **g.** The avenue by which a chemical comes into contact with an organism, *e.g.*, inhalation, ingestion, dermal contact, injection. [USEPA, 1997a: EPA Terms of Environment]

Exposure scenario - **a.** A set of facts,

assumptions, and inferences about how exposure takes place that aids the exposure assessor in evaluating, estimating, or quantifying exposures. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project] [USEPA, 1997b: Exposure Factors Handbook]; **b.** A set of assumptions concerning how an exposure may take place, including assumptions about the exposure setting, stressor characteristics, and activities that may lead to exposure. [USEPA, 1998a: Guidelines for Ecological Risk Assessment] [CENR, 1999: Ecorisk in the Federal Government]

Exposure time - A term used in probabilistic ground shaking maps. The period of time (for example, 50 years) that a structure or a community is exposed to potential earthquake ground shaking and other earthquake hazards. [PDM, 2000: Disaster Terminology]

External dose or exposure - That portion of the dose equivalent received from radiation sources outside the body (*e.g.*, "external sources"). [USDOE, 1998: Radiological Control Manual]

External radiation dose - The dose from sources of radiation located outside the body. This is most often from gamma rays, though beta rays can contribute to dose in the skin and other relatively superficial tissues. [USDOE, 2000: RAIS Glossary]

Fault tree - a method of analyzing potential outcomes which starts with the final event and works backwards, identifying all causes of the event, the contributing factors of those causes, etc., back to the basic events. Probabilities can be assigned to the basic events, and a likelihood thus estimated for the final event. See also *event tree*. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]

Fault tree analysis - A technique by which many events that interact to produce other events can be related using simple logical relationships permitting a methodical building of a structure that represents the system. [SRA, 1999: Glossary of Risk Analysis Terms]

Flux - **a.** The rate of continuous change, flow or movement of liquid, particles or energy. The rate of discharge of a liquid, removal of energy or particle depositing from one body to another. [SHSU, 2000: Atmospheric Chemistry Glossary, attributed to Journal of Alloys and Compounds; **195:407** (1993) and Ecological Monographs **58:177** (1988)]; **b.** Amount of chemical absorbed across a defined surface

area of the skin per unit time ($\text{mg}/\text{cm}^2/\text{hr}$). This is equal to the dermal permeability coefficient multiplied by the concentration of the chemical. Flux and concentration are interdependent. [USEPA, 1992a: Dermal Exposure Assessment]; **c.** (1) A flowing or flow. (2) A substance used to help metals fuse together. [USEPA, 1997a: EPA Terms of Environment]

Food consumption - Food consumption is an estimate of per capita quantity of a food or group of foods eaten by a specified population over a defined period of time. Food consumption is expressed in grams of food per person per day. [FAO/WHO, 1997: Food Consumption & Exp. Assessment of Chemicals]

Frequency distribution - see **distribution**

Frequency of exposure - see **exposure frequency**

Fugitive emissions - **a.** Emissions not caught by a capture system which are often due to equipment leaks, evaporative processes, and windblown disturbances. [CARB, 2000: Glossary of Air Pollution Terms]; **b.** Emissions not caught by a capture system. [USEPA, 1997a: EPA Terms of Environment]

General population - The total of individuals inhabiting an area or making up a whole group. [USEPA, 1997b: Exposure Factors Handbook]

Geographic information system (GIS) - **a.** A computer hardware and software system designed to collect, manipulate, analyze, and display spatially referenced data for solving complex resource, environmental, and social problems. [ATSDR, 1999: Online Glossary]; **b.** Computer programs linking features commonly seen on maps (such as roads, town boundaries, water bodies) with related information not usually presented on maps, such as type of road surface, population, type of agriculture, type of vegetation, or water quality information. A GIS is a unique information system in which individual observations can be spatially referenced to each other. [NCSU, 1997: Watersheds Glossary]; **c.** organized collections of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze and display all forms of geographically referenced information. GIS is being used by many researchers in the environmental field to view a number of different indicators simultaneously as data layers on a geographic grid. By associating data of all kinds with points on a map, GIS can illustrate patterns

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and trends that might otherwise be incomprehensive. For example, using GIS, a researcher can map multiple health indicators at and around a specific toxic waste site. [RFF, 2000: Glossary of Terms and Concepts]; **d.** A computer system designed for storing, manipulating, analyzing, and displaying data in a geographic context. See SADA . [USDOE, 2000: RAIS Glossary]

Geometric mean - a. A measure of central tendency. Calculable only for positive values. It is calculated by taking the logarithms of the values, calculating their arithmetic mean, then converting back by taking the antilogarithm. [Last, 1983: A Dictionary of Epidemiology]; **b.** The n^{th} root of the product of n values. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment][USEPA, 1997b: Exposure Factors Handbook]

Half life - a. The time in which the concentration of a chemical in the environment is reduced by half. [ED, 2000: Environmental Scorecard Glossary]; **b.** The time required for half of a substance introduced to a living system or ecosystem to be eliminated or disintegrated by natural processes. [NCSU, 1997: Watersheds Glossary]; **c.** the time required for half the amount of a substance to be eliminated from the body or to be converted to another substance(s). [NIAID, 1997: HIV Vaccine Glossary]; **d.** The time required for half of a sample of a given radioactive isotope to decay into another element or isotope. The half-life of an isotope is inversely related to its decay constant. [SHSU, 2000: Atmospheric Chemistry Glossary]; **e.** (1) The time in which half the atoms of a given quantity of a particular radioactive substance disintegrate to another nuclear form. Measured half_lives vary from millionths of a second to billions of years. (2) Similarly, the time in which half the molecules of a chemical substance disappear as a result of chemical or biochemical transformation. [SRA, 1999: Glossary of Risk Analysis Terms, attributed to Stephen L. Brown]; **f.** The time in which half the atoms of a radioactive substance will have disintegrated, leaving half the original amount. Half of the residue will disintegrate in another equal period of time. [USDOE, 2000: RAIS Glossary]; **g.** (1) The time required for a pollutant to lose one_half of its original concentration. For example, the biochemical half_life of DDT in the environment is 15 years. (2) The time required for half of the atoms of a radioactive element to undergo self_transmutation or decay (half_life of radium is 1620 years). (3) The time required for the elimination of half a total dose from the body. [USEPA, 1997a: EPA Terms of Environment] [cf. **biological half-life**]

Harmonic mean - a. A measure of central tendency computed by summing the reciprocals of all the individual values and dividing the resulting sum into the number of values. [Last, 1983: A Dictionary of Epidemiology]

High-end exposure (dose) estimate - a. A plausible estimate of individual exposure or dose for those persons at the upper end of an exposure or dose distribution, conceptually above the 90th percentile, but not higher than the individual in the population who has the highest exposure or dose. [USEPA, 1992: GL for Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project]; **b.** An estimate of exposure, or dose level received anyone in a defined population that is greater than the 90th percentile of all individuals in that population, but less than the exposure at the highest percentile in that population. A high end risk descriptor is an estimate of the risk level for such individuals. Note that risk is based on a combination of exposure and susceptibility to the stressor. [USEPA, 1997a: EPA Terms of Environment]

Household interview survey - Collection of information from a (representative) sample of a civilian noninstitutionalized population, by trained interviewers, who go to the dwellings of the persons selected for interview. [Last, 1983: A Dictionary of Epidemiology]

Household waste (domestic waste) - Solid waste, composed of garbage and rubbish, which normally originates in a private home or apartment house. Domestic waste may contain a significant amount of toxic or hazardous waste. [USEPA, 1997a: EPA Terms of Environment]

Human equivalent concentration (HEC) or human equivalent dose (HED) - a. The human concentration (for inhalation exposure) or dose (for other routes of exposure) of an agent that is believed to induce the same magnitude of toxic effect as the experimental animal species concentration or dose. This adjustment may incorporate toxicokinetic information on the particular agent, if available, or use a default procedure, such as assuming that daily oral doses experienced for a lifetime are proportional to body weight raised to the 0.75 power. [IRIS, 1999: Glossary of IRIS Terms]; **b.** [human equivalent concentration] Exposure concentration for humans that has been adjusted for dosimetric differences between experimental animal species and humans to be equivalent to the exposure concentration associated with observed effects in the experimental animal species. If occupational

human exposures are used for extrapolation, the human equivalent concentration represents the equivalent human exposure concentration adjusted to a continuous basis. [USDOE, 2000: RAIS Glossary]; **c.** [human equivalent dose] A dose that, when administered to humans, produces an effect equal to that produced by a dose in animals. [REAP, 1995: Residential Exposure Assessment Project] [USEPA, 1997a: EPA Terms of Environment] [USDOE, 2000: RAIS Glossary]

Human exposure evaluation - a. Describing the nature and size of the population exposed to a substance and the magnitude and duration of their exposure. The evaluation could concern past, current, or anticipated exposures. [USDOE, 2000: RAIS Glossary]; **b.** Describing the nature and size of the population exposed to a substance and the magnitude and duration of their exposure. [USEPA, 1997a: EPA Terms of Environment]

Hygienic measures - those measures as to prevent diseases following a major disaster, because the infrastructure of the stricken area is non_ or malfunctioning. [PDM, 2000: Disaster Terminology; from Debacker, et al., 1999]

Incidental ingestion - Unintentional intake of small amounts of agents, particularly associated with children's from hand-to-mouth activity. [REAP, 1995: Residential Exposure Assessment Project]

Indirect contact - A mode of transmission of infection involving fomites or vectors. Vectors may be mechanical (e.g., filth flies) or biological (the disease agent under goes part of its life cycle in the vector species). [Last, 1983: A Dictionary of Epidemiology]

Indirect exposure - Often defined as an exposure involving multimedia transport of agents from source to exposed individual. Examples include exposures to chemicals deposited onto soils from the air, chemicals released into the ground water beneath a hazardous waste site, or consumption of fruits or vegetables with pesticide residues. [REAP, 1995: Residential Exposure Assessment Project]

Indirect source - a. Any facility, building, structure, or installation, or combination thereof, which generates or attracts mobile source activity that results in emissions of any pollutant (or precursor) for which there is a state ambient air quality standard. Examples of indirect sources include employment sites, shopping centers, sports facilities, housing developments, airports, commercial and industrial development, and parking lots and

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garages. [CARB, 2000: Glossary of Air Pollution Terms]; **b.** Any facility or building, property, road or parking area that attracts motor vehicle traffic and, indirectly, causes pollution. [USEPA, 1997a: EPA Terms of Environment]

Infectious agent - Any organism, such as a pathogenic virus, parasite, or bacterium, that is capable of invading body tissues, multiplying, and causing disease. [USEPA, 1997a: EPA Terms of Environment]

Influent - Water, wastewater, or other liquid flowing into a reservoir, basin, or treatment plant. [USEPA, 1997a: EPA Terms of Environment] [USDOE, 2000: RAIS Glossary]

Ingestion - **a.** Oral intake of chemicals. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** Swallowing (such as eating or drinking). Chemicals can get in or on food, drink, utensils, cigarettes, or hands where they can be ingested. After ingestion, chemicals can be absorbed into the blood and distributed throughout the body. [ATSDR, 1999: Online Glossary] [New York Department of Health, 1999: Glossary of Environmental Health Terms]; **c.** Swallowing (such as eating or drinking). Chemicals can get into or onto food, drink, utensils, cigarettes, or hands where they can then be ingested. [ED, 2000: Environmental Scorecard Glossary]; **d.** The intake of water or food particles by "swallowing" them, taking them into the body cavity or into a vacuole. Contrast with absorption. [UCMP, 1998: Glossary of Ecological Terms]; **e.** Swallowing. One of the ways a toxic substance can enter the body. [University of Kentucky, 1999: Glossary of Safety Terms]

