

A glossary of terms

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Daily Record News Group*

The nuclear industry uses a language all its own. Some of it will be familiar from high school chemistry classes, but other acronyms and definitions are like a foreign language to people who do not work in the industry. Here are some of the terms and phrases that readers might find in this series of stories.

Glossary

ALARA - As Low As Reasonably Achievable, or keeping radiation emissions and exposures to levels set as far below regulatory limits as is reasonably possible in order to protect public health and the environment.

Alpha radiation - The most energetic but least penetrating form of radiation. It can be stopped by a sheet of paper and cannot penetrate human skin. However, if an alpha-emitting isotope is inhaled or ingested, it will cause highly concentrated local damage.

Aquifer - A permeable body of rock capable of yielding quantities of groundwater to wells and springs.

AR - Administrative Record, a required, comprehensive file of documents that forms the basis of decisions made regarding cleanup.

ARARs - Applicable or relevant and appropriate requirements, a comprehensive set of laws and regulations that are relevant to guide the selection of cleanup activity at a particular site.

Atom - The smallest particle of an element having the chemical properties of that element; the fundamental building block of matter.

Background radiation - The natural radioactivity in the environment. Natural radiation consists of cosmic rays, filtered through the atmosphere from outer space, and radiation from the naturally radioactive elements in the earth (primarily uranium, thorium, radium and potassium). Also known as natural radiation.

Beta radiation - High-energy electrons (beta particles) emitted from certain radioactive material. Can pass through 1 to 2 centimeters of water or human flesh and can be shielded by a thin sheet of aluminum. Beta particles are more deeply penetrating than alpha particles but, because of their smaller size, cause less localized damage.

BDN - Bionitrification, the process of breaking down nitrates into harmless elements through the use of living bacteria.

Biological effects - The early or delayed results of biological damages caused by nuclear radiation (alpha, beta gamma).

Biosphere - The part of the earth and its atmosphere in which living things exist.

BRA - Baseline risk assessment, the study and estimation of risk from taking no activity. Involves estimates of probability and consequence.

Carcinogen - A cancer-causing agent.

CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act (also known as Superfund), the federal law that guides cleanup of hazardous waste sites. Not all FUSRAP sites are Superfund sites.

CFR - Code of Federal Regulations

Characterization - Facility or site sampling, monitoring and analysis activities to determine the extent and nature of a release.

Characterization provides the basis for acquiring the necessary technical information to develop, screen, analyze, and select appropriate cleanup techniques.

Cleanup - The general term for environmental restoration, the process designed to ensure that risks to the environment and to human health and safety from waste sites either are eliminated or reduced to prescribed, safe levels.

Closure plan - Documentation prepared to guide the deactivation, stabilization and surveillance of a waste management unit or facility under the Resource Conservation and Recovery Act.

Comment period - Time provided for the public to review and comment formally on a proposed action or decision.

Contamination - The presence of foreign materials, chemicals or radioactive substances in the environment (soil, sediment, water or air) in significant concentrations.

Cubic meters - A unit equal to the volume of a cube measuring one meter in each dimension.

Cubic yards - A unit equal to the volume of a cube measuring one yard in each dimension.

Curie - A unit of radioactivity that represents the amount of radioactivity associated with one gram of radium. To say that a sample of radioactive material exhibits one curie of radioactivity means that the element is emitting radiation at the rate of 3.7 million times a second. A smoke detector contains 10 microcuries of radiation, or 10 millionths of a Curie. Named after Marie Curie, an early nuclear scientist.

Daughter product - An element formed by the radioactive decay of another element; often daughter products are radioactive themselves. Radon is a daughter product of thorium.

Decay - The process whereby radioactive particles undergo a change from one form, or isotope, to another, releasing radioactive particles and/or energy.

Decontamination - The removal of unwanted material (typically radioactive material) from facilities, soils, or equipment by washing, chemical action, mechanical cleansing or other techniques.

Defense wastes - Radioactive wastes resulting from weapons research and development, the operation of naval reactors, the production of

weapons materials, the reprocessing of defense spent fuel, and the decommissioning of nuclear-powered ships and submarines.

Dioxin - One of the most hazardous of all chemicals, can cause both acute and long-term effects ranging from chloracne, a skin disease, to cancer, reproductive failures, and reduced resistance to infectious disease.

