

# Radioactive Waste Management Glossary

**2003 Edition**



**IAEA**

International Atomic Energy Agency

**RADIOACTIVE WASTE  
MANAGEMENT GLOSSARY**

2003 Edition

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The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

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Printed by the IAEA in Austria  
July 2003  
STI/PUB/1155

# RADIOACTIVE WASTE MANAGEMENT GLOSSARY

2003 Edition

INTERNATIONAL ATOMIC ENERGY AGENCY  
VIENNA, 2003

**IAEA Library Cataloguing in Publication Data**

Radioactive waste management glossary : 2003 ed. — Vienna : International Atomic Energy Agency, 2003.

p. ; 24 cm.

STI/PUB/1155

ISBN 92-0-105303-7

Includes bibliographical references.

1. Radioactive waste disposal — Dictionaries. I. International Atomic Energy Agency.

IAEAL

03-00320

## FOREWORD

This is the fourth version of the IAEA Radioactive Waste Management Glossary. Previous versions were published in 1982 (IAEA-TECDOC-264), 1988 (IAEA-TECDOC-447) and 1993. The need for updating and revision is, to some extent, a reflection of continuing developments in radioactive waste management and related fields. In addition, the introduction of a new publications series, the IAEA Radioactive Waste Safety Standards (RADWASS), was an important factor in prompting the third revision, which was intended “to contribute to a common use of terms in the RADWASS series”. In the meantime a harmonized procedure has been adopted for preparation and review of the IAEA’s safety related publications, particularly Safety Standards. In this respect, the IAEA Safety Glossary has been prepared as a ‘living’ document, which covers all areas of nuclear safety including radioactive waste safety. Thus, this fourth version of the Glossary has been harmonized as regards waste safety terms with the Safety Glossary.

As with prior editions, this Glossary can continue to be improved upon and grow as it is used. Suggestions for modifications or additions will be welcomed. Please address comments to the Radioactive Waste Management Glossary, Waste Technology Section, Division of Nuclear Fuel Cycle and Waste Technology, IAEA, Wagramer Strasse 5, P.O. Box 100, A-1400 Vienna, Austria, or by e-mail to [wmg@iaea.org](mailto:wmg@iaea.org).

*EDITORIAL NOTE*

*Although great care has been taken to maintain the accuracy of information contained in this publication, neither the IAEA nor its Member States assume any responsibility for consequences which may arise from its use.*

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# 1. INTRODUCTION

In 1982, a Waste Management Glossary was published by the IAEA as IAEA-TECDOC-264. A revised and updated version was issued in 1988 as IAEA-TECDOC-447, and a third edition [1] was published in 1993 “to contribute to a common use of terms in the RADWASS series”. This is the fourth edition of the Glossary.

The purpose of this fourth updated Radioactive Waste Management Glossary remains the same as before, i.e. to provide a source of terms that are commonly used or have special meanings in the field of radioactive waste management. The Glossary reflects modifications to the meanings of some terms and includes new terms that have come into use in the meantime. However, it should be noted that some terms are used and defined differently in other areas of technology and even in other IAEA publications.

To keep the Glossary to a manageable size, terms whose meaning in the waste management literature is unchanged from that found in standard dictionaries are generally omitted. Technical terms whose meanings are unchanged from those of a specific discipline, such as engineering or geology, have also been omitted. To restrict the scope to terms that are used internationally, terms used in only one country will not be included. The Glossary has been prepared as an independent one for both technology and safety related radioactive waste management terms in full recognition of the existence of other glossaries within the IAEA. The range of terms covered encompasses all terms likely to be used in waste management publications, including publications of the IAEA Radioactive Waste Safety Standards (RADWASS) programme. However, very specialized radiation protection related terms have been excluded; the reader is referred to the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources [2] for definitions of those terms.

This Glossary describing the usage of waste management terminology has a direct interface with the IAEA document “Safety Glossary” (<http://www.iaea.org/ns/CoordiNet/safetypubs/iaeaglossary/glossaryhomepage.htm>), which also contains waste management terms. Common terms have been harmonized. Harmonization was also necessary with the definitions of terms used in the higher level publications in the IAEA Safety Standards Series and in the document on the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [3]. However, some of the definitions in the Joint Convention have been specially agreed for the Convention and are unlikely to be used elsewhere.

In the organization of the Glossary an overall format similar to that of the third edition has been retained. The use of modifiers (e.g. adverbs and adjectives) has been kept to a minimum. Many phrases are indexed under the key word in the phrase. For example, the term ‘radioactive waste’ appears as ‘waste, radioactive’. Cross-references

are also provided. Where definitions are given in terms of other words for which definitions are provided in the Glossary, the defined words appear in *italic* type face if it is considered that they might be of value to the reader to consult them to fully understand the original term.

In the context of this Glossary, the term ‘waste’ refers, in general, to radioactive waste unless otherwise specified.

## 2. GLOSSARY

**absorbed dose.** See *dose, absorbed.*

**absorption.** See *sorption.*

**accelerated test.** See *test, accelerated.*

**acid digestion.** See *digestion, acid.*

**actinide burning.** See *transmutation.*

**activation.** The process of inducing *radioactivity*. Most commonly used to refer to the induction of *radioactivity* in moderators, coolants, and structural and shielding materials, caused by irradiation with neutrons.

**activation product.** A *radionuclide* produced by *activation*. Often used in distinction from *fission products*. For example, in decommissioning waste comprising structural materials from a *nuclear facility*, activation products might typically be found primarily within the matrix of the material, whereas *fission products* are more likely to be present in the form of *contamination* on surfaces.

**activity.** The quantity  $A$  for an amount of *radionuclide* in a given energy state at a given time, defined as:

$$A(t) = \frac{dN}{dt}$$

where  $dN$  is the expectation value of the number of spontaneous nuclear transformations from the given energy state in the time interval  $dt$ . The SI unit of activity is the reciprocal second ( $s^{-1}$ ), termed the becquerel (Bq). Formerly expressed in curie (Ci), which is still sometimes used:  $1 \text{ Ci} = 3.7 \times 10^{10} \text{ Bq}$  (exactly).