Inhalable particles - All dust capable of entering the human respiratory tract. [USEPA, 1997a: EPA Terms of Environment]

Inhalation - **a.** Intake of chemicals through the respiratory system. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** Breathing. Exposure may occur from inhaling contaminants because they can be deposited in the lungs, taken into the blood, or both. [ATSDR, 1999: Online Glossary]; **c.** Breathing. Once inhaled, contaminants can be deposited in the lungs, taken into the blood, or both. [ED, 2000: Environmental Scorecard Glossary]; **d.** In the lungs, taken into the blood or both. [New York Department of Health, 1999: Glossary of Environmental Health Terms]; **e.** Breathing in. The most common way for a toxic substance to enter the body. [University of Kentucky, 1999: Glossary of Safety Terms]

Inhalation exposure - Intake of a chemical or substance (e.g., dust) into the body through the lungs. [OFA, 2000: Oxyfuels Glossary]

Inhaled dose - The amount of an inhaled substance that is available for interaction with metabolic processes or biologically significant receptors after crossing the outer boundary of an organism. [USEPA, 1997b: Exposure Factors Handbook]

Insensible fluid loss - Insensible routes of fluid loss are those that are not readily observed and include the loss of fluid through the respiratory tract during respiration and loss of fluid by sweating. Dogs and cats sweat minimally through their foot pads so most insensible losses are through the respiratory tract. The fluid lost during breathing is close to pure water and does not contain many solutes (a hypotonic loss). The basal loss of water through breathing is about: 10_15 ml/lb/day. High environmental temperatures, fever and activity result in increased insensible losses. [WSU, 1999: Definitions and Abbreviations of Veterinary Terms]

Insensible water loss - Evaporative water losses that occur during breast feeding. Corrections are made to account for insensible water loss when estimating breast milk intake using the test weighing method. [USEPA, 1997b: Exposure Factors Handbook]

Inspirable fraction - That fraction of airborne particulate capable of entering the respiratory tract via the nose and the mouth, so providing a source of absorption into the body, either from direct inhalation or from subsequent oral ingestion. [OECD, 1997: Occupational Exposure to Pesticides]

Instantaneous point exposure - Contact between an agent and a target at a single point on a contact boundary at a single instant in time; the joint occurrence of two events: 1) point i of the target is located at (x_i, y_i, z_i) , and 2) an agent of concentration C_i , the exposure concentration, is present at location (x_i, y_i, z_i) ; measured as a concentration [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Instantaneous rate - In a short time interval (e.g. a week), the number of events (e.g. births in the UK) taking place during the interval is approximately proportional to the length of the interval. The constant of proportionality is the rate at which these events occur. This argument becomes more and more exact as the length of the time interval becomes shorter and shorter. When the time interval has shrunk to an instant, the rate has become an

'instantaneous rate'. A bad term; just call it a rate. [Swinton, 1999: A Dictionary of Epidemiology]

Intake - **a.** A measure of exposure expressed as mass of substance in contact with the exchange boundary per unit body weight per unit time, i.e., mg/kg-day. (1) **acute**: intake averaged over a period less than two weeks; (2) **chronic** (daily) - intake averaged over a long period of time (seven years to lifetime); (3) **subchronic** - intake averaged over a period from two weeks to seven years. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist, attributed to USEPA RAGS, 1989]; **b.** The amount of contact with a medium containing an agent. Used for estimating dose received from a particular medium. [REAP, 1995: Residential Exposure Assessment Project]; **c.** The process by which a substance crosses the outer boundary of an organism without passing an absorption barrier, e.g., through ingestion or inhalation. (See also potential dose) [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment] [USEPA, 1997b: Exposure Factors Handbook]

Intake dose - Dose resulting from the agent crossing the contact boundary without subsequently diffusing through a resisting boundary layer [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Intake rate - Rate of inhalation, ingestion, and dermal contact depending on the route of exposure. For ingestion, the intake rate is simply the amount of food containing the contaminant of interest that an individual ingests during some specific time period (units of mass/time). For inhalation, the intake rate is the rate at which contaminated air is inhaled. Factors that affect dermal exposure are the amount of material that comes into contact with the skin, and the rate at which the contaminant is absorbed. [USEPA, 1997b: Exposure Factors Handbook]

Integrated exposure assessment - Cumulative summation (over time) of the magnitude of exposure to a toxic chemical in all media. [USEPA, 1997a: EPA Terms of Environment]

Intensity - **a. seismology.** (1) A measure of the power or force (magnitude) of the event in relation to the time over which the event occurs and the area over or in which it occurs (Dorland 843). (2) A numerical index denoted by Roman numerals from I to XII describing the physical effects of an earthquake at a specific location on the earth's surface, man, or on structures built by man. These values are determined subjectively by individuals

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performing postearthquake investigations to determine the nature and spatial extent of the damage distribution. There are no instrumental readings. The most commonly used scales throughout the world are Modified Mercalli Intensity (MMI), developed in the 1930's and named for the Italian author, and the MSK scale, developed in the 1960's and denoted by the first initial of the last name of two scientists of the former Soviet Union and one scientist of the former Czechoslovakia who created the scale. Intensity VI denotes the threshold for potential ground failure such as liquefaction. Intensity VII denotes the threshold for architectural damage. Intensity VIII denotes the threshold for structural damage. Intensity IX denotes intense structural damage. Intensities X to XII denote various levels of destruction up to total destruction. The MMI and MSK scales are essentially equivalent for intensities VII to X. An earthquake has many intensities, but only one magnitude. (3) [seismic intensity] The degree of shaking or of vibrations, signifying the intensity of an earthquake as measured numerically on the Mercalli scale. [PDM, 2000: Disaster Terminology]; **b. parasitology.** (1) (Traditional) The mean parasite burden within all the infected members of the host population. Also called mean abundance. (2) (Newer) The mean parasite burden within both infected and uninfected hosts. It is important to indicate which usage is adopted, since they give different statistics, unless the prevalence is 100%. Macroparasites, and infections like malaria, are usually measured in terms of intensity. [Swinton, 1999: A Dictionary of Epidemiology]; **c. exposure assessment.** Amount of energy-form agent per area [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Internal dose - a. Refers to the amount of the environmental contaminant absorbed in body tissue or interacting with an organ's membrane surface. [NRC, 1991: Human Exp. for Airborne Pollutants]; **b.** That portion of the dose equivalent received from radioactive material taken into the body (e.g., "internal sources"). [USDOE, 1998: Radiological Control Manual] **c.** The amount of a substance penetrating across the absorption barriers (the exchange boundaries) of an organism, via either physical or biological processes. For the purpose of these Guidelines, this term is synonymous with absorbed dose. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project] [USEPA, 1997b: Exposure Factors Handbook]; **d.** In exposure assessment, the amount of a substance penetrating the

absorption barriers (e.g., skin., lung tissue, gastrointestinal tract) of an organism through either physical or biological processes. (See: absorbed dose) [USEPA, 1997a: EPA Terms of Environment]; **e.** The amount of pesticide absorbed through the exchange boundaries of the body (equivalent to the absorbed dose). [USEPA, 1998: Postapp. Exposure Test GL.] [cf. **absorbed dose**]

Internal exposure - Amount of the substance which is bioavailable. [EC, 1996: Risk Assessment for New Notified Subs]

Internal radiation dose - The dose to organs of the body from radioactive materials inside the body. It may consist of any combination of alpha, beta, and gamma radiation. [USDOE, 2000: RAIS Glossary]

Lifetime - a. Covering the life span of an organism (generally considered 70 years for humans). [USEPA, 1995: Benchmark Dose]; **b. [atmospheric lifetime]** The lifetime of a greenhouse gas refers to the approximate amount of time it would take for the anthropogenic increment to an atmospheric pollutant concentration to return to its natural level (assuming emissions cease) as a result of either being converted to another chemical compound or being taken out of the atmosphere via a sink. This time depends on the pollutant's sources and sinks as well as its reactivity. The lifetime of a pollutant is often considered in conjunction with the mixing of pollutants in the atmosphere; a long lifetime will allow the pollutant to mix throughout the atmosphere. Average lifetimes can vary from about a week (sulfate aerosols) to more than a century (CFCs, carbon dioxide). [USEPA, 2000: Global Warming Glossary]

Lifetime average daily dose (LADD) - a. Total dose received over a lifetime multiplied by fraction of lifetime during which exposure occurs, expressed in mg/kg body weight/day. Ordinarily used for assessing cancer risk. [REAP, 1995: Residential Exposure Assessment Project]; **b.** Figure for estimating excess lifetime cancer risk. [USEPA, 1997a: EPA Terms of Environment]; **c.** Dose rate averaged over a lifetime. The LADD is used for compounds with carcinogenic or chronic effects. The LADD is usually expressed in terms of mg/kg-day or other mass/mass-time units. [USEPA, 1997b: Exposure Factors Handbook]; **d.** Dose that is averaged over an individual's lifetime taking into account the frequency, duration, and intensity of exposure events. LADDs are usually expressed in units of mg/kg/day. [USEPA, 1998: Postapp. Exposure Test GL.] **Lifetime dose -** Total occupational exposure over a worker's lifetime, including external and

committed internal dose. [USDOE, 1998: Radiological Control Manual]

Lifetime exposure - Total amount of exposure to a substance that a human would receive in a lifetime (usually assumed to be 70 years). [USEPA, 1997a: EPA Terms of Environment] [USDOE, 2000: RAIS Glossary]

Limit of detection (LOD) - a. The lowest concentration of a substance that can reliably be measured. [CARB, 2000: Glossary of Air Pollution Terms]; **b. [limit of determination]** The LOD is the lowest concentration of a pesticide residue or contaminant that can be identified and quantitatively measured in a specified food, agricultural commodity, or animal feed with an acceptable degree of certainty by a regulatory method of analysis. The LOD is considered synonymous with the limit of quantitation/quantification. [FAO/WHO, 1997: Food Consumption & Exp. Assessment of Chemicals]; **c.** The level at which a pesticide can be detected but not quantified for a given analytical procedure. [OECD, 1997: Occupational Exposure to Pesticides]; **d.** [also, **method detection limit (MDL)**] The minimum concentration of an analyte that, in a given matrix and with a specific method, has a 99% probability of being identified, qualitatively or quantitatively measured, and reported to be greater than zero. [USEPA, 1992: GL for Exposure Assessment]; **e.** The minimum concentration of a substance being analyzed test that has a 99 percent probability of being identified. [USEPA, 1997a: EPA Terms of Environment]; **f.** LOD is the point at which "a measured value becomes...larger than the uncertainty associated with it" (Taylor, 1987). The LOD can be defined in a number of ways, such as the background response plus three times the standard deviation of the lowest measurable concentration, three times the signal-to-noise ratio of baseline noise, three times the standard deviation of the lowest measurable concentration, etc. [USEPA, 1998: Postapp. Exposure Test GL.]

Limit of quantification (LOQ) - a. The smallest amount of the pesticide that can be quantified by the analytical method. [OECD, 1997: Occupational Exposure to Pesticides]; **b.** LOQ is the point at which "measurements become quantitatively meaningful" (Taylor, 1987). It is the lowest pesticide residue that can be accurately quantitated in a reproducible fashion. The LOQ can be defined in a number of ways, such as the background response plus ten times the standard deviation of the lowest measurable concentration, ten times the signal-to-noise ratio of the baseline noise, ten times

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the standard deviation of the lowest measurable concentration, etc. In practice, the LOQ is the lowest fortification level that shows adequate recovery during the method validation process. [USEPA, 1998: Postapp. Exposure Test GL.]