Disposal - Waste emplacement designed to ensure isolation of waste from the biosphere, with no intention of retrieval for the foreseeable future.

DOE - U.S. Department of Energy.

Dose - Quantity of radiation or energy absorbed; measured in rads.

Dose equivalent - A term used to express the amount of effective radiation received by an individual. A dose equivalent considers the type of radiation, the amount of body exposed, and the risk of exposure. Measured in rems.

Dosimeter - An instrument that measures exposure to radiation.

EA - A written environmental analysis that is prepared under the National Environmental Policy Act to determine whether a federal action would significantly affect the environment and thus require preparation of a more detailed environmental impact statement.

EE/CA - Engineering evaluation and cost analysis, which is a CERCLA document, prepared to address interim cleanup activities.

Effluent - A waste discharged as a liquid.

EIS - Environmental impact statement, required by the National Environmental Policy Act. (See NEPA).

Electron - An elementary particle with a unit negative charge and a mass $1/1837$ that of the proton. Electrons surround the positively charged nucleus and determine the chemical properties of the atom.

Element - Any of the 109 substances that cannot be broken down further without changing its chemical properties. Singly or in combination, the elements constitute all matter.

Environmental restoration - The process of environmental cleanup designed to ensure that risks to the environment and to human health and safety from waste sites either are eliminated or reduced to prescribed, safe levels.

Erosion control - Methods to control land surface features to prevent erosion by surface water or precipitation runoff.

Exposure - A measurement of the displacement of electrons from atoms caused by X-rays or by gamma radiation. Acute exposure generally refers to a high level of exposure of short duration; chronic exposure is lower-level exposure of long duration.

Final disposition - Methods for permanent disposal of waste or contaminated soils after excavation/treatment.

Fission - The splitting of a heavy nucleus into two or more radioactive

nuclei, accompanied by the emission of gamma rays, neutrons and a significant amount of energy. Fission usually is initiated by the heavy nucleus absorbing a neutron, but it also can occur spontaneously.

FR - Federal Register

Friable asbestos - Asbestos insulation that is loose and capable of becoming airborne.

FS - Feasibility study, the Superfund study following a remedial investigation, which identifies, develops, evaluates and selects remedial action alternatives.

FUSRAP - Formerly Utilized Sites Remedial Action Program, which was created in 1974 to study sites used during World War II through the 1950s as part of the nation's atomic energy program. These early sites were decontaminated under guidelines in effect during that period. Using today's more-stringent environmental laws and better technology, the U. S. Army Corps of Engineers will restore these environmentally damaged sites.

Gamma rays - Penetrating electromagnetic waves or rays emitted from nuclei during radioactive decay, similar to X-rays. Dense materials such as concrete and lead are used to provide shielding against gamma radiation.

Geohydrologic - Pertaining to groundwater and its movements through the geologic environment.

Geohydrology - The science dealing with underground water, often referred to as hydrogeology.

Groundwater - Water beneath the earth's surface that fills pores between materials such as sand, soil or gravel. Groundwater is a major source of water for agricultural and industrial purposes and is an important source of drinking water for about half of all Americans.

Half-life - The time required for a radioactive substance to lose 50 percent of its radioactivity by decay. The half-life of the radioisotope plutonium-239, for example, is about 24,000 years. Starting with a pound of plutonium-239, in 24,000 years there will be one-half pound of plutonium-239, in another 24,000 years there will be one-fourth pound, and so on. (A pound of material remains, but it gradually becomes a stable element.)

Hazardous waste - A solid or liquid waste or combination of solid and liquid wastes that, because of quantity, concentration or physical, chemical or infectious characteristics, may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness or pose a substantial hazard to human health or the environment when improperly treated, stored, transported, disposed or otherwise managed.

About 290 million tons of hazardous wastes are generated in the United States each year. A small percentage (about 4 percent) is recycled. The rest is treated, stored or disposed. Of the hazardous wastes disposed, most are injected as a liquid into the ground in specially designed injection wells. A large quantity is placed in surface impoundments (pits, ponds and lagoons). A small portion is placed directly on the land or buried.

Heavy metals - Metals that have a dense molecular structure. Examples include mercury, lead, silver, gold and uranium.

HEPA Filter - High-efficiency particulate air filter.

High-level radioactive wastes - Highly radioactive material, containing fission products, traces of uranium and plutonium, and other transuranic elements, that results from chemical reprocessing of spent fuel. Originally produced in liquid form, high-level waste must be solidified before disposal.