**activity, specific.** Of a *radionuclide*, the *activity* per unit mass of that nuclide. Of a material, the *activity* per unit mass or volume of the material in which the *radionuclides* are essentially uniformly distributed.

**adsorption.** See *sorption*.

**advection.** The movement or transfer of a substance, heat, etc. by the motion of the fluid medium (e.g. air or water) in which it is present.

**aerobic.** A chemical or biological condition that denotes the presence of free oxygen (O<sub>2</sub>). See also *anaerobic*.

**ageing.** The general process in which characteristics of a structure, system or component gradually change with time or use.

**ageing, physical.** *Ageing* of structures, systems and components due to physical, chemical and/or biological processes.

**ALARA.** See *optimization*.

**alpha bearing waste.** See *waste, alpha bearing*.

**anaerobic.** A chemical or biological condition that denotes the absence or effective absence (i.e. very low partial pressure) of free oxygen (O<sub>2</sub>). See also *aerobic*.

**analysis.** Often used interchangeably with *assessment*, especially in more specific terms such as *safety analysis*. In general, however, analysis suggests a more narrowly technical process than *assessment*, aimed at understanding the subject of the analysis rather than determining whether or not it is acceptable. Analysis is also often associated with the use of a specific technique. Hence, one or more forms of analysis may be used in *assessment*.

**analysis, consequence.** A *safety analysis* that estimates potential individual or collective radiation *doses* to humans on the basis of *radionuclide* releases and transport from a *nuclear facility* (e.g. a waste *storage* facility or *disposal* site) to the human environment as defined by hypothetical release and transport *scenarios*.

**analysis, deterministic.** A simulation of the behaviour of a system utilizing one set of parameters, events and features. See also *analysis, probabilistic*.

**analysis, probabilistic.** A simulation of the behaviour of a system defined by parameters, events and features whose values are represented by a statistical distribution. The analysis gives a corresponding distribution of results. See also *analysis, deterministic*.

**analysis, risk.** An analysis of possible events and their probabilities of occurrence together with their potential consequences.

**analysis, safety.** An evaluation of the potential hazards associated with the implementation of a proposed activity.

**analysis, sensitivity.** A quantitative examination of how the behaviour of a simulated system (e.g. a computer model) varies with change, usually in the values of its parameters. Two common approaches used are: parameter variation, in which the variation of the results is investigated for changes in one or more input parameter values within a range around selected reference or mean values, and perturbation analysis, in which the variations of the results with respect to changes in all the input parameter values are obtained by applying differential, integral or *probabilistic analysis*.

**analysis, uncertainty.** An analysis of the amount of variation in the results of assessments or analyses due to incomplete knowledge about the current and future states of a system.

**anhydrite.** A mineral (dehydrated gypsum,  $\text{CaSO}_4$ ) commonly occurring in white or greyish granular to compact mass.

**aquifer.** A water bearing formation below the surface of the earth that can furnish an appreciable supply of water for a well or spring.

**area, controlled.** A defined area in which specific protection measures and safety provisions are or could be required for controlling *normal exposures* or preventing the spread of *contamination* during normal working conditions, and preventing or limiting the extent of *potential exposures*.

**area, operations.** A geographical area that contains an authorized *facility*. It is enclosed by a physical *barrier* (the *operations boundary*), to prevent unauthorized access and by means of which the management of the authorized *facility* can exercise direct authority.

**area survey.** See *survey, area*.

**argillaceous.** The term applied to all rocks and substances composed of clay or having a notable proportion of clay in their composition.

**assessment.** The process, and the result, of analysing systematically the hazards associated with *sources* and *practices*, and associated protection and safety measures, aimed at quantifying performance measures for comparison with criteria. Assessment should be distinguished from *analysis*. Assessment is aimed at providing information that forms the basis of a decision whether something is satisfactory or not. Various kinds of *analysis* may be used as tools in doing this. Hence an assessment may include a number of *analyses*<sup>1</sup>.

**assessment, consequence.** An assessment of the radiological consequences (e.g. doses and activity concentrations) of normal operation and possible accidents associated with a proposed or authorized facility or part thereof. This differs from *risk assessment* in that probabilities are not included in the *assessment*.

**assessment, environmental (impact).** An evaluation of radiological and non-radiological impacts of a proposed activity, where the performance measure is overall environmental impact, including radiological and other global measures of impact on safety and environment.

**assessment, performance.** An *assessment* of the performance of a system or subsystem and its implications for protection and safety at a planned or an authorized *facility*. This differs from *safety assessment* in that it can be applied to parts of a *facility*, and does not necessarily require assessment of radiological impacts.

**assessment, risk.** An *assessment* of the radiological *risks* associated with normal *operation* and potential accidents involving a *source* or *practice*. This will normally include *consequence assessment* and associated probabilities.

**assessment, safety.** An analysis to evaluate the performance of an overall system and its impact, where the performance measure is radiological impact or some other global measure of impact on safety. See also *assessment, performance*.

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<sup>1</sup> Here and elsewhere the plural of the entry (*analyses*) is also italicized unless it is formed by adding an 's' to the singular form. The reference is however made to the singular form (*analysis*).

**audit.** A documented activity performed to determine by investigation, examination and evaluation of objective evidence the adequacy of, and adherence to, established procedures, instructions, specifications, codes, standards, administrative or operational programmes and other applicable documents, and the effectiveness of implementation.

**authorization.** The granting by a *regulatory body* or other governmental body of written permission for an *operator* to perform specified activities. Authorization could include, for example, licensing, certification and registration. See also *licence*.