Linear dose response - A pattern of frequency or severity of biological response that varies proportionately with the amount of dose of an agent. [IRIS, 1999: Glossary of IRIS Terms]

Linear model - A statistical model of a dependent variable y as a function of a factor, x : $y = a + bx + E$, where E represents random variation. [Last, 1983: A Dictionary of Epidemiology]

Log normal distribution - If a variable Y is such that $X = \log Y$ is normally distributed, it is said to have log normal distribution. This is a skew distribution. [Last, 1983: A Dictionary of Epidemiology]

Lowest acceptable daily dose - The largest quantity of a chemical that will not cause a toxic effect, as determined by animal studies. [USEPA, 1997a: EPA Terms of Environment]

Margin of Exposure (MOE) - **a.** The LED_{10} or other point of departure divided by the actual or projected environmental exposure of interest. [IRIS, 1999: Glossary of IRIS Terms]; **b.** The ratio of the $NO(A)EL$ or $NOEL$ to an estimated dose/exposure level. [REAP, 1995: Residential Exposure Assessment Project]; **c.** The ratio of the $no_observed\ adverse_effect_level$ to the estimated exposure dose. [USEPA, 1997a: EPA Terms of Environment]; **d.** Represents the ratio of a no observable adverse effect level ($NOAEL$) to an estimated dose/exposure level. [USEPA, 1998: Postapp. Exposure Test GL.]

Mathematical model - **a.** A representation of a system, process, or relationship in mathematical form in which equations are used to simulate the behavior of the system or process under study. The model usually consists of two parts: the mathematical structure itself, e.g., Newton's inverse square law or Gauss's "normal" law, and the particular constants or parameters associated with them, such as Newton's gravitational constant or the Gaussian standard deviation. A mathematical model is deterministic if the relations between the variables involved take on values not allowing for any play of chance. A model is said to be statistical, stochastic, or random, if random variation is allowed to enter the picture. [Last, 1983: A Dictionary of

Epidemiology]; **b.** A formal framework to convey ideas about the components of a host-parasite interaction. Construction requires three major types of information: (a) a clear understanding of the interaction within the individual host between the infectious agent and the host, (b) the mode and rate of transmission between individuals, and (c) host population characteristics such as demography and behaviour. Mathematical models can aid exploration of the behaviour of the system under various conditions from which to determine the dominant factors generating observed patterns and phenomena. They also aid data collection and interpretation and parameter estimation, and provide tools for identifying possible approaches to control and for assessing the potential impact of different intervention measures. [Swinton, 1999: A Dictionary of Epidemiology]

Maximally exposed individual (MEI) - [sometimes, **most exposed individual**] **a.** The single individual with the highest exposure in a given population (also, maximum exposed individual). This term has historically been defined various ways, including as defined here and also synonymously with worst case or bounding estimate. Assessors are cautioned to look for contextual definitions when encountering this term in the literature. [USEPA, 1992: GL for Exposure Assessment]; **b.** The single individual with the highest exposure in a given population. [USEPA, 1992a: Dermal Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project] [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist, attributed to USEPA, 1992a]; **c.** The person with the highest exposure in a given population. [USEPA, 1997a: EPA Terms of Environment]

Maximum exposure limit (MEL) - The maximum permitted concentration of a chemical to which a worker may be exposed over an extended period of time. Typically, MELs are quoted in ppm for an 8-hour reference period, though shorter periods may be quoted for some materials. MELs are, in many countries, enforceable by law. A list of chemicals for which MELs are defined in the UK is held at <http://physchem.ox.ac.uk/MSDS/mels.html> [Oxford University, 2000 - Chemical Safety Information Glossary]

Maximum exposure range - **a.** A semiquantitative term referring to the extreme uppermost portion of the distribution of exposures. For consistency, this term (and the dose or risk analogues) should refer to the portion of the individual exposure distribution that conceptually falls above about the 98th percentile of the distribution, but is not higher

than the individual with the highest exposure. [USEPA, 1992: GL for Exposure Assessment]; **b.** Estimate of exposure or dose level received by an individual in a defined population that is greater than the 98th percentile dose for all individuals in that population, but less than the exposure level received by the person receiving the highest exposure level. [USEPA, 1997a: EPA Terms of Environment]

Mean - see **arithmetic mean, geometric mean, harmonic mean**

Mean, arithmetic - see **arithmetic mean**

Mean, geometric - see **geometric mean**

Mean, harmonic - see **harmonic mean**

Measure of exposure - **a.** A measurable stressor characteristic that is used to help quantify exposure. [CENR, 1999: Ecorisk in the Federal Government]; **b.** A measurable characteristic of a stressor (such as the specific amount of mercury in a body of water) used to help quantify the exposure of an ecological entity or individual organism. [USEPA, 1997a: EPA Terms of Environment]; **c.** A measure of stressor existence and movement in the environment and its contact or co-occurrence with the assessment endpoint. [USEPA, 1998a: Guidelines for Ecological Risk Assessment]

Measurement - The procedure of applying a standard scale to a variable or to a set of values. [Last, 1983: A Dictionary of Epidemiology]

Measurement, problems with terminology - There is uncertainty about the terms used to describe the properties of measurement: accuracy, precision, validity, reliability, repeatability, and reproducibility. Accuracy and precision are often used synonymously, validity is defined variously, and reliability, repeatability, and reproducibility are frequently used interchangeably. Etymologies are helpful in making a case for preferred usages, but they are not always decisive. *Accuracy* is from the Latin *cure*, care, and while this may be of interest to those in the health field, it does not illuminate the origins of the standard definition, that is, "conforming to a standard or a true value" (OLD). Accuracy is distinguished from precision in this way: A measurement or statement can reflect or represent a true value without detail. A temperature reading of 98.6°F is accurate, but it is not precise if a more refined thermometer registers a temperature of 98.637°F. *Precision*, (from Latin *praecidere*, cut short) is the quality of being sharply defined through exact

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detail. A faulty measurement may be expressed precisely, but may not be accurate. Measurements should be both accurate and precise, but the two terms are not synonymous. In Kendall and Buckland's *Dictionary of Statistical Terms*, precision is defined as "a quality associated with a class of measurements and refers to the way in which repeated observations conform to themselves." Standard, as well as epidemiologic definitions are not in agreement with this statistical usage. Consistency or reliability describes the property of measurements or results that conform to themselves. *Reliability* (Latin *religare*, to bind) is defined by the *OED* as a quality that is sound and dependable. Its epidemiologic usage is similar; a result or measurement is said to be reliable when it is stable, i.e., when repetition of an experiment or measurement gives the same results. The terms "repeatability" and "reproducibility" are synonymous (the *OED* defines each in terms of the other), but they do not refer to a quality of measurement, rather only to the action of performing something more than once. Thus, a way of discovering whether or not a measurement is reliable is to repeat or reproduce it. The terms "repeatability" and "reproducibility," formed from their respective verbs, are used inaccurately when they are substituted for "reliability," a noun that refers to the measuring procedure rather than the attribute being measured. However, in common usage, both repeatability and reproducibility refer to the capacity of a measuring procedure to produce the same result on each occasion in a series of procedures conducted under identical conditions. *Validity* is used correctly when it agrees with the standard definition given by the *QED*: "sound and sufficient." If, in the epidemiologic sense, a test measures what it purports to measure (it is sufficient) then the test is said to be valid. [Last, 1983: A Dictionary of Epidemiology]

Measures of central tendency - A general term for several characteristics of the distribution of a set of values or measurements around a value or values at or near the middle of the set. The principal measures of central tendency are the mean (average), median, and mode. [Last, 1983: A Dictionary of Epidemiology]

Median - **a.** The middle value in a population distribution, above and below which lie an equal number of individual values; midpoint. [CARB, 2000: Glossary of Air Pollution Terms]; **b.** A measure of central tendency. The simplest division of a set of measurements is into two parts—the lower and the upper half. The point on the scale that divides the group in this way is called the "median." [Last,

1983: A Dictionary of Epidemiology]; **c.** The midpoint value obtained by ranking all values from highest to lowest and choosing the value in the middle. The median divides a population into two equal halves. [NIAID, 1997: HIV Vaccine Glossary]

Medium (pl. media) - **a.** Any one of the basic categories of material surrounding or contacting an organism (e.g., outdoor air, indoor air, water, soil, sediments) through which chemicals or pollutants can move and reach the organism. [USEPA, 1992a: Dermal Exposure Assessment]; **b.** The environmental substance (e.g. air, water, soil) originally contaminated. [USEPA, 1999: Superfund Risk Assessment Glossary]

Medium intake rate - the rate at which the carrier medium crosses the contact boundary [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

MEL - see **maximum exposure limit**

Microenvironment - A three dimensional space with a volume in which contaminant concentration is spatially uniform during some specific interval. [NRC, 1991: Human Exp. for Airborne Pollutants]

Microenvironments - **a.** Well-defined surroundings such as the home, office, automobile, kitchen, store, etc. that can be treated as homogeneous (or well characterized) in the concentrations of a chemical or other agent. [USEPA, 1992: GL for Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project]; **b.** Well defined areas such as the home, office, automobile, kitchen, store, etc. that can be treated as homogeneous (or well characterized) in the concentrations of a chemical or other agent. [USEPA, 1992a: Dermal Exposure Assessment]; **c.** Well defined surroundings such as the home, office, or kitchen that can be treated as uniform in terms of stressor concentration. [USEPA, 1997a: EPA Terms of Environment]

Microenvironment method - **a.** A method used in predictive exposure assessments to estimate exposures by sequentially assessing exposure for a series of areas (microenvironments) that can be approximated by constant or well-characterized concentrations of a chemical or other agent. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment]; **b.** A method for sequentially assessing exposure for a series of microenvironments that can be approximated by constant concentrations of a stressor. [USEPA, 1997a: EPA Terms of Environment]

Mobile source - **a.** A source of air pollution, such as automobiles, motorcycles, trucks, off_road vehicles, boats, and airplanes. [CARB, 2000: Glossary of Air Pollution Terms]; **b.** A moving object that releases regulated air pollutants, e.g. cars, trucks, buses, planes, trains, motorcycles, and gas_powered lawn mowers. [ODEQ, 1999: Air Quality Glossary]; **c.** A moving producer of air pollution, mainly forms of transportation _ cars, motorcycles, planes. [SRA, 1999: Glossary of Risk Analysis Terms]; **d.** Any non_stationary source of air pollution such as cars, trucks, motorcycles, buses, airplanes, and locomotives. [USEPA, 1997a: EPA Terms of Environment] [Cf. **stationary source**]

Mobility - The ability of a chemical element or a pollutant to move into and through the environment (e.g., the mobilization of an element from a water column to sediment) [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]

Mode - **a.** One of the measures of central tendency. The most frequently occurring value in a set of observations. [Last, 1983: A Dictionary of Epidemiology]; **b.** The value in the data set that occurs most frequently. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment] [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]

Model - **a.** A mathematical function with parameters that can be adjusted so the function closely describes a set of empirical data. A mechanistic model usually reflects observed or hypothesized biological or physical mechanisms, and has model parameters with real world interpretation. In contrast, statistical or empirical models selected for particular numerical properties are fitted to data; model parameters may or may not have real world interpretation. When data quality is otherwise equivalent, extrapolation from mechanistic models (e.g., biologically based dose_response models) often carries higher confidence than extrapolation using empirical models (e.g., logistic model). [IRIS, 1999: Glossary of IRIS Terms]; **b.** A representation or simulation of an actual situation. This may be either (1) a mathematical representation of characteristics of a situation that can be used to examine consequences of various actions, or (2) a representation of a country's situation through an "average region" with characteristics resembling those of the whole country. In epidemiology the use of models began with an effort to predict the onset and course of epidemics. In the second report of the Registrar_General of England and Wales (1840), William Farr developed the beginnings