Holding ponds - An impoundment made by excavation or earth fill for temporary storage of liquid wastes.

Impoundment liner - A continuous layer of natural or man-made materials, beneath or on the sides of a surface impoundment, which restricts the downward or lateral escape of by-product material, hazardous constituents, or leachate.

IR - Information Repository, where information relating to the Formerly Utilized Sites Remedial Action Program may be found.

Ion - Atomic particle, atom or chemical radical bearing an electric charge, either negative or positive.

Ionization - Removal of electrons from an atom, for example, by means of radiation, so that the atom becomes charged.

Ionizing radiation - Radiation that has enough energy to remove electrons from substances it passes through, forming ions.

Isotopes - Atoms of the same element that have equal numbers of protons, but different numbers of neutrons. Isotopes of an element have the same atomic number but different atomic mass. For example, uranium-238 and uranium-235.

Leachate - The solution formed when soluble components have been removed from a material.

Leaching - To remove a soluble substance from a material by dissolving it in a liquid, and then removing the liquid from what is left. Liquids also can leach into soils and aquifers.

LLW - Low-level waste, discarded radioactive material such as rags, construction rubble, glass, etc. that is only slightly or moderately contaminated. This waste usually is disposed of by land burial.

MCL - Maximum concentration limit, the regulatory limit for various constituents, usually organics and inorganics; there are different levels for different media, such as air, soil, and water. The MCL cannot be exceeded.

Millirem - A unit of radiation dosage equal to one-thousandth of a rem. A member of the public can safely receive up to 500 millirems per year, according to federal standards, but the U.S. EPA ordinarily limits public exposure to 25 to 100 mrem/year.

Mixed waste - Contains both radioactive and hazardous components.

Mobility - The ability of radionuclides to move through food chains in the environment.

Molybdenum - A silver-white metallic element used as an alloy with iron in making hard, high-speed cutting tools. It is not a heavy metal.

Monitoring well - A hole drilled into the ground with a pipe inserted to allow for the collection of groundwater samples.

Natural radiation - Radiation that is always present in the environment from such sources as cosmic rays and radioactive materials in rocks and soils. Also known as background radiation.

NCP - National Oil and Hazardous Substances Pollution Contingency Plan, which implements CERCLA.

NEPA - National Environmental Policy Act, requires a study of the impacts of activities at federal facilities.

Neutron - A particle that appears in the nucleus of all atoms except hydrogen. Neutrons are one of three basic particles that make up the atom. Neutrons have no electrical charge.

NOA - Notice of availability, published when a document on some aspect of cleanup is issued. Documents are available in the administrative record and information repositories.

NPDES - National Pollutant Discharge Elimination System.

NPL - National Priorities List, the list of the nation's worst Superfund sites.

NRC - Nuclear Regulatory Commission

NTS - Nevada Test Site, a repository for radioactive wastes.

Nuclear radiation - Ionizing radiation originating in the nuclei of atoms; alpha, beta, and gamma radiation.

Nucleus - The central part of an atom that contains protons, neutrons and other particles.

OSHA - Occupational Health & Safety Act. Also the Occupational Health and Safety Administration.

Pathways - The means by which contaminants move. Possible pathways include air, surface water, groundwater, plants and animals.

PCB - Polychlorinated biphenyl, a synthetic, organic chemical once widely used in electrical equipment, specialized hydraulic systems, heat transfer systems, and other industrial products. Highly toxic and a potent carcinogen. Any hazardous wastes that contain more than 50 parts per million of PCBs are subject to regulation under the Toxic Substances Control Act.

Picocuries - Measurement of radioactivity. A picocurie is one million millionth, or a trillionth, of a curie, and represents about 2.2 radioactive particle disintegrations per minute.

Plume - A defined area of groundwater containing contamination that originates from a particular source such as a waste unit.

Plutonium - An artificially produced element that is fissile and radioactive. It is created when an atom of uranium-238 captures a slow neutron in its nucleus.

PP - Proposed plan, a CERCLA document that summarizes what cleanup remedy has been selected, and why. The public is permitted to comment about the PP.

RA - Risk assessment, the study and estimation of risk from a current or proposed activity. Involves estimates of the probability and consequence of an action.