**authorized limit.** See *limit, authorized*.

**authorized use.** See *use, authorized*.

**backfill.** The material used to refill excavated portions of a *repository* (*drifts*, disposal rooms or *boreholes*) during and after *waste* has been emplaced.

**background (radiation).** The *dose*, dose rate or an observed measure related to the *dose* or dose rate, attributable to all *sources* other than the one(s) specified.

**barren solution.** Acid or alkaline liquor from which the recoverable uranium (and/or thorium) has been removed. This solution often contains reusable reagents.

**barrier.** A physical obstruction that prevents or delays the movement of *radionuclides* or other material between components in a system, for example a *waste repository*. In general, a barrier can be an engineered barrier which is constructed or a natural (or geological) barrier.

**barrier, intrusion.** The components of a *repository* designed to prevent inadvertent access to the *waste* by humans, animals and plants.

**barriers, multiple.** Two or more natural or engineered *barriers* used to isolate *radioactive waste* in, and prevent *radionuclide* migration from, a *repository*. See also *barrier*.

**basalt.** A fine grained basic *igneous rock*, commonly extrusive, composed primarily of calcium-rich plagioclase feldspar and pyroxene; other materials present may be olivine, magnetite and apatite. Basalt is the most common type of volcanic lava.

**bedded salt.** See *salt formation*.

**bentonite.** A soft light coloured *clay* formed by chemical alteration of volcanic ash. It is composed essentially of montmorillonite and related *minerals* of the smectite group. Bentonite is used as *backfill* and *buffer* material in repositories.

**biological half-life.** See *half-life, biological*.

**biosphere.** That part of the environment normally inhabited by living organisms. In practice, the biosphere is not usually defined with great precision, but is generally taken to include the atmosphere and the earth's surface, including the soil, surface water bodies, seas and oceans and their sediments. There is no generally accepted definition of the depth below the surface at which soil or sediment ceases to be part of the biosphere, but this might typically be taken to be the depth affected by basic human actions, particularly farming. In *radioactive waste management* in particular, the biosphere is normally distinguished from the *geosphere*. See also *geosphere*.

**bituminization.** See *solidification*.

**borehole.** A cylindrical excavation, made by a drilling device. Boreholes are drilled during *site* investigation and testing and are also used for *waste* emplacement in repositories and *monitoring*.

**borehole disposal.** See *disposal, borehole*.

**borosilicate glass.** See *glass (waste matrix material)*.

**brine.** An aqueous solution containing a high concentration of dissolved salts.

**buffer.** Any substance placed around a *waste package* in a *repository* to serve as an additional *barrier* to: stabilize the surrounding environment; restrict the access of *groundwater* to the *waste package*; and reduce by *sorption* the rate of eventual radionuclide *migration* from the *waste*.

**calcination.** A process of drying and heating substances in air, to sufficiently high temperatures, so as to produce oxides of the constituents. A technique usually employed for processing of residues from *evaporations* of liquid *wastes*.

**calibration, model.** The process whereby *model* simulations are compared with field observations and/or experimental measurements from the system being

modelled, and the *model* adjusted if necessary to achieve a best fit to the measured/observed data. A *model* may be calibrated by using data obtained from a particular location or for a limited range of conditions. It may then be considered valid for use in those circumstances but not necessarily in all circumstances.

**canister, waste.** See *container, waste*.

**cask.** A vessel for the transport and/or *storage* of *spent fuel* and other radioactive materials. The cask serves several functions. It provides chemical, mechanical, thermal and radiological protection, and dissipates decay heat during handling, transport and *storage*.

**cementation.** See *solidification*.

**ceramic material.** A solid crystalline material, usually containing silicon dioxide (SiO<sub>2</sub>) and other inorganic oxides, fabricated at high temperatures (800°C or above) and usually at elevated pressures.

**characterization, site.** Detailed surface and subsurface investigations and activities at candidate *disposal* sites to obtain information to determine the suitability of the *site* for a *repository* and to evaluate the long term performance of a *repository* at the *site*.

**characterization, waste.** Determination of the physical, chemical and radiological properties of the *waste* to establish the need for further adjustment, *treatment, conditioning*, or its suitability for further handling, *processing, storage* or *disposal*.

**chemical decontamination.** See *decontamination, chemical*.

**chemical precipitation.** See *precipitation, chemical*.

**chemisorption.** See *sorption*.

**clay.** *Minerals* that are essentially hydrated aluminium silicates or occasionally hydrated magnesium silicates, with sodium, calcium, potassium and magnesium cations. Also denotes a natural material with plastic properties which is essentially a composition of fine to very fine clay particles. Clays differ greatly mineralogically and chemically and consequently in their physical properties. Because of their large surface areas, most of them have good *sorption* characteristics.



**cleanup.** Any measures that may be carried out to reduce the *radiation exposure* from existing *contamination* through actions applied to the *contamination* itself (the *source*) or to the *exposure pathways* to humans. In a *radioactive waste management* context, cleanup has essentially the same meaning as rehabilitation, remediation and restoration.

**clearance.** Removal of *radioactive materials* or radioactive objects within authorized *practices* from any further *regulatory control* by the *regulatory body*.

**clearance level.** See *level, clearance*.

**closeout.** See *closure (2)*.

**closure.** (1) Administrative and technical actions directed at a *repository* at the end of its operating lifetime — for example covering the disposed *waste* (for a *near surface repository*) or backfilling and/or sealing (for a *geological repository* and the passages leading to it) — and termination and completion of activities in any associated structures. (2) Administrative and technical actions directed at a *tailings impoundment* to place it in a condition such that little or no future *surveillance* and maintenance are required. The same concept may apply to mining debris piles, heap and *in situ leaching* piles, and mines. The term closeout is also sometimes used to describe this concept.

**colloid.** A state of subdivision of matter in which the particle size varies from that of true ‘molecular’ solutions to that of a coarse suspension. The diameters of the particles range between 1 and 1000 nm and the particles are dispersed in a liquid phase and do not sediment out.