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of a predictive model for communicable disease epidemics. He had recognized regularities in the smallpox epidemics of the 1830s. By calculating frequency curves for these past outbreaks, he estimated the deaths to be expected. [Last, 1983: A Dictionary of Epidemiology]; **c.** A mathematical representation of a natural system intended to mimic the behavior of the real system, allowing description of empirical data and predictions about untested states of the system. [USEPA, 1995: Benchmark Dose]

Modeling - Use of mathematical equations to simulate and predict real events and processes. [REAP, 1995: Residential Exposure Assessment Project]

Moderator variable - (Syn: qualifier variable) In a study of a possible causal factor and an outcome, a moderator variable is a third variable exhibiting statistical interaction by virtue of its being antecedent or intermediate in the causal process under study. If it is antecedent, it is termed a conditional moderator variable or effect modifier; if it is intermediate, it is a contingent moderator variable. [Last, 1983: A Dictionary of Epidemiology]

Monte Carlo simulation - A technique that can provide a probability function of estimated exposure using distributed values of exposure factors in an exposure scenario. The Monte Carlo simulation involves assigning a joint probability distribution to the input variables (*i.e.*, exposure factors) of an exposure scenario. Next, a large number of independent samples from the assigned joint distribution are taken and the corresponding outputs calculated. This is accomplished by repeated computer runs (*i.e.*, >=1,000 iterations) using random numbers to assign values to the exposure factors. The simulated output represents a sample from the true output distribution. Methods of statistical inference are used to estimate, from the exposure output sample, some parameters of the exposure distribution, such as percentiles, mean, variance, and confidence intervals. The Monte Carlo simulation can also be used to test the effect that an input parameter has on the output distribution. [REAP, 1995: Residential Exposure Assessment Project]

Monte Carlo technique - A repeated random sampling from the distribution of values for each of the parameters in a generic (exposure or dose) equation to derive an estimate of the distribution of (exposures or doses in) the population. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment] [USEPA, 1997b: Exposure Factors Handbook] [IRIS, 1999:

Glossary of IRIS Terms] [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]

Multimedia exposure - Exposure to a toxic substance from multiple pathways such as air, water, soil, food, and breast milk. [CARB, 2000: Glossary of Air Pollution Terms]

National estimated daily intake (NEDI) - The NEDI is a prediction of the daily intake of a pesticide residue which is based on the most realistic estimate of residue levels in food and the best available data on food consumption for a specific population. The residue levels may be estimated based on median residues from supervised trials and allowing for residues in edible portion of a commodity. The residue includes the parent, metabolites and degradation products considered to be toxicologically significant. Changes in residues resulting from processing and cooking may be included. The proportion of the commodity treated or imported may be used to correct residue estimates. When adequate information is available, monitoring and surveillance data or total diet studies may also be used. When appropriate, exposure to residues from other known uses are assessed. The NEDI is calculated in milligrams of the residue per person and expressed as a percent of the ADI. [FAO/WHO, 1997: Food Consumption & Exp. Assessment of Chemicals]

Natural sources - Non-manmade emission sources, including biological and geological sources, wildfires, and windblown dust. [CARB, 2000: Glossary of Air Pollution Terms]

Negative dose - the amount of agent exiting a target over a specified time interval. (*cf.* "positive dose") [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Non-linear dose response - A pattern of frequency or severity of biological response that does not vary proportionately with the amount of dose of an agent. When mode of action information indicates that responses may not follow a linear pattern below the dose range of the observed data, non-linear methods for determining risk at low dose may be justified. [IRIS, 1999: Glossary of IRIS Terms]

Nonpoint source - **a.** A diffuse pollution source that is not recognized to have a single point of origin. [CARB, 2000: Glossary of Air Pollution Terms]; **b.** A contributing factor to water pollution that cannot be traced to a specific spot; like agricultural fertilizer runoff, sediment from construction. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE,

2000: RAIS Glossary]; **c.** A diffuse pollution source (*i.e.*, without a single point of origin or not introduced into a receiving stream from a specific outlet). The pollutants are generally carried off the land by storm water. Common non-point sources are agriculture, forestry, urban, mining, construction, dams, channels, land disposal, saltwater intrusion, and city streets. [USEPA, 1997a: EPA Terms of Environment]

Nonpoint source controls - General phrase used to refer to all methods employed to control or reduce nonpoint source pollution. [NCSU, 1997: Watersheds Glossary]

Normal distribution - (Syn: Gaussian distribution) The continuous frequency distribution of infinite range represented by the equation: $f(x) = (1/[2BF^2]^{1/2}) e^{-(x-\mu)^2/2F^2}$, where x is the abscissa, $f(x)$ is the ordinate, μ is the mean, and F the standard deviation. The properties of a normal distribution include the following: (1) It is a continuous, symmetrical distribution; both tails extend to infinity; (2) the arithmetic mean, mode, and median are identical; and (3) its shape is completely determined by the mean and standard deviation. [Last, 1983: A Dictionary of Epidemiology]

Occupational exposure limit (OEL) - A (generally legally enforceable) limit on the amount or concentration of a chemical to which workers may be exposed. [Oxford University, 2000 - Chemical Safety Information Glossary]

Occupational tenure - The cumulative number of years a person worked in his or her current occupation, regardless of number of employers, interruptions in employment, or time spent in other occupations. [USEPA, 1997b: Exposure Factors Handbook]

Passive dosimetry - A method of measuring the amount of pesticide coming into contact with an individual. [OECD, 1997: Occupational Exposure to Pesticides]

Pathway - see **exposure pathway**

Per capita intake rate - The average quantity of food consumed per person in a population composed of both individuals who ate the food during a specified time period and those that did not. [USEPA, 1997b: Exposure Factors Handbook]

Percutaneous Absorption - The process by which pesticides pass through the skin barrier and enter systemic circulation; normally expressed as flux (mass per unit skin surface area per unit time), but may also be expressed

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as a percent (fraction of amount deposited on skin (exposure) reaching systemic circulation times 100) per unit time. [USEPA, 1998: Postapp. Exposure Test GL.]

Permissible dose - The dose of a chemical that may be received by an individual without the expectation of a significantly harmful result. [USEPA, 1997a: EPA Terms of Environment]

Permissible exposure limit (PEL) - [sometimes, **permissible exposure level**] **a.** An occupational health standard to safeguard employees against dangerous chemicals or contaminants in the workplace. [Last, 1983: A Dictionary of Epidemiology]; **b.** The legal limit for occupational exposure to airborne concentrations of several hundred agents. Established by OSHA (U.S. Occupational Safety and Health Administration). [REAP, 1995: Residential Exposure Assessment Project]; **c.** OSHA's number that tells the concentration of a chemical in air that a worker may breathe for a given period of time, without experiencing adverse effects, (see TLV). [University of Kentucky, 1999: Glossary of Safety Terms]

Persistence - **a.** In Scorecard, persistence generally refers to environmental persistence: the length of time a chemical stays in the environment, once introduced. Persistent chemicals do not break down easily in the environment. [ED, 2000: Environmental Scorecard Glossary]; **b.** The quality of remaining for a long period of time (such as in the environment or the body). Persistent chemicals (such as DDT and PCBs) are not easily broken down. [New York Department of Health, 1999: Glossary of Environmental Health Terms]; **c.** Refers to the length of time a compound stays in the environment, once introduced. A compound may persist for less than a second or indefinitely. [USEPA, 1997a: EPA Terms of Environment] [CARB, 2000: Glossary of Air Pollution Terms]

Person_time - A unit of measurement combining persons and time, used as denominator in instantaneous incidence rates. It is the sum of individual units of time that the persons in the study population have been exposed to the condition of interest. A variant is **person_distance**, e.g., as in **passenger_miles**. The most frequently used **person_time** is **person_years**. With this approach, each subject contributes only as many years of observation to the population at risk as he is actually observed; if he leaves after one year, he contributes one **person_year**; if after ten, ten **person_years**. The method can be used to measure incidence over extended and variable time periods. [Last, 1983: A Dictionary of

Epidemiology]

Person_year - The sum of the number of years each person in the study population is at risk; a metric used to aggregate the total population at risk assuming that 10 people at risk for one year is equivalent to 1 person at risk for 10 years. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]

Personal air samples - Air samples taken with a pump that is directly attached to the worker with the collecting filter and cassette placed in the worker's breathing zone (required under OSHA asbestos standards and EPA worker protection rule). [USEPA, 1997a: EPA Terms of Environment]

Personal exposure monitor - A device worn on or near the contact boundary that measures concentration [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Personal measurement - A measurement collected from an individual's immediate environment using active or passive devices to collect the samples. [USEPA, 1992a: Dermal Exposure Assessment]

Pharmacodynamics - Broadly, this is the science concerned with the study of the way in which xenobiotics exert their effects on living organisms. Such a study aims to define the fundamental physicochemical processes which lead to the biological effect observed. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary] [Cf. **toxicodynamics**]

Pharmacokinetic model - A model that can be used to predict the time course of absorption, distribution, metabolism, and excretion of a foreign substance in an organism's body (e.g., pesticide). [USEPA, 1998: Postapp. Exposure Test GL.]

Pharmacokinetics - **a.** This is the science which describes quantitatively the uptake of drugs by the body, their biotransformation, their distribution, metabolism, and elimination from the body. Both total amounts and tissue and organ concentrations are considered. "Toxicokinetics" is essentially the same term applied to xenobiotics other than drugs. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]; **b.** The processes of absorption, distribution, metabolism and excretion of a drug or vaccine. [NIAID, 1997: HIV Vaccine Glossary]; **c.** The study of the absorption, distribution, metabolism and excretion of a substance in any living system. [OECD, 1997: Occupational Exposure to Pesticides]; **d.** The processes by which a chemical is handled, and transported within the body, including how it is absorbed

into the body, how it is distributed in the body tissues, how it is transformed in the body to metabolites and other breakdown compounds, and how it is excreted. [OFA, 2000: Oxyfuels Glossary]; **e.** The study of the time course of absorption, distribution, metabolism, and excretion of a foreign substance (e.g., a drug or pollutant) in an organism's body. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project]; **f.** The field of study concerned with defining, through measurement or modeling, the absorption, distribution, metabolism, and excretion of drugs or chemicals in a biological system as a function of time. [USEPA, 1995: Benchmark Dose]; **g.** The study of the way that drugs move through the body after they are swallowed or injected. [USEPA, 1997a: EPA Terms of Environment] [Cf. **toxicokinetics**]

Physiologically Based Pharmacokinetic (PBPK) Model - **a.** Physiologically based compartmental model used to characterize pharmacokinetic behavior of a chemical. Available data on blood flow rates, and metabolic and other processes which the chemical undergoes within each compartment are used to construct a mass balance framework for the PBPK model. [IRIS, 1999: Glossary of IRIS Terms]; **b.** For dermal exposure testing, use of models to estimate the dermal permeability constant and amounts absorbed by the **best_fit** method based on blood concentration-time profile data or by monitoring the appearance and amounts of metabolites in postexposure urine samples or by measuring the concentration of parent compound in the expired air. [USEPA, 1992a: Dermal Exposure Assessment]

Pica - Deliberate ingestion of non-nutritive substances such as soil. [USEPA, 1997b: Exposure Factors Handbook]

Plume - **a.** An area of chemicals in a particular medium, such as air or groundwater, moving away from its source in a long band or column. A plume can be a column of smoke from a chimney or chemicals moving with groundwater. [ATSDR, 1999: Online Glossary]; **b.** A visible or measurable discharge of a contaminant from a given point of origin that can be measured according to the Ringelmann scale. [CARB, 2000: Glossary of Air Pollution Terms]; **c.** An area of chemicals moving away from its source in a long band or column. A plume, for example, can be a column of smoke from a chimney or chemicals moving with groundwater. [New York Department of Health, 1999: Glossary of Environmental Health Terms]; **d.** A plume is a visible smoke-like structure, which may