Rad - Radiation absorbed dose, a measurement of ionizing radiation absorbed by any material. A rad measures the absorption of a specific amount of work (100 ergs) in a gram of matter. The rad measures the amount of energy deposited in a material. It is not a measure of biological effect of that energy, but together with other factors is used to calculate the biological effect in units of rem (see rem).

Radiation - Fast particles and electromagnetic waves emitted from the nucleus of an atom during radioactive disintegration.

Radioactive - Giving off, or capable of giving off, radiant energy in the form of particles (alpha or beta radiation) or rays (gamma radiation) by the spontaneous disintegration of the nuclei of atoms. Radioisotopes of elements lose particles and energy through the process of radioactive decay. Elements may decay into different atoms or a different state of the same atom.

Radioactive waste - A solid, liquid or gaseous material of negligible economic value that contains radionuclides in excess of threshold quantities except for radioactive material from post-weapons-test activities.

Radioisotope - An unstable isotope of an element that eventually will undergo radioactive decay or disintegration. Radioisotopes with special properties are produced routinely for use in medical treatment and diagnosis, industrial tracers, and for general research.

Radionuclide - A radioactive species of an atom.

Radium - One of four primary radionuclides in FUSRAP wastes. They include radium-226, radon-222, thorium-230, uranium-234, uranium-235 and uranium-238.

Radon - A radioactive gas produced by the decay of one of the daughters of radium. Radon is hazardous in unventilated areas because it can build up to high concentrations and, if inhaled for long periods of time, may cause lung cancer.

RCRA - Resource Conservation and Recovery Act, the federal environmental law designed to account for and ensure proper management of hazardous wastes, from creation to disposition.

Reclamation - The act of processing of reclaiming. A restoration as to productivity, usefulness.

Rem - Roentgen equivalent man, a unit used in radiation protection to measure the amount of damage to human tissue from a dose of ionizing radiation. Incorporates the health risks from radiation. One rem is roughly the average dose received in three years of exposure to background radiation. A typical x-ray is equivalent to 0.03 rem and a mammogram is about 0.3 rem.

Remedial action - Long-term cleanup activities.

Remedial design - A phase of remedial action that follows the remedial investigation/feasibility study and includes development of engineering drawings and specifications for a site cleanup.

Remediation - Those activities performed to remove or treat hazardous waste sites or to relieve their effects.

Removal action - Interim cleanup activities that are identified as needed to protect public health and the environment.

Restoration - (See environmental restoration)

RI - Remedial investigation, the CERCLA process of determining the extent of hazardous substance contamination and, as appropriate, conducting treatability investigations.

RI/FS - Two distinct, but related studies, the remedial investigation and feasibility study. Together, they characterize environmental problems and outline remedial actions to solve those problems.

Risk assessment - (See RA)

Risk communication - The exchange of information about health or environmental risks between risk assessors, risk managers, the general public, news media, interest groups, etc.

Risk management - The process of evaluating alternative regulatory and non-regulatory responses to risk and selecting among them. The selection process necessarily requires the consideration of legal, economic and social factors.

ROD - Record of decision, a written decision that identifies the selected method for long-term cleanup of contamination at a site.

SARA - Super-fund Amendments and Reauthorization Act

Scoping - In CERCLA, scoping is the initial planning phase of the cleanup process, when requirements are discussed and the projects defined. In the NEPA process, scoping relates to public involvement to help identify significant issues early so that efforts can be focused on those areas requiring resolution and to present a balanced environmental impact statement.

Sludge - A semi-solid residue from any of a number of air or water treatment processes. Sludge can be a hazardous waste.

Slurry - A watery mixture of insoluble matter that results from some pollution control techniques.

Solidification - The conversion of either liquid or loose hazardous waste into a solid.

Solubility - A measure of how much of a given substance will dissolve in a liquid. Usually measured in weight per unit volume.

Somatic effects - Effects of radiation limited to the exposed individual, as distinguished from genetic effects, which also affect subsequent, unexposed generations.

Stable isotope - An isotope of an element that is not radioactive.

Surface impoundment - A natural topographic depression, man-made

excavation, or dike area, which is designed to hold an accumulation of liquid wastes or wastes containing free liquids and which is not an injection well.

Superfund - The program operated under the legislative authority of CERCLA and SARA that funds and carries out the EPA solid waste emergency and long-term removal remedial activities. These activities include establishing the National Priorities List, investigating sites for inclusion on the list, determining their priority level on the list, and conducting and/or supervising the ultimately determined cleanup and other remedial actions.