**commissioning.** The process during which systems and components of facilities and activities, having been constructed, are made operational and verified to be in accordance with design specifications and to have met the required performance criteria. Commissioning may include both non-radioactive and radioactive testing.

**compaction.** (1) A *treatment* method where the bulk volume of a compressible material is reduced by application of external pressure — hence an increase in its density (mass per unit volume). (2) Compaction of soil materials covering a *near surface disposal* facility to reduce the soil *permeability*. See also *volume reduction; treatment*.

**compartment.** Any part of the environment or process which may conveniently be considered as a single entity. A concept used in developing *mathematical models*.

**complexation.** A chemical term that refers to formation of molecules in which a metal ion is chemically bonded to ligands surrounding it. The chemical properties of the complexes differ from the properties of the metal ion.

**computational model.** See *model, computational*.

**concentration ratio.** The concentration of a dissolved or fine particulate substance present in an organism, an organ or a tissue, divided by the concentration of that substance in the surrounding medium.

**conceptual model.** See *model, conceptual*.

**conditioning.** Those operations that produce a *waste package* suitable for handling, transport, *storage* and/or *disposal*. Conditioning may include the conversion of the *waste* to a solid *waste form*, enclosure of the *waste* in *containers*, and, if necessary, providing an *overpack*. See also *immobilization*.

**conductivity, hydraulic,  $K$ .** Ratio of flow rate  $v$  to driving force  $dh/dl$  (the change of hydraulic head with distance) for viscous flow of a fluid in a porous medium. This is the so-called constant of proportionality  $K$  in Darcy's law:

$$v = -K dh/dl$$

and depends on both the porous medium and the fluid properties. See also *permeability*.

**confinement.** A *barrier* which surrounds the main parts of a *facility* containing *radioactive materials* and which is designed to prevent or mitigate the uncontrolled release of *radioactive material* to the environment. Confinement is similar in meaning to *containment*, but confinement is typically used to refer to the *barriers* immediately surrounding the *radioactive material*, whereas *containment* refers to the additional layers of defence intended to prevent the *radioactive materials* reaching the environment if the confinement is breached.

**consequence analysis.** See *analysis, consequence*.

**consequence assessment.** See *assessment, consequence*.

**container, waste.** The vessel into which the *waste form* is placed for handling, transport, *storage* and/or eventual *disposal*; also the outer *barrier* protecting the *waste* from external intrusions. The waste container is a component of the *waste package*. For example, molten *HLW* glass would be poured into a specially designed container (canister) where it would cool and solidify. See also *barrier*; *cask*; *waste package*.

**containment.** Methods or physical structures designed to prevent the dispersion of *radioactive substances*. Although approximately synonymous with *confinement*, containment is normally used to refer to methods or structures that prevent radioactive substances being dispersed in the environment if *confinement* fails. See *confinement* for a more extensive discussion.

**contamination.** (1) *Radioactive substances* on surfaces, or within solids, liquids or gases (including the human body), where their presence is unintended or undesirable, (2) the presence of such substances in such places or (3) the process giving rise to their presence in such places.

**contamination, fixed.** *Contamination* other than *non-fixed contamination*.

**contamination, non-fixed.** *Contamination* that can be removed from a surface during any handling activities, including routine conditions of transport.

**control, institutional.** Control of a *waste site* by an authority or institution designated under the laws of a country. This control may be active (*monitoring*, *surveillance* and remedial work) or passive (land use control) and may be a factor in the *design* of a *nuclear facility* (e.g. a *near surface repository*).

**control, regulatory.** Any form of control applied to facilities or activities by a *regulatory body* for reasons related to protection or safety.

**controlled area.** See *area, controlled*.

**cooling.** A term used to describe the process of allowing *radioactivity* to decay and the rate of heat generation to decrease as in the case of vitrified *HLW* and *spent fuel*. See also *storage*.

**co-precipitation.** Simultaneous precipitation of more than one substance, for example a chemical treatment method for transferring *radionuclides* from the liquid phase to an insoluble precipitate.

**core.** In mining, geotechnical and civil engineering, an intact sample of material obtained by drilling.

**corrosion.** Progressive surface dissolution of a material. A term generally used for metals. In *radioactive waste management*, it is also used for *glasses* and *ceramic waste forms*. Corrosion can be uniform over the surface of the material or non-uniform through enhanced corrosion in stressed areas at physical discontinuities. Selective localized formation of rounded cavities on the surface is called pitting corrosion.

**cover.** A layer of material or materials placed over the *waste packages* or physical structures in a *near surface repository*. The main purpose of covers is to prevent ingress of *surface water* into the *repositories* and to reduce the likelihood of intrusion.

**creep.** The gradual deformation of a material due to external forces and/or its own mass. For example, a *repository* in a *salt formation* may gradually seal itself via this mechanism.

**criteria.** Conditions on which a decision or judgement can be based. They may be qualitative or quantitative and should result from established principles and standards. See also *requirement*; *specifications*.

**critical group.** A group of members of the public which is reasonably homogeneous with respect to its *exposure* for a given radiation *source* and given *exposure pathway* and is typical of individuals receiving the highest *effective dose* or *equivalent dose* (as applicable) by the given *exposure pathway* from the given *source*.

**critical pathway.** The dominant environmental route by which members of the *critical group* are exposed to radiation. For example, the *critical pathway* for iodine discharged with gaseous *effluents* is from pasture to cows and then to milk. Consumption of the milk by individuals gives rise to *exposure* to radiation.

**crystalline rock.** See *rock, crystalline*.

**decommissioning.** Administrative and technical actions taken to allow the removal of some or all of the *regulatory controls* from a *facility*. This does not apply to a *repository* or to certain *nuclear facilities* used for mining and *milling* of *radioactive materials*, for which *closure* is used.