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contain pollutants emitted from an exhaust or smoke stack and released into the atmosphere. This elongated band of smoke has changing characteristics that vary with its local environmental conditions. These conditions may include the physical and chemical nature of the pollutant, weather conditions and downwind topography. [SHSU, 2000: Atmospheric Chemistry Glossary, attributed to World Press Review **41**:24 (1994); Journal of Applied Meteorology **33**:996-1016 (1994); and *Air Quality* by Thad Godish, pages 58-64 (1985)]; **e.** (1) The cloud of steam or smoke that comes from a chimney stack and blows downwind. (2) The contaminated portion of groundwater that moves past a source of pollution. [SRA, 1999: Glossary of Risk Analysis Terms, attributed to Stephen L. Brown]; **f.** (1) A visible or measurable discharge of a contaminant from a given point of origin. Can be visible or thermal in water, or visible in the air as, for example, a plume of smoke. (2) The area of radiation leaking from a damaged reactor. 3. Area downwind within which a release could be dangerous for those exposed to leaking fumes. [USEPA, 1997a: EPA Terms of Environment] [USDOE, 2000: RAIS Glossary]

Point estimate - a single numerical value resulting from calculation(s). [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]

Point-of-contact exposure - Exposure expressed as the product of the concentration of an agent in the medium of exposure and the duration and surface area of contact with the body surface (e.g. mg/cm²-hours). Some agents do not need to be absorbed into the body but rather produce toxicity directly at the point of contact (e.g., the skin, mouth, GI tract, nose, bronchial tubes, or lungs). In such cases the absorbed dose is not the relevant measure of exposure; rather it is the amount of toxic agents coming directly into contact with the body surface. [REAP, 1995: Residential Exposure Assessment Project]

Point-of-contact measurement of exposure -

a. An approach to quantifying exposure by taking measurements of concentration over time at or near the point of contact between the chemical and an organism while the exposure is taking place. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project]; **b.** Estimating exposure by measuring concentrations over time (while the exposure is taking place) at or near the place where it is occurring. [USEPA, 1997a: EPA Terms of Environment]

Point source - **a.** Any confined and discrete

conveyance from which pollutants are or may be discharged. These include pipes, ditches, channels, tunnels, conduits, wells, containers, and concentrated animal feeding operations. [NCSU, 1997: Watersheds Glossary]; **b.** A single isolated stationary source of pollution. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]; **c.** A stationary location or fixed facility from which pollutants are discharged; any single identifiable source of pollution; e.g., a pipe, ditch, ship, ore pit, factory smokestack. [USEPA, 1997a: EPA Terms of Environment]

Population - **a.** (1) All the inhabitants of a given country or area considered together; the number of inhabitants of a given country or area. (2) *sampling*. The whole collection of units from which a sample may be drawn; not necessarily a population of persons; the units may be institutions, records, or events. The sample is intended to give results that are representative of the whole population. [Last, 1983: A Dictionary of Epidemiology]; **b.** A group of interbreeding organisms occupying a particular space; the number of humans or other living creatures in a designated area. [USEPA, 1997a: EPA Terms of Environment]; **c.** An aggregate of individuals of a species within a specified location in space and time. [USEPA, 1998a: Guidelines for Ecological Risk Assessment]; **d.** A group of individuals with common ancestry that are much more likely to mate with one another than with individuals from another such group. [WRI, 1992: Biodiversity Glossary of Terms]

Population based - Pertaining to a general population defined by geopolitical boundaries; this population is the denominator and/or the sampling frame. [Last, 1983: A Dictionary of Epidemiology]

Population dose (population exposure) - The summation of individual radiation doses received by all those exposed to the source or event being considered. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]

Positive dose - The amount of agent entering a target over a specified time interval (*cf.* "negative dose") [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Potential dermal exposure - The total amount of pesticide coming into contact with the protective clothing, work clothing and exposed skin. [OECD, 1997: Occupational Exposure to Pesticides]

Potential dose - **a.** An exposure value multiplied by a contact rate (e.g., rates of inhalation, ingestion, or absorption through the

skin) and assumes total absorption of the contaminant. [NRC, 1991: Human Exp. for Airborne Pollutants]; **b.** The amount of a chemical contained in material ingested, air breathed, or bulk material applied to the skin. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project] [USEPA, 1997b: Exposure Factors Handbook]; **c.** The amount of a compound contained in material swallowed, breathed, or applied to the skin. Potentially Responsible Party (PRP): Any individual or company—including owners, operators, transporters or generators—potentially responsible for, or contributing to a spill or other contamination at a Superfund site. Whenever possible, through administrative and legal actions, EPA requires PRPs to clean up hazardous sites they have contaminated. [USEPA, 1997a: EPA Terms of Environment]; **d.** The amount of chemical that could be inhaled without wearing a respirator, or which could be deposited on the skin without wearing clothing. Potential dose is typically expressed as a mass per unit body weight per unit time (i.e., mg/kg/day). [USEPA, 1998: Postapp. Exposure Test GL.]

Potentially exposed - The condition where valid information, usually analytical environmental data, indicates the presence of contaminant(s) of a public health concern in one or more environmental media contacting humans (i.e., air, drinking water, soil, food chain, surface water), and there is evidence that some of those persons have an identified route(s) of exposure (i.e., drinking contaminated water, breathing contaminated air, having contact with contaminated soil, or eating contaminated food). [ATSDR, 1999: Online Glossary: ATSDR-specific term]

Precision - **a.** Quality of being exactly or sharply defined or stated. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** (1) The quality of being sharply defined or stated. One measure of precision is the number of distinguishable alternatives from which a measurement was selected, sometimes indicated by the number of significant digits in the measurement. Another measure of precision is the standard error of measurement, the standard deviation of a series of replicate determinations of the same quantity. See also **measurement, problems with terminology**. (2) In statistics, precision is defined as the inverse of the variance of a measurement or estimate. [Last, 1983: A Dictionary of Epidemiology]; **c.** A measure of how consistently the result is determined by repeated determinations without reference to any "true" value. [SRA, 1999:

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Glossary of Risk Analysis Terms]; **d.** A measure of the reproducibility of a measured value under a given set of conditions. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1997b: Exposure Factors Handbook] [Cf. **accuracy**]

Probabilistic analysis - Calculation and expression of health risks using multiple risk descriptors to provide the likelihood of various risk levels. Probabilistic risk results approximate a full range of possible outcomes and the likelihood of each, which often is presented as a frequency distribution graph, thus allowing uncertainty or variability to be expressed quantitatively. [USEPA, 1999: Superfund Risk Assessment Glossary]

Probabilistic uncertainty analysis - Technique that assigns a probability density function to each input parameter, then randomly selects values from each of the distributions and inserts them into the exposure equation. Repeated calculations produce a distribution of predicted values reflecting the combined impact of variability in each input to the calculation. Monte Carlo is a common type of probabilistic uncertainty analysis. [USEPA, 1997b: Exposure Factors Handbook]

Probability - **a.** A basic concept that may be considered undefinable, expressing "degree of belief." Alternatively, it is the limit of the relative frequency of an event in a sequence of n random trials as n approaches infinity: (Number of occurrences of the event) / n . [Last, 1983: A Dictionary of Epidemiology]; **b.** A probability assignment is a numerical encoding of the relative state of knowledge. [SRA, 1999: Glossary of Risk Analysis Terms]; **c.** The chance that a particular event will occur given the population of all possible events. See definition for risk. [USDOE, 2000: RAIS Glossary]

Probability density function (PDF) - Probability density functions are particularly useful in describing the relative likelihood that a variable will have different particular values of x . The probability that a variable will have a value within a small interval around x can be approximated by multiplying $f(x)$ (i.e., the value of y at x in a PDF plot) by the width of the interval. [Note: *the original has a sample PDF plot that is not reproduced here.*] [USEPA, 1998a: Guidelines for Ecological Risk Assessment]

Probability sample - see **random sample**

Probable error - The magnitude of error which is estimated to have been made in determination of results. [SRA, 1999:

Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]

Protective clothing - Clothing provided to personnel to minimize the potential for skin, personal and company issued clothing contamination. Also referred to as "anticontamination clothing," "anti-Cs" and "PCs." [USDOE, 1998: Radiological Control Manual]

Qualitative data - Observations or information characterized by measurement on a categorical scale, i.e., a dichotomous or nominal scale, or, if the categories are ordered, an ordinal scale. Examples are sex, hair color, death or survival, and nationality. [Last, 1983: A Dictionary of Epidemiology]

Random error - Indefiniteness of result due to finite precision of experiment. Measure of fluctuation in result upon repeated experimentation. [SRA, 1999: Glossary of Risk Analysis Terms]

Random sample - **a.** A sample that is arrived at by selecting sample units such that each possible unit has a fixed and determinate probability of selection. [Last, 1983: A Dictionary of Epidemiology]; **b.** A sample selected from a statistical population such that each individual has an equal probability of being selected. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1997b: Exposure Factors Handbook]

Range - The difference between the largest and smallest values in a measurement data set. [USEPA, 1992: GL for Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project] [USEPA, 1997b: Exposure Factors Handbook]

Reasonable maximum exposure (RME) - **a.** Used in conservative exposure assessment calculations; based not on worst-case scenario, but on 90% or 95% upper confidence limits on input parameters. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** The maximum exposure reasonably expected to occur in a population. [USEPA, 1997a: EPA Terms of Environment] [USDOE, 2000: RAIS Glossary]

Reasonable worst case - **a.** Reasonable unfavourable but not unrealistic situation: covering normal use patterns, including cases where populations are exposed to the same substance in more than one scenario, e.g. consumers or workers may use several products containing the same substance. The reasonable worst case prediction should also consider upper estimates of the extreme use and reasonably foreseeable misuse. [EC, 1996: Risk Assessment for New Notified Subs]; **b.**

The lower portion of the "high end" of the exposure, dose, or risk distribution. The reasonable worst case conceptually should be targeted at or above the 90th percentile in the distribution, but below the 98th percentile. [REAP, 1995: Residential Exposure Assessment Project]; **c.** A semiquantitative term referring to the lower portion of the high end of the exposure, dose, or risk distribution. The reasonable worst case has historically been loosely defined, including synonymously with maximum exposure or worst case, and assessors are cautioned to look for contextual definitions when encountering this term in the literature. As a semiquantitative term, it is sometimes useful to refer to individual exposures, doses, or risks that, while in the high end of the distribution, are not in the extreme tail. For consistency, it should refer to a range that can conceptually be described as above the 90th percentile in the distribution, but below about the 98th percentile. (compare maximum exposure range, worst case). [USEPA, 1992: GL for Exposure Assessment]; **d.** An estimate of the individual dose, exposure, or risk level received by an individual in a defined population that is greater than the 90th percentile but less than that received by anyone in the 98th percentile in the same population. Reasonably Available Control Technology (RACT): Control technology that is reasonably available, and both technologically and economically feasible. Usually applied to existing sources in nonattainment areas; in most cases is less stringent than new source performance standards. Reasonably Available Control Measures (RACM): A broadly defined term referring to technological and other measures for pollution control. [USEPA, 1997a: EPA Terms of Environment]

Receptor - **a. molecular biology.** A molecule on the surface of a cell that serves as a recognition or binding site for antigens, antibodies or other cellular or immunologic components. [NIAID, 1997: HIV Vaccine Glossary]; **b. ecology.** A plant, animal, community of organisms, or ecosystem that is exposed to stressors in the environment. [SETAC, 1997: Ecological Risk Assessment Technical Issue Paper]; **c. ecology.** The (ecological) entity which is exposed to the stressor. [USEPA, 1997: Guidance on Cumulative Risk Assessment, Planning and Scoping] [USEPA, 1997a: EPA Terms of Environment] [USEPA, 1998a: Guidelines for Ecological Risk Assessment] [CENR, 1999: Ecorisk in the Federal Government]

Receptor population - The exposed individual relative to the exposure pathway considered. [USEPA, 1999: Superfund Risk Assessment Glossary]

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Recommended Exposure Limit (REL) - An 8_ or 10_ hour time_ weighted average (TWA) or ceiling (C) exposure concentration recommended by NIOSH that is based on an evaluation of the health effects data. NIOSH Definition [OSHA, 2000: On-line OSHA/NIOSH Glossary of Respiratory Protective Terms]

Reconstructed source - Facility in which components are replaced to such an extent that the fixed capital cost of the new components exceeds 50 percent of the capital cost of constructing a comparable brand_ new facility. New_ source performance standards may be applied to sources reconstructed after the proposal of the standard if it is technologically and economically feasible to meet the standards. [USEPA, 1997a: EPA Terms of Environment]

Reconstruction of dose - a. An approach to quantifying exposure from internal dose, which is in turn reconstructed after exposure has occurred, from evidence within an organism such as chemical levels in tissues or fluids or from evidence of other biomarkers of exposure. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project]; **b.** Estimating exposure after it has occurred by using evidence within an organism such as chemical levels in tissue or fluids. [USEPA, 1997a: EPA Terms of Environment]

Reentry dose level (RDL) - Dose level at which reentry into an area previously treated with a chemical can occur with negligible deleterious effects caused by exposure to the chemical because the biological mode of action threshold for that chemical has not been met (mg/kg/day). [USEPA, 1998: Postapp. Exposure Test GL.]