Tailings - Uranium mill tailings are the residual wastes of milled ore that remains after the uranium has been removed. The tailings are generated during the extraction of the uranium from the ore as it is fed to the mill. Uranium mill tailings are primarily the sandy process waste material from a conventional mill.

Thorium - A naturally occurring radioactive element and one of four primary radionuclides in FUSRAP wastes. They include radium-226, radon-222, uranium-234, uranium-235 and uranium-238. It is used in lantern mantles, in the production of ceramics and in alloys, among other uses.

Threshold dose - The minimum dose of radiation that will produce a detectable effect.

Toxic - Relating to a harmful effect by a poisonous substance on the human body by physical contact, ingestion or inhalation.

Toxicology - The science that deals with poisons and their effects on plant, animal and human life.

Transuranic wastes - Waste materials contaminated with isotopes above uranium in the periodic table. Transuranic waste is long-lived, but only moderately radioactive.

Treatment - Any activity that alters the chemical or physical nature of a waste to reduce its toxicity or prepare it for disposal.

Uranium - The heaviest element found in nature. Approximately 997 out of every 1,000 uranium atoms are uranium-238. The remaining 3 atoms are the fissile uranium-235. The uranium-235 atom splits into lighter elements when its nucleus is struck by a neutron. One of four primary radionuclides in FUSRAP wastes, including radium-226, radon-222 and thorium-230.

U.S. EPA - United States Environmental Protection Agency, sometimes referred to as EPA.

Uranium oxide - The generic name for a group of uranium compounds that includes uranium dioxide (UO₂), uranium trioxide (UO₃), and uranyl-uranium oxide (U₃O₈), and uranium peroxide (UO₄·2H₂O).

USACE - U.S. Army Corps of Engineers, the federal agency managing cleanup of the Formerly Utilized Sites Remedial Action Program.

UST - Any underground storage tank or associated piping containing hazardous materials.

Vitrification - A method of immobilizing waste that produces a glass-like solid that permanently captures the radioactive materials.

VOCs - Volatile organic compounds, chemicals that contain carbon and commonly also contain hydrogen, oxygen and other elements. The prefix "volatile" means that the compound evaporates rapidly. Most industrial solvents are volatile. Found in some liquid and air waste releases.

Waste minimization - Employing new techniques to reduce the amount of hazardous and radioactive wastes generated to as low a level as possible.

WIPP - Waste Isolation Pilot Project, a planned disposal facility in New Mexico for transuranic and other radioactive waste.

X-rays - Electromagnetic radiations used in medical diagnosis; a penetrating electromagnetic radiation, usually generated by accelerating atoms to high velocity and suddenly stopping them by collision with a solid body.

Yellowcake - Ammonium diuranate $(\text{NH}_4)_2\text{U}_2\text{O}_7$, a uranium concentrate with a characteristic yellow color. Yellowcake is the product of the uranium extraction (milling) process: early production methods resulted in a bright yellow compound, hence, the name yellowcake.

Concentration Comparisons

Parts per million:

- One automobile in bumper-to-bumper traffic from Cleveland to San Francisco
- One drop of gasoline in a full-size car's tank full of gas
- One facial tissue in a stack taller than the Empire State Building One pancake in a stack four miles high

Parts per billion:

- One silver dollar in a roll of silver dollars stretching from Detroit to Salt Lake City
- One kernel of corn in enough corn to fill a 4.5 foot-silo, 16 feet in diameter
- One sheet in a roll of toilet paper stretching from New York to London

Parts per trillion:

- One square foot of floor tile on a kitchen floor the size of Indiana. One drop of detergent in enough dishwater to fill a train load of railroad tank cars 10 miles long
- One mile on a two-month journey at the speed of light

Parts per quadrillion:

- One postage stamp on a letter the size of California and Oregon combined

- The palm of one's hand resting on a table the size of the United States. One human hair out of all the hair on all the heads of all the people in the world

- One mile in a journey of 170 light years

Sources: Glossary of Environmental Restoration Terms and Acronym List (EPA/IOPA-87-017, August 1988)

Glossary of Environmental Restoration (OE, Office of Environmental Restorations and Waste Management, Oak Ridge Operations, October 1990 and October 1991)

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