**decommissioning, phased.** *Decommissioning* carried out in a series of phases separated by one or more periods of time. See also *decommissioning phase*.

**decommissioning option.** One of various *decommissioning* strategies which may be considered when *decommissioning* is being planned. A variety of factors, such as timing and the availability of technologies, will influence which *decommissioning* strategy is ultimately chosen.

**decommissioning phase.** Well defined and discrete set of activities within the *decommissioning* process.

**decommissioning plan.** Documentation containing information on the proposed *decommissioning* activities for a *facility*. This would allow the *regulatory body* to make a proper evaluation to ensure that *decommissioning* of the *facility* can be performed in a safe manner.

**decontamination.** The complete or partial removal of *contamination* by a deliberate physical, chemical or biological process.

**decontamination, chemical.** The removal or reduction of radioactive *contamination* from surfaces by chemical processes. See also *decontamination*.

**decontamination factor.** The ratio of the *activity* per unit area (or per unit mass or volume) before a particular *decontamination* technique is applied to the *activity* per unit area (or per unit mass or volume) after application of the technique. May be specified for a particular *radionuclide* or for gross *activity*.

**deep geological disposal.** See *repository, geological*.

**defence in depth.** The application of more than one protective measure for a given safety objective, such that the objective is achieved even if one of the protective measures fails.

**denitration.** Conversion (reduction) of the nitrate ion ( $\text{NO}_3^-$ ) to another chemical entity, normally a volatile nitrogen oxide. This may be done by thermal, chemical or electrolytic methods. Because *reprocessing* of *spent fuel* is usually done in a nitric acid medium, denitration can be an important step in *waste processing*.

**depleted uranium.** See *uranium, depleted*.

**design.** The process and result of developing a concept, detailed plans, supporting calculations and *specifications* for a *facility* and its parts.

**design intent.** Statement of the objectives that need to be met in the performance of a process, system or a *facility*, based on the concept employed, plans drawn and *specifications* used, in the development, *design* and construction.

**design life.** The period during which a facility or component is expected to perform according to the technical *specifications* to which it will be or was engineered.

**desorption.** See *sorption*.

**deterministic analysis.** See *analysis, deterministic*.

**devitrification (crystallization).** The change of an amorphous *glass* to a crystalline material in which atoms display a higher degree of order. Thermodynamically, a *glass* has higher free energy than an assembly of crystals having the same composition, hence devitrification can occur at elevated temperatures or over long times. The durability of a devitrified material may be different than for the original (parent) *glass*.

**diffusion.** The movement of atoms or molecules from a region of higher concentration of the diffusing species to regions of lower concentration, due to a concentration gradient.

**digestion, acid.** In treating *radioactive waste*, the use of oxidizing acids to chemically decompose a material into its simpler constituents (usually soluble or gaseous), thereby preparing the *waste* for subsequent *processing*. For example, organic material (resins, paper, gloves, etc.) contaminated with alpha emitting nuclides may be acid digested for subsequent concentration of the *radionuclides*. See also *treatment*.

**direct disposal.** See *disposal, direct*.

**discharge.** A planned and controlled release of (usually gaseous or liquid) *radioactive material* to the environment.

**discharge, authorized.** A *discharge* in accordance with an *authorization*. See *limit, authorized*.

**discharges, radioactive.** *Radioactive substances* arising from a *source* within a *practice* which are discharged to the environment, generally with the purpose of dilution and *dispersion*.

**dismantling.** The disassembly and removal of any structure, system or component during *decommissioning*. Dismantling may be performed immediately after permanent retirement of a *nuclear facility* or it may be deferred.

**dispersion.** The tendency of particles (e.g. *radionuclides*) in fluid to spread out due to small scale variations in the velocity of the fluid.

**disposal.** Emplacement of *waste* in an appropriate *facility* without the intention of retrieval. Some countries use the term *disposal* to include *discharges* of effluents to the environment.

**disposal, borehole.** The emplacement of *waste* in a *borehole* from the earth's surface.

**disposal, deep sea.** *Disposal* of *waste* packaged in *waste containers* on the deep ocean floor. (As practised until 1982 in accordance with the requirements of the London Convention 1972 [4].)

**disposal, direct.** *Disposal* of *spent fuel* as *waste*.

**disposal, geological.** See *repository, geological*.

**disposal, near surface.** See *repository, near surface*.

**disposal, on-site.** *Disposal* of the *nuclear facility* or portions thereof within the nuclear *site* boundary. It includes *in situ disposal* (*entombment*) where the *nuclear facility* is disposed wholly or partly at its existing location; or *on-site* transfer and *disposal* where the *nuclear facility* or portions thereof are moved to a *repository* at an adjacent location on the *site*.

**disposal, subseabed.** *Disposal* in the rock underlying the ocean floor.

**disposal facility.** Synonymous with *repository*.

**distribution coefficient,  $K_d$ .** The ratio of the amount of substance sorbed on a unit mass of dry solid to the concentration of the substance in a solution in contact with the solid, assuming equilibrium conditions. The SI units are: m<sup>3</sup>/kg.

**disturbed zone.** Also called *excavation disturbed zone*. The zone of the *host medium rock* around an underground excavation whose characteristics are altered by excavation.

**disused source.** See *source, disused*.

**dose.** A measure of the energy deposited by radiation in a target. *Absorbed dose*, committed equivalent dose, committed effective dose, *effective dose*, *equivalent dose* or organ dose, depending on the context. All these quantities have the dimensions of energy divided by mass.

**dose, absorbed,  $D$ .** The fundamental dosimetric quantity  $D$ , defined as:

$$D = \frac{d\bar{\epsilon}}{dm}$$

where  $d\bar{\epsilon}$  is the mean energy imparted by *ionizing radiation* to matter in a volume element and  $dm$  is the mass of matter in the volume element [2]. The unit is J/kg, termed the gray (Gy).