Reference Concentration (RfC) - a. An estimate, derived by the U.S. EPA with an uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population, (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime of exposure. The RfC is derived from a no or lowest observed adverse effect level from human or animal exposures, to which uncertainty or "safety" factors are applied. [CARB, 2000: Glossary of Air Pollution Terms]; **b.** An estimate of the daily inhalation dose, expressed in terms of an ambient concentration, that can be taken daily over a lifetime without appreciable risk. [ED, 2000: Environmental Scorecard Glossary]; **c.** An estimate (with uncertainty spanning

perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It can be derived from a NOAEL, LOAEL, or benchmark concentration, with uncertainty factors generally applied to reflect limitations of the data used. Generally used in EPA's noncancer health assessments. [IRIS, 1999: Glossary of IRIS Terms]; **d.** An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious noncancer effects during a lifetime. [USEPA, 1995: Benchmark Dose] [USDOE, 2000: RAIS Glossary]

Reference Dose (RfD) - a. EPA toxicity value for evaluating noncarcinogenic effects resulting from exposures at Superfund sites; an estimate (with uncertainty spanning an order of magnitude or greater) of daily exposure level for humans, including sensitive subpopulations, that is likely to be without an appreciable risk or deleterious effects during a lifetime.(1) **chronic RfD:** applicable for time periods of seven years to lifetime; (2) **developmental RfD:** likely to be without appreciable risk of developmental effects, applicable to a single exposure event; (3) **subchronic RfD:** applicable for time periods of two weeks to seven years. (Source: RAGS, 1989) [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** An estimate delivered by the U.S. EPA (with uncertainty spanning perhaps an order of magnitude) of the daily exposure to the human population, (including sensitive subpopulations) that is likely to be without deleterious effects during a lifetime. The RfD is reported in units of mg of substance/kg body weight/day for oral exposures. [CARB, 2000: Glossary of Air Pollution Terms]; **c.** An estimate of the daily ingestion dose, expressed in terms of amount per unit of body weight, that can be taken daily over a lifetime without appreciable risk. [ED, 2000: Environmental Scorecard Glossary]; **d.** An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It can be derived from a NOAEL, LOAEL, or benchmark dose, with uncertainty factors generally applied to reflect limitations of the data used. Generally used in EPA's noncancer health assessments. [IRIS, 1999: Glossary of IRIS Terms]; **e.** A dose of a pesticide that the U.S. EPA considers safe for regular daily consumption by humans without

adverse health effects. Generated by taking the NOAEL from animal studies and adding uncertainty factors to account for differences between animals and humans, and susceptibility within the human population. [NRDC, 1998: Trouble on the Farm]; **f.** Toxicity value for evaluating noncarcinogenic (systemic) effects of daily exposure to contaminant levels without appreciable deleterious effects during a lifetime. See our toxicity values. [USDOE, 2000: RAIS Glossary]; **g.** An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious noncancer effects during a lifetime. [USEPA, 1995: Benchmark Dose]

Reference Exposure Level (REL) - A term used in risk assessment. It is the concentration at or below which no adverse health effects are anticipated for a specified exposure period. [CARB, 2000: Glossary of Air Pollution Terms]

Representative sample - a. The term "representative" as it is commonly used is undefined in the statistical or mathematical sense; it means simply that the sample resembles the population in some way. The use of probability sampling will not ensure that any single sample will be "representative" of the population in all possible respects. If, for example, it is found that the sample age distribution is quite different from that of the population, it is possible to make corrections for the known differences. A common fallacy lies in the unwarranted assumption that, if the sample resembles the population closely on those factors that have been checked, it is "totally representative" and that no difference exists between the sample and the universe or reference population. Kendall and Buckland (1971) comment as follows: "In the widest sense, a sample which is representative of a population. Some confusion arises according to whether 'representative' is regarded as meaning 'selected by some process which gives all samples an equal chance of appearing to represent the population'; or, alternatively, whether it means 'typical in respect of certain characteristics, however chosen'. On the whole, it seems best to confine the word 'representative' to samples which turn out to be so, however chosen, rather than apply it to those chosen with the object of being representative." [Last, 1983: A Dictionary of Epidemiology]; **b.** A sample that closely approximates both the concentration of activity and the physical and chemical properties of material (e.g., particle size and solubility in case of air sampling of the aerosol to which workers may be exposed). [USDOE,

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1998: Radiological Control Manual]; **c.** A portion of material or water that is as nearly identical in content and consistency as possible to that in the larger body of material or water being sampled. [USEPA, 1997a: EPA Terms of Environment]

Representativeness - The degree to which a sample is, or samples are, characteristic of the whole medium, exposure, or dose for which the samples are being used to make inferences. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1997b: Exposure Factors Handbook]

Respirable particle - Particle of the size (<5.0 :m) most likely to be deposited in the pulmonary portion of the respiratory tract. [SRA, 1999: Glossary of Risk Analysis Terms]

Respiration - The process by which animals use up stored foods (by combustion with oxygen) to produce energy. [USEPA, 2000: Global Warming Glossary]

Response rate - The number of completed or returned survey instruments (questionnaires, interviews, etc.) divided by the total number of persons who would have been surveyed if all had participated. Usually expressed as a percentage. Nonresponse can have several causes, e.g., death, removal out of the survey community, and refusal. [Last, 1983: A Dictionary of Epidemiology]

Risk specific dose - The dose associated with a specified risk level. [USEPA, 1997a: EPA Terms of Environment] [USDOE, 2000: RAIS Glossary]

Route - see **exposure route**

Route of administration - The way a drug is administered to an animal; i.e. orally, intramuscularly, intravenously. [WSU, 1999: Definitions and Abbreviations of Veterinary Terms]

Route of entry - Means by which a chemical enters the body: ingestion, inhalation, dermal absorption, or injection. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist] [Cf. **exposure route**]

Route of exposure - see **exposure route**

Sample - **a.** A selected subset of a population. A sample may be random or nonrandom and may be representative or nonrepresentative. Several types of sample can be distinguished, including the following: *Cluster sample*: Each unit selected is a group of persons (all persons in a city block, a family, etc.) rather than an individual. *Grab sample* (Syn: sample of convenience): These ill-defined terms describe samples selected by easily employed but

basically nonprobabilistic methods.

"Man_inthe_street" surveys and a survey of blood pressure among volunteers who drop in at an examination booth are in this category. It is improper to generalize from the results of a survey based upon such a sample for there is no way of knowing what sorts of bias may have been operating. *Probability (random) sample*: All individuals have a known chance of selection. They may all have an equal chance of being selected, or, if a stratified sampling method is used, the rate at which individuals from several subsets are sampled can be varied so as to produce greater representation of some classes than of others. A probability sample is created by assigning an identity (label, number) to all individuals in the "universe" population, e.g., by arranging them in alphabetical order and numbering in sequence, or simply assigning a number to each, or by grouping according to area of residence and numbering the groups. The next step is to select individuals (or groups) for study by a procedure such as use of a table of random numbers (or comparable procedure) to ensure that the chance of selection is known. *Simple random sample*: In this elementary kind of sample each person has an equal chance of being selected out of the entire population. One way of carrying out this procedure is to assign each person a number, starting with 1, 2, 3, and so on. The *l* numbers are selected at random, preferably from a table of random numbers, until the desired sample size is attained. *Stratified random sample*: This involves dividing the population into distinct subgroups according to some important characteristic, such as age or socioeconomic status, and selecting a random sample out of each subgroup. If the proportion of the sample drawn from each of the subgroups, or strata, is the same as the proportion of the total population contained in each stratum (e.g., age group 40_59 constitutes 20% of the population, and 20% of the sample comes from this age stratum), then all strata will be fairly represented with regard to numbers of person in the sample. *Systematic sample*: The procedure of selecting according to some simple, systematic rule, such as all persons whose names begin with specified alphabetical letters, bar on certain dates or located at specified points on a master list. A systematic sample may lead to errors that invalidate generalizations. [Last, 1983: A Dictionary of Epidemiology]; **b.** A small part of something designed to show the nature or quality of the whole. Exposure-related measurements are usually samples of environmental or ambient media, exposures of a small subset of a population for a short time, or biological samples, all for the purpose of inferring the nature and quality of parameters important to evaluating exposure. [USEPA, 1992: GL for Exposure Assessment] [USEPA,

1997b: Exposure Factors Handbook]

Scenario evaluation - An approach to quantifying exposure by measurement or estimation of both the amount of a substance contacted, and the frequency/duration of contact, and subsequently linking these together to estimate exposure or dose.

[USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project]

Scenario timeframe - The time period (current and/or future) being considered for the exposure pathway. [USEPA, 1999: Superfund Risk Assessment Glossary]

Sensitivity - **a.** The degree to which a system will respond to a change in climatic conditions. [RFF, 2000: Glossary of Terms and Concepts]; **b.** The ability of a test to work on people you know have the infection. More precisely TP/(TP+FN), where TP is the number of true positives and FN is the number of false negatives [Swinton, 1999: A Dictionary of Epidemiology]

Sensitivity analysis - **a.** In uncertainty analysis, comparison of risk estimates based on the means and upper bounds of the probability distributions of the input variables. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** A technique that tests the sensitivity of an output variable to the possible variation in the input variables of a given model. The purpose of sensitivity analysis is to quantify the influence of input variables on the output variable and develop bounds on the model output. The sensitivity of the output variable of a given mathematical model depends on the nature of the mathematical relationship of the model (and plausible values of its input variables). For a given model, the sensitivity of the output variable with respect to each input variable is computed, and the sensitivities of all input variables are compared. When computing the sensitivity with respect to a given input variable, all other input variables are held fixed at their nominal values. Sensitivity can be calculated for a point estimate of an input variable or over a range of an input variable. Varying several input parameters at the same time will often highlight interaction effects in the model which are not obvious during "one at a time" variation. [REAP, 1995: Residential Exposure Assessment Project]; **c.** Process of changing one variable while leaving the others constant to determine its effect on the output. This procedure fixes each uncertain quantity at its credible lower and upper bounds (holding all others at their nominal values, such as medians) and computes the results of each combination of values. The results help to

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identify the variables that have the greatest effect on exposure estimates and help focus further information gathering efforts. [USEPA, 1997b: Exposure Factors Handbook]

Sensitivity and specificity (of a screening test) - *Sensitivity* is the proportion of truly diseased persons in the screened population who are identified as diseased by the screening test. Sensitivity is a measure of the probability of correctly diagnosing a case, or the probability that any given case will be identified by the test (Syn: true positive rate). *Specificity* is the proportion of truly nondiseased persons who are so identified by the screening test. It is a measure of the probability of correctly identifying a nondiseased person with a screening test (Syn: true negative rate). [Last, 1983: A Dictionary of Epidemiology]

Short Term Exposure Limit (STEL)- a. According to American Conference of Governmental Hygienists, this is the time weighted average (TWA) airborne concentration to which workers may be exposed for periods up to 15 minutes, with no more than 4 such excursions per day and at least 60 minutes between them. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]; **b.** The maximum permissible concentration of a material, generally expressed in ppm in air, for a defined short period of time (typically 5 minutes). These values, which may differ from country to country, are often backed up by regulation and therefore may be legally enforceable. [Oxford University, 2000 - Chemical Safety Information Glossary]; **c.** Represented as STEL or TLVSTEL, this is the maximum concentration to which workers can be exposed for a short period of time (15 minutes) for only four times throughout the day with at least one hour between exposures. Also the daily TLVTWA must not be exceeded. [University of Kentucky, 1999: Glossary of Safety Terms] [also see **time weighted average**]

Short Term Exposure - Multiple or continuous exposure to an agent for a short period of time, usually one week. [IRIS, 1999: Glossary of IRIS Terms]

Skew distribution - An older and less recommended term for an asymmetrical frequency distribution. If a unimodal distribution has a longer tail extending toward lower values of the variate, it is said to have negative skewness; in the contrary case, positive skewness. [Last, 1983: A Dictionary of Epidemiology]

Skin Adherence - The property of a material

which causes it to be retained on the surface of the epidermis (adheres to the skin). [USEPA, 1992a: Dermal Exposure Assessment]

Sorption - **a.** A general term covering the processes of adsorption, absorption, desorption, ion exchange, ion exclusion, ion retardation, chemisorption, and dialysis. (1) **adsorption**: surface retention of solid, liquid, or gas molecules, atoms, or ions by a solid or liquid; (2) **absorption**: penetration of substances into the bulk of the solid or liquid; (3) **desorption**: process of removing a sorbed substance by the reverse of adsorption or absorption. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** A class of processes by which one material is taken up by another. Absorption is refers to the process of the penetration of one material into another; adsorption to the action of one material being collected on another's surface. [SHSU, 2000: Atmospheric Chemistry Glossary, attributed to Crutzen, Paul J. and Graedel, T.E. *Atmospheric Change: An Earth System Perspective*, p. 435]; **c.** The action of soaking up or attracting substances; process used in many pollution control systems. [USEPA, 1997a: EPA Terms of Environment]

Source - **a.** Any place or object from which air pollutants are released. Sources that are fixed in space are stationary sources and sources that move are mobile sources. [CARB, 2000: Glossary of Air Pollution Terms] [ODEQ, 1999: Air Quality Glossary]; **b.** The activity or entity from which an agent is released for potential human exposure. [REAP, 1995: Residential Exposure Assessment Project]; **c.** A place where pollutants are emitted, for example a chimney stack. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]; **d.** An entity or action that releases to the environment or imposes on the environment chemical, biological, or physical stressor or stressors. [USEPA, 1997: Guidance on Cumulative Risk Assessment, Planning and Scoping] [USEPA, 1998a: Guidelines for Ecological Risk Assessment] [CENR, 1999: Ecorisk in the Federal Government]

Source term - **a.** As applied to chemical stressors, the type, magnitude, and patterns of chemical(s) released. [USEPA, 1998a: Guidelines for Ecological Risk Assessment]; **b.** The release rate of hazardous agent from a facility or activity. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]

Spatially-averaged boundary exposure - the spatially-integrated exposure divided by the contact boundary area [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Spatially-averaged exposure - The spatially-integrated exposure divided by the volume of the contact zone [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Spatially-integrated exposure - The amount of agent present in the contact zone [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Standard deviation - **a.** A measure of dispersion or variation. It is the most widely used measure of dispersion of a frequency distribution. It is equal to the positive square root of the VARIANCE. The mean tells where the values for a group are centered. The standard deviation is a summary of how widely dispersed the values are around this center. [Last, 1983: A Dictionary of Epidemiology]; **b.** A measure of dispersion or variation, usually taken as the square root of the variance. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]

Standard error - The standard deviation of an estimate. [Last, 1983: A Dictionary of Epidemiology]

Stationary source - **a.** A non_mobile source such as a power plant, refinery, or manufacturing facility which emits air pollutants. [CARB, 2000: Glossary of Air Pollution Terms]; **b.** A fixed source of regulated air pollutants (e.g. industrial facility). See also source; mobile sources. [ODEQ, 1999: Air Quality Glossary]; **c.** A pollution location that is fixed rather than moving. [SRA, 1999: Glossary of Risk Analysis Terms]; **d.** A fixed_site producer of pollution, mainly power plants and other facilities using industrial combustion processes. (See: point source.) [USEPA, 1997a: EPA Terms of Environment] [Cf. **mobile source**]

Statistical power - The probability that one can detect an effect if there really is one. [FACS, 2000: Epidemiology for Journalists]

Statistical significance - **a.** The probability of obtaining a result as extreme or more extreme as that observed even if the null hypothesis is true. [FACS, 2000: Epidemiology for Journalists]; **b.** The probability that a result likely to be due to chance alone. By convention, a difference between two groups is usually considered statistically significant if chance could explain it only 5% of the time or less. Study design considerations may influence the a priori choice of a different statistical significance level. [IRIS, 1999: Glossary of IRIS Terms]; **c.** Statistical methods allow an estimate to be

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made of the probability of the observed or greater degree of association between independent and dependent variables under the null hypothesis. From this estimate, in a sample of given size, the statistical "significance" of a result can be stated. Usually the level of statistical significance is stated by the P value. [Last, 1983: A Dictionary of Epidemiology]; **d.** the probability that an event or difference occurred as the result of the intervention (vaccine) rather than by chance alone. This probability is determined by using statistical tests to evaluate collected data. Guidelines for defining significance are chosen before data collection begins. [NIAID, 1997: HIV Vaccine Glossary]; **e.** The statistical significance determined by using appropriate standard techniques of statistical analysis with results interpreted at the stated confidence level and based on data relating species which are present in sufficient numbers at control areas to permit a valid statistical comparison with the areas being tested. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]; **f.** An inference that the probability is low that the observed difference in quantities being measured could be due to variability in the data rather than an actual difference in the quantities themselves. The inference that an observed difference is statistically significant is typically based on a test to reject one hypothesis and accept another. [USEPA, 1992: GL for Exposure Assessment]

Statistically significant effect - In statistical analysis of data, a health effect that exhibits differences between a study population and a control group that are unlikely to have arisen by chance alone. [USEPA, 1995: Benchmark Dose]

Steady state exposure - Exposure to an environmental pollutant whose concentration remains constant for a period of time. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]

STEL - see **short term exposure limit**

Stochastic - This is the adjective applied to any phenomenon obeying the laws of probability. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]

Stochastic model - A mathematical model which takes into consideration the presence of some randomness in one or more of its parameters or variables. The predictions of the model therefore do not give a single point estimate but a probability distribution of possible estimates. Contrast with deterministic.

We might distinguish demographic stochasticity which arises from the discreteness of individuals and individual events such as birth, and environmental stochasticity arising from more_or_less unpredictable interactions with the outside world. [Swinton, 1999: A Dictionary of Epidemiology]

Stressor - Any physical, chemical, or biological entity that can induce an adverse response. [SETAC, 1997: Ecological Risk Assessment Technical Issue Paper] [USEPA, 1997: Guidance on Cumulative Risk Assessment, Planning and Scoping] [USEPA, 1997a: EPA Terms of Environment] [USEPA, 1998a: Guidelines for Ecological Risk Assessment] [CENR, 1999: Ecorisk in the Federal Government] [**Note:** Some of the definitions above also say that "stressor" is synonymous with "agent." Although this is generally true, the term "stressor" also includes the connotation that the adverse response can be the result of a *lack* of something – such as a habitat – which would also be called a "stressor." The term "agent" does not have this connotation, and is only used to denote a causative entity which actually physically exists as part of the environment.]

Subchronic Exposure - **a.** Exposure to a substance spanning approximately 10% of the lifetime of an organism. [IRIS, 1999: Glossary of IRIS Terms]; **b.** An exposure of intermediate duration between acute and chronic. [REAP, 1995: Residential Exposure Assessment Project]; **c.** Exposure to a substance spanning no more than approximately 10 percent of the lifetime of an organism. [USEPA, 1995: Benchmark Dose]; **d.** Multiple or continuous exposures lasting for approximately ten percent of an experimental species lifetime, usually over a three_month period. [USEPA, 1997a: EPA Terms of Environment]

Synergism - [also, **synergy**] **a.** When the adverse effect or risk from two or more chemicals interacting with each other is greater than what it would be if each chemical was acting separately. [ED, 2000: Environmental Scorecard Glossary]; **b.** The definition of synergism in epidemiology is somewhat controversial. We offer two definitions, the first a common dictionary definition, the second a more specific definition encountered in bioassay. (1) A situation in which the combined effect of two or more factors is greater than the sum of their solitary effects. (2) Two factors act synergistically if there are persons who will get the disease when exposed to both factors but not when exposed to either alone. Antagonism, the opposite of synergism, exists if there are persons who will get the disease when exposed to one of the factors

alone, but not when exposed to both. Note that under these definitions, two factors may act synergistically in some persons and antagonistically in others. [Last, 1983: A Dictionary of Epidemiology]; **c.** An interaction between two substances that results in a greater effect than both of the substances could have had acting independently. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary] [USEPA, 1997a: EPA Terms of Environment]

Synergistic effect - **a.** A synergistic effect is the any effect of two chemicals acting together which is greater than the simple sum of their effects when acting alone: such chemicals are said to show synergism. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]; **b.** Joint effects of two or more agents, such as drugs that increase each other's effectiveness when taken together. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]

Systematic error - A reproducible inaccuracy introduced by faulty equipment, calibration, or technique. [SRA, 1999: Glossary of Risk Analysis Terms] [Cf. **bias**]

Systemic dose - The dose of agent within the body (*i.e.*, not localized at the point of contact). Thus skin irritation cause by contact with an agent is not a systemic effect, but liver damage due to absorption of the agent through the skin is. [REAP, 1995: Residential Exposure Assessment Project]

Target - A physical, biological, or ecological object exposed to an agent [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Target organ - **a.** The biological organ(s) most adversely effected by exposure to a chemical substance. [IRIS, 1999: Glossary of IRIS Terms]; **b.** An organ (such as the liver or kidney) that is specifically affected by a toxic chemical. [New York Department of Health, 1999: Glossary of Environmental Health Terms]

Target organ dose - The target organ dose is the amount of a potentially toxic substance reaching the organ chiefly affected by that substance. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]

Target population - 1. The collection of individuals, items, measurements, etc., about which we want to make inferences. The term is sometimes used to indicate the population from which a sample is drawn and sometimes to denote any "reference" population about

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which inferences are required. 2. The group of persons for whom an intervention is planned. [Last, 1983: A Dictionary of Epidemiology]

Temporally-averaged exposure - The temporally-integrated exposure divided by the duration of the time period [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Temporally-integrated exposure - The integral of instantaneous point exposure values over a time period [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Theoretical maximum daily intake (TMDI) - The TMDI is a prediction of the maximum daily intake of a pesticide residue, assuming that residues are present at the MRLs and that average daily consumption of foods per person is represented by regional diets. The TMDI is calculated for the various GEMS/Food regional diets in milligrams of residue per person and is expressed as a percent of the ADI. [FAO/WHO, 1997: Food Consumption & Exp. Assessment of Chemicals]