**dose, effective,  $E$ .** A summation of the tissue *equivalent doses*, each multiplied by the appropriate tissue weighting factor:

$$E = \sum_T w_T H_T$$

where  $H_T$  is the *equivalent dose* in tissue  $T$  and  $w_T$  is the tissue weighting factor for tissue  $T$ . From the definition of *equivalent dose*, it follows that:

$$E = \sum_T w_T \sum_R w_R D_{T,R}$$

where  $w_R$  is the radiation weighting factor for radiation  $R$  and  $D_{T,R}$  is the average absorbed dose in the organ or tissue  $T$ . The unit of effective dose is J/kg, with the special name sievert (Sv).

**dose, equivalent,  $H_{T,R}$ .** The quantity  $H_{T,R}$ , defined as:

$$H_{T,R} = w_R D_{T,R}$$

where  $D_{T,R}$  is the *absorbed dose* delivered by radiation type  $R$  averaged over a tissue or organ  $T$  and  $w_R$  is the radiation weighting factor for radiation type  $R$ . When the radiation field is composed of different radiation types with different values of  $w_R$  the *equivalent dose* [2] is:



$$H_T = \sum_R W_R D_{T,R}$$

The unit of equivalent dose is J/kg, termed sievert (Sv).

**dose conversion factor (biosphere).** In *safety assessment*, the dose rate resulting from unit *radionuclide* concentration in *groundwater* at the *geosphere–biosphere* interface or from unit release rate from the *geosphere* into the *biosphere*.

**dose limit.** See *limit, dose*.

**drift.** A horizontal or nearly horizontal mined passageway.

**dry storage.** See *storage, dry*.

**effective dose.** See *dose, effective*.

**effective half-life.** See *half-life, effective*.

**effluent.** Gaseous or liquid *radioactive materials* which are discharged to the environment. See also *discharge, authorized*.

**emanation.** Generation of radioactive gas by the decay of a radioactive solid.

**embedding.** *Immobilization* of solid *waste* (e.g. metallic materials) by surrounding it with a *matrix* material in order to produce a *waste form*. See also *immobilization*.

**encapsulation.** (1) *Immobilization* of dispersed solids (e.g. ash or powder) by mixing them with a *matrix* material in order to produce a *waste form*. See also *immobilization*. (2) Emplacement of a solid *waste form* (e.g. *spent fuel* assemblies) in a container.

**enclosure, safe** (during *decommissioning*). A condition of a *nuclear facility* during the *decommissioning* process in which only *surveillance* and maintenance of the *facility* take place. See also *decommissioning, phased*.

**engineered barrier.** See *barrier*.

**engineered barrier system.** The designed, or engineered, components of a *repository*, including *waste packages* and other *engineered barriers*. See also *barrier*.

**entombment.** See *disposal, on-site*.

**environmental (impact) assessment.** See *assessment, environmental (impact)*.

**environmental impact statement.** A set of documents recording the results of an evaluation of the physical, ecological, cultural and socioeconomic effects of a planned *facility* (e.g. a *repository*) or of a new technology.

**environmental monitoring.** See *monitoring, environmental*.

**equilibrium, radioactive.** The state of a radioactive decay chain (or part thereof) where the *activity* of each *radionuclide* in the chain (or part of the chain) is the same. This state is achieved when the parent nuclide has a much longer *half-life* than any of the progeny, and after a time equal to several times the *half-life* of the longest lived of the progeny.

**equivalent dose.** See *dose, equivalent*.

**evaporation.** Concentration of a liquid by conversion of some fraction of the volatile material content to the vapour state by latent heat. Evaporation, a *treatment* method, is used to concentrate some types of radioactive solutions. See also *waste concentrate; treatment*.

**evapotranspiration.** The total amount of water lost from a particular area, being the sum of *evaporation* from the soil and transpiration from vegetation.

**excavation disturbed zone.** See *disturbed zone*.

**exempt waste.** See *waste, exempt*.

**exemption.** The determination by a *regulatory body* that a *source* or *practice* need not be subject to some or all aspects of *regulatory control* on the basis that the *exposure* (including *potential exposure*) due to the *source* or *practice* is too small to warrant the application of those aspects. See also *level, clearance*.

**exemption level.** See *level, exemption*.

**exposure.** The act or condition of being subject to irradiation. Exposure can either be external exposure due to *sources* outside the body or internal exposure due to *sources* inside the body.

**exposure, normal.** *Exposure* which is expected to occur under the normal operating conditions of a *facility* or activity, including possible minor mishaps that can be kept under control, i.e. during normal operation and anticipated operational occurrences.

**exposure, potential.** *Exposure* that is not expected to occur with certainty but that may result from an accident at a *source* or owing to an event or sequence of events of a probabilistic nature, including equipment failures and operating errors.

**exposure pathway.** A route by which radiation or *radionuclides* can reach humans and cause *exposure*. An exposure pathway may be very simple, for example external *exposure* from airborne *radionuclides*, or involve a more complex chain, for example internal *exposure* from drinking milk from cows that ate grass contaminated with deposited *radionuclides*.

**facility.** See *nuclear facility*.

**far field.** The *geosphere* beyond the *near field*. See also *near field*.

**fault.** A *fracture* or fracture zone along which the rocks on both sides have undergone a displacement relative to one another parallel to the *fracture*. See also *fracture*.

**filtration.** The separation of solids from liquids or gases by passing the mixture through the interstices of a suitable medium, for example filter paper, cloth or glass wool.

**fissile.** Capable of undergoing fission by interaction with slow neutrons.

**fissile material.** Uranium-233, uranium-235, plutonium-239, plutonium-241, or any combination of these *radionuclides*. Excepted from this definition is: (a) *natural uranium* or *depleted uranium* which is unirradiated, (b) *natural uranium* or *depleted uranium* which has been irradiated in thermal reactors only.

**fission product.** A *radionuclide* produced by nuclear fission.

**fixation (of radionuclides).** A method of physically bonding *radionuclides* to a solid surface in order to prevent their *dispersion*. The term often refers to the application of paint or a similar material to a contaminated surface in order to prevent the *radionuclides* from becoming airborne or transferred by casual contact.

**fixed contamination.** See *contamination, fixed*.

**flow, unsaturated.** The flow of water in unsaturated soil by capillary action and gravity.

**fluidized bed.** Technology involving the suspension of solid particles in a loose bed of material by an upward moving stream of gas for enhancing a chemical or physical process.

**fracture.** A general term for any break in *rock* whether or not it causes displacement.

**frit.** The fused or partially fused materials used in making *glass*. Solid or liquid *waste* can be mixed with frit and the mixture heated until a homogeneous *glass* mass results. See also *glass; immobilization*.

**fuel cycle.** All operations associated with the production of nuclear energy, including: mining and *milling*, processing and enrichment of uranium or thorium; manufacture of nuclear fuel; operation of nuclear reactors (including research reactors); *reprocessing* of nuclear fuel; any related research and development activities; and all related *radioactive waste management* activities (including *decommissioning*).

**fuel cycle, once through.** Refers to the *fuel cycle* option where *spent fuel* is disposed of directly after *conditioning* and is not reprocessed. See also *direct disposal*.

**fuel, mixed oxide (MOX).** Nuclear reactor fuel which contains more than one type of fissile nuclide, both or all being in the form of oxides. Most commonly refers to fuel containing both uranium oxide and plutonium oxide.

**fuel, nuclear.** Fissionable and fertile material used in a nuclear reactor for the purpose of generating energy.

**fuel, spent (used).** Nuclear fuel removed from a reactor following irradiation, which is no longer usable in its present form because of depletion of *fissile material*, buildup of poison or radiation damage.

**geological barrier.** See *barrier*.

**geological disposal.** See *repository, geological*.

**geological repository.** See *repository, geological*.

**geosphere.** Those parts of the lithosphere not considered to be part of the *biosphere*. In *radioactive waste management*, usually used to distinguish the subsoil and *rock* from the soil that is part of the *biosphere*. See also *biosphere*.

**glass (waste matrix material).** An amorphous material with a molecule distribution similar to that of a liquid but with a *viscosity* so great that its physical properties are those of a solid. Glasses used in the *solidification* of liquid *high level waste* are generally based on a silicon–oxygen network. Additional network formers such as aluminium, or modifiers such as boron, lead to aluminosilicate or borosilicate glass.

**glass ceramic.** The product resulting after a *glass* has been transformed into a crystalline material by a controlled process such as heating. The product may retain the desirable properties of both a *glass* and a ceramic. See also *ceramic material*.

**gradient, hydraulic.** The change in total hydraulic head per unit distance of flow in a given direction.

**gradient, thermal.** The change in temperature per unit of distance.

**granite.** Broadly applied, any holocrystalline quartz-bearing *plutonic rock*. The main components of granite are feldspar, quartz and, as a minor essential mineral, mica. Granite formations are being considered as possible hosts for *geological repositories*.

**groundwater.** Water that is held in *rocks* and soil beneath the surface of the earth.

**half-life,  $T_{1/2}$ .** The time taken for the quantity of a specified material (e.g. a *radionuclide*) in a specified place to decrease by half as a result of any specified process or processes that follow similar exponential patterns to radioactive decay.

**half-life, biological.** The time taken for the quantity of a material in a specified tissue, organ or region of the body (or any other specified biota) to halve as a result of biological processes.

**half-life, effective,  $T_{eff}$**  The time taken for the *activity* of a *radionuclide* in a specified place to halve as a result of all relevant processes.

**half-life, radioactive.** For a *radionuclide*, the time required for the *activity* to decrease, by a radioactive decay process, by half.

**heap leaching.** In mining and *milling*, the process whereby leach liquor percolates through a pile of mined ore placed on an impervious base in such a way that the *leachate* can be collected for recovery of the metal values.

**heat generating waste.** See *waste, heat generating*.

**HEPA filter (high efficiency particulate air filter).** Filters used for removing sub-micrometre particles from a gaseous stream. See also *scrubber; off-gas*.

**HEU.** See *uranium, highly enriched*.

**high level waste (HLW).** See *waste, high level*.

**highly enriched uranium (HEU).** See *uranium, highly enriched*.

**HLW.** See *waste, high level*.

**host medium/rock.** See *rock, host*.

**hydraulic conductivity, K.** See *conductivity, hydraulic*.

**hydraulic gradient.** See *gradient, hydraulic*.

**hydraulic transmissivity.** See *transmissivity, hydraulic*.

**hydrostatic pressure.** The static pressure exerted by water at some point in a body of water such as a lake or in a saturated medium such as an *aquifer*. The SI units are: kg/m<sup>2</sup>.

**igneous rock.** See *rock, igneous*.

**ILW.** See *waste, low and intermediate level*.

**immobilization.** Conversion of *waste* into a *waste form* by *solidification, embedding* or *encapsulation*. The aim is to reduce the potential for *migration* or *dispersion* of *radionuclides* during handling, transport, *storage* and/or *disposal*. See also *conditioning*.

**impoundment.** See *tailings impoundment*.

**in situ disposal.** See *disposal, on-site*.

**in situ leaching.** See *leaching, in situ*.

**in situ testing.** Tests conducted within a geological environment that is essentially equivalent to the environment of a potential *repository*. A special underground laboratory, called an *underground research laboratory (URL)*, may be built for in situ testing or tests may be carried out in an actual *repository* excavation. Only in such a *facility* can the full range of *repository* environment properties and *waste repository* system interactions be measured.

**incineration.** A *waste treatment* process of burning combustible *waste* to reduce its volume and yield an ash residue.

**infiltration.** The downward entry of water through the ground surface into soil or *rock*.

**institutional control.** See *control, institutional*.

**integrated approach.** This term refers to a logical and preferably optimized strategy used in the planning and implementation of a *radioactive waste management* programme as a whole *from* waste generation to *disposal* such that the interactions between the various stages are taken into account so that decisions made at one stage do not foreclose certain alternatives at a subsequent stage. For example, the generation of *waste* is highly dependent on the design, planning and *operation* of a *nuclear facility*.

**intermediate level waste (ILW).** See *waste, low and intermediate level*.

**intervention.** Any action intended to reduce or avert *exposure* or the likelihood of *exposure* to *sources* which are not part of a controlled *practice* or which are out of control as a consequence of an accident.

**intrusion barrier.** See *barrier, intrusion*.

**ion exchange.** A usually reversible exchange of one ion with another, either on a solid surface, or within a lattice. A commonly used method for *treatment* of liquid *waste*. See also *treatment*.

**ionic strength.** In chemistry, for a solution containing charged particles (ions), the ionic strength is given mathematically as one half the sum of the molal concentration of each ion times the square of its charge.

**irradiated fuel.** See *fuel, spent (used)*.

$K_d$ . See *distribution coefficient*.

**leach rate.** The rate of dissolution or erosion of material or the release by *diffusion* from a solid, which is hence a measure of how rapidly *radionuclides* may be released from that material. The term usually refers to the durability of a solid *waste form* but also describes the removal of sorbed material from the surface of a solid or porous bed.

**leach test.** A test conducted to determine the *leach rate* of a *waste form*. The test results may be used for judging and comparing different types of *waste forms*, or may serve as input data for a *long term safety assessment* of a *repository*. Many different test parameters have to be taken into account, for example water composition and temperature.

**leachate.** A solution that has been in contact with *waste form* and, as a result, may contain *radionuclides*.

**leaching.** (1) Extraction of a soluble substance from a solid by a solvent with which the solid is in contact. (2) A term often used in *radioactive waste management* to describe the gradual dissolution/erosion of an emplaced solid *waste package* or the removal of sorbed material from the surface of a solid or porous bed.

**leaching, in situ.** In mining and *milling*, the process whereby leach liquor is percolated through or injected into the ore body in such a way that the *leachate* can be collected for recovery of the metal values.

LEU. See *uranium, low enriched*.

**level, clearance.** A value, established by a *regulatory body* and expressed in terms of activity concentration and/or total *activity*, at or below which a *source* of radiation may be released from *regulatory control*. See also *clearance*.

**level, exemption.** A value, established by a *regulatory body* and expressed in terms of activity concentration and/or total *activity*, at or below which a *source* of



radiation may be granted *exemption* from *regulatory control* without further consideration.

**licence.** A legal document issued by the *regulatory body* granting *authorization* to perform specified activities related to a *facility* or activity. The holder of a current licence is termed a licensee. A licence is a product of the *authorization* process, although the term licensing process is sometimes used.

**licensee.** See *licence*.

**licensing process.** See *licence*.

**LILW.** See *waste, low and intermediate level*.

**limit, authorized.** A limit on a measurable quantity, established or formally accepted by a *regulatory body*. Authorized limit has been commonly used particularly in the context of limits on *discharges*. See also *discharge, authorized*.

**limit, dose.** The value of the *effective dose* or the *equivalent dose* to individuals from controlled *practices* that shall not be exceeded.

**liner.** (1) A layer of material placed between a *waste form* and a container to resist *corrosion* or any other degradation of a *waste package*. (2) A layer of *clay*, plaster, asphalt or other impermeable material placed around or beneath a *repository* or *tailings impoundment* to prevent leakage and/or erosion. (3) A structural component (made, for example, of concrete or steel) on the surface of a tunnel or *shaft* in a *repository*.

**lithosphere.** The solid portion of the earth (as opposed to the atmosphere or hydrosphere). It includes the crust and part of the upper mantle and is of the order of 100 km in thickness. See also *biosphere*; *geosphere*.

**lithostatic pressure.** Pressure due to the weight of overlying *rock* and/or soil and water.

**LLW.** See *waste, low and intermediate level*.

**long lived waste.** See *waste, long lived*.

**long term.** In *radioactive waste disposal*, refers to periods of time which exceed the time during which active *institutional control* can be expected to last.

**low and intermediate level waste (LILW).** See *waste, low and intermediate level*.

**low enriched uranium (LEU).** See *uranium, low enriched*.

**low level waste (LLW).** See *waste, low and intermediate level*.

**lysimeter.** A device for assessing the in situ migration of water and/or *radionuclides* in a soil profile.

**mathematical model.** See *model, mathematical*.

**matrix.** A non-radioactive material used to immobilize *waste*. Examples of matrices are bitumen, cement, various polymers and *glass*. See also *conditioning; immobilization*.

**matrix diffusion.** *Diffusion* of solutes from a water bearing *fracture* to pores and microfractures of the adjacent *rock* matrix and vice versa. See also *diffusion*.

**medium level waste (MLW).** See *waste, low and intermediate level*.

**metamorphic rock.** See *rock, metamorphic*.

**migration.** The movement of *radionuclides* in the environment as a result of natural processes.

**mill tailings.** See *tailings*.

**mill tailings slimes.** That fraction of a ground ore or *tailings* slurry consisting of very fine particles, usually of size less than 30–40  $\mu\text{m}$  and typically with much material below 10  $\mu\text{m}$  particle size. The solid particles will settle only slowly in an aqueous system (in a gravitational force field) and the removal of interstitial water and development of shear strength within the settled solids can be achieved only with difficulty.

**milling.** The operation of processing ore to extract uranium or thorium for conversion into reactor fuel.

**mineral.** A naturally occurring inorganic solid substance with a characteristic chemical composition.

**minimization, waste.** The process of reducing the amount and *activity* of *radioactive waste* to a level as low as reasonably achievable, at all stages from the *design* of a *facility* or activity to *decommissioning*