Threshold limit value (TLV) - a. The maximum permissible concentration of a material, generally expressed in parts per million in air for some defined period of time (often 8 hours). These values, which may differ from country to country, are often backed up by regulation and therefore may be legally enforceable. [Oxford University, 2000 - Chemical Safety Information Glossary]; **b.** The **TLV_C** (ceiling exposure limit) is an exposure limit which should not be exceeded under any circumstances. [Oxford University, 2000 - Chemical Safety Information Glossary]

Time profile - A continuous record of instantaneous values (e.g., exposure, dose, or medium intake rate) over a time period [Zartarian, et al., 1997: Quant. Def. of Exp. & Related Concepts]

Time weighted average concentration (TWA) - a. This is a regulatory value defining the concentration of a substance to which a person is exposed in ambient air, averaged over a period, usually 8 hours. For a person exposed to 0.1 mg m⁻³ for 6 hours and 0.2 mg m⁻³ for 2 hours, the 8 hour TWA is $(0.1 \times 6 + 0.2 \times 2) / 8$ which equals 0.125 mg m⁻³. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]; **b.** The average value of a parameter (such as concentration of an agent in air) that varies over time. [REAP, 1995: Residential Exposure Assessment Project]; **c.** The average time, over a given work period (e.g., 8 hour work day), of a person's exposure to a chemical or an agent. The average is determined by sampling for the contaminant throughout the

time period. Represented as TLV_TWA. [University of Kentucky, 1999: Glossary of Safety Terms]

Time-activity Pattern - Information on activities in which various individuals engage, length of time spent performing various activities, locations in which individuals spend time, and length of time spent by individuals within various environments. [REAP, 1995: Residential Exposure Assessment Project]

TLV or TLV-C - see **threshold limit value**

Tolerable Daily Intake (TDI) - TDIs are applied to chemical contaminants in food and drinking water. The presence of contaminants is unwanted and they have no useful function, differing from additives and residues where there is or was deliberate use resulting in their presence. TDIs are calculated on the basis of laboratory toxicity data with the application of uncertainty factors. A TDI is thus an estimate of the amount of a substance (contaminant) in food or drinking water that can be ingested daily over a lifetime without appreciable health risk. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]

Total effective dose equivalent (TEDE) - The sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). Deep dose equivalent to the whole body may be used as effective dose equivalent for external exposures. [USDOE, 1998: Radiological Control Manual]

Total fluid intake - Consumption of all types of fluids including tap water, milk, soft drinks, alcoholic beverages, and water intrinsic to purchased foods. [USEPA, 1997b: Exposure Factors Handbook]

Total human exposure - Accounts for all exposures a person has to a specific contaminant, regardless of environmental medium or route of entry (inhalation, ingestion, and dermal absorption). Sometimes total exposure is used incorrectly to refer to exposure to all pollutants in an environment. Total exposure to more than one pollutant should be stated explicitly as such. [NRC, 1991: Human Exp. for Airborne Pollutants]

Toxicodynamics - a. Alterations in a biological system resulting from exposure to chemicals. [JHU, 1999: Altweb Glossary]; **b.** See pharmacodynamics. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary] [**Note:** The terms "toxicodynamics" and "pharmacodynamics" describe the same processes; "pharmacodynamics" was derived in reference

to drugs or other substances used for treatment, while "toxicodynamics" has more recently been used to refer to non-pharmaceutical toxic substances such as environmental pollutants.] [Cf. **pharmacodynamics**]

Toxicokinetics - a. The absorption, distribution, metabolism, storage, and excretion of chemicals. [JHU, 1999: Altweb Glossary]; **b.** See pharmacokinetics. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary] [**Note:** The terms "toxicokinetics" and "pharmacokinetics" describe the same processes; "pharmacokinetics" was derived in reference to drugs or other substances used for treatment, while "toxicokinetics" has more recently been used to refer to non-pharmaceutical toxic substances such as environmental pollutants.] [Cf. **pharmacokinetics**]

Transport - a. The movement of chemicals within one environmental compartment, or from one compartment to another. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** The movement of a soil particle, nutrient, or pesticide from its original position. This movement may occur in water or air currents. Nutrients and pesticides can be attached to soil particles or dissolved in water as they move. [NCSU, 1997: Watersheds Glossary]

Uncertainty - a. The deviation in predicted values from the actual values; may result from lack of data or variability in the data. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** A lack of confidence in the prediction of a risk assessment that may result from natural variability in natural processes, imperfect or incomplete knowledge, or errors in conducting an assessment. [SETAC, 1997: Ecological Risk Assessment Technical Issue Paper] [CENR, 1999: Ecorisk in the Federal Government]; **c.** In the conduct of risk assessment (hazard identification, dose_response assessment, exposure assessment, risk characterization) the need to make assumptions or best judgments in the absence of precise scientific data creates uncertainties. These uncertainties, expressed qualitatively and sometimes quantitatively, attempt to define the usefulness of a particular evaluation in making a decision based on the available data. [USEPA, 1995: Benchmark Dose]; **d.** Uncertainty represents a lack of knowledge about factors affecting exposure or risk and can lead to inaccurate or biased estimates of exposure. The types of uncertainty include: scenario uncertainty, parameter uncertainty, and model uncertainty.

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[USEPA, 1997b: Exposure Factors Handbook]

Uncertainty analysis - **a.** A process in which the sources of uncertainty in an estimate are identified, and an estimate made of the magnitude and direction of the resulting error. (1) **qualitative:** utilizes descriptive methods; (2) **semi-quantitative:** uses simple mathematical techniques such as *sensitivity analysis*; (3) **quantitative:** uses complex mathematical techniques such as *Monte Carlo* analysis. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** A detailed examination of the systematic and random errors of a measurement or estimate; an analytical process to provide information regarding the uncertainty. [SRA, 1999: Glossary of Risk Analysis Terms] [USDOE, 2000: RAIS Glossary]

Uncertainty factor (UF) - [sometimes also called **safety factor** or **modifying factor**] **a.** Used in converting NOAELs / LOAELs to RfDs and generally equal 10; account for (1) intraspecies variation, (2) interspecies variation, (3) use of a RfD based on a different time period, or (4) use of a LOAEL rather than a NOAEL to develop a RfD. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** This term may be used in either of two ways depending upon the context (i) Mathematical expression of uncertainty applied to data that are used to protect populations from hazards which cannot be assessed with high precision. (ii) With regard to food additives and contaminants, a factor applied to the no_observed effect level to derive acceptable daily intake (ADI) (the no_observed_effect level is divided by the safety factor to calculate the ADI). The value of the safety factor depends on the nature of the toxic effect, the size and type of the population to be protected, and the quality of the toxicological information available. [Duffus, 2000: Univ. Edinburgh Med School On-line Chemical Safety Glossary]; **c.** One of several, generally 10_fold factors, used in operationally deriving the RfD and RfC from experimental data. UFs are intended to account for (1) the variation in sensitivity among the members of the human population, i.e., interhuman or intraspecies variability; (2) the uncertainty in extrapolating animal data to humans, i.e., interspecies variability; (3) the uncertainty in extrapolating from data obtained in a study with less_than_lifetime exposure to lifetime exposure, i.e., extrapolating from subchronic to chronic exposure; (4) the uncertainty in extrapolating from a LOAEL rather than from a NOAEL; and (5) the uncertainty associated with extrapolation from animal data when the data base is incomplete. [IRIS, 1999: Glossary of IRIS Terms]; **d.** Factors used to adjust for multiple sources of

uncertainty encountered in using experimental animal data for predicting effects on humans, such as intraspecies variation, interspecies variation, synergism, and different route of exposure (i.e. oral versus inhalation). [REAP, 1995: Residential Exposure Assessment Project]; **e.** One of several, generally 10_fold factors used in operationally deriving the reference dose (RfD) from experimental data. UFs are intended to account for (1) the variation in sensitivity among members of the human population; (2) the uncertainty in extrapolating animal data to the case of humans; (3) the uncertainty in extrapolating from data obtained in a study that is of less_than_lifetime exposure; and (4) the uncertainty in using LOAEL data rather than NOAEL data. [USEPA, 1995: Benchmark Dose] [USEPA, 1997a: EPA Terms of Environment] [USDOE, 2000: RAIS Glossary]

Upper bound - An plausible upper limit to the true value of a quantity. This is usually not a true statistical confidence limit. [IRIS, 1999: Glossary of IRIS Terms]

Uptake - The process by which a substance crosses an absorption barrier and is absorbed into the body. [USEPA, 1992: GL for Exposure Assessment] [USEPA, 1992a: Dermal Exposure Assessment] [USEPA, 1997b: Exposure Factors Handbook]

Variability - **a.** A source of uncertainty in risk assessment, due to the fact that many parameters are best described not as point values but as probability distributions. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]; **b.** Variability arises from true heterogeneity across people, places or time, and can affect the precision of exposure estimates and the degree to which they can be generalized. The types of variability include: spatial variability, temporal variability, and inter-individual variability. [USEPA, 1997b: Exposure Factors Handbook]

Variable - **a.** Any quantity that varies. Any attribute, phenomenon, or event that can have different values. [Last, 1983: A Dictionary of Epidemiology]; **b.** A water quality constituent (for example, total phosphorus pollutant concentration) or other measured factors (such as streamflow, rainfall). [NCSU, 1997: Watersheds Glossary]

Variance - **a.** *statistics.* A measure of the variation shown by a set of observations, defined by the sum of the squares of deviations from the mean, divided by the number of degrees of freedom in the set of observations. [Last, 1983: A Dictionary of Epidemiology]; **b.** *law.* Permission granted for a limited time

(under stated conditions) for a person or company to operate outside the limits prescribed in a regulation. [CARB, 2000: Glossary of Air Pollution Terms]; **c.** *law.* Government permission for a delay or exception in the application of a given law, ordinance, or regulation. [USEPA, 1997a: EPA Terms of Environment] [USDOE, 2000: RAIS Glossary]

Wet deposition - The removal of atmospheric particles to the earth's surface by rain or snow. [SRA, 1999: Glossary of Risk Analysis Terms]

Whole body dose - The sum of the annual deep dose equivalent for external exposures and the committed effective dose equivalent for internal exposures. [USDOE, 1998: Radiological Control Manual]

Whole body - For the purposes of external exposure, head, trunk (including male gonads), arms above and including the elbow, or legs above and including the knee. [USDOE, 1998: Radiological Control Manual]

Worst case - A semiquantitative term referring to the maximum possible exposure, dose, or risk, that can conceivably occur, whether or not this exposure, dose, or risk actually occurs or is observed in a specific population. Historically, this term has been loosely defined in an *ad hoc* way in the literature, so assessors are cautioned to look for contextual definitions when encountering this term. It should refer to a hypothetical situation in which everything that can plausibly happen to maximize exposure, dose, or risk does in fact happen. This worst case may occur (or even be observed) in a given population, but since it is usually a very unlikely set of circumstances, in most cases, a worst-case estimate will be somewhat higher than occurs in a specific population. As in other fields, the worst-case scenario is a useful device when low probability events may result in a catastrophe that must be avoided even at great cost, but in most health risk assessments, a worst-case scenario is essentially a type of bounding estimate. [USEPA, 1992: GL for Exposure Assessment] [REAP, 1995: Residential Exposure Assessment Project]

Worst-case scenario - a method of conducting an exposure assessment in which the most conservative value of each input parameter is selected. See also *reasonable maximum exposure*. [AIHA, 2000: Risk Assessment Principles for the Industrial Hygienist]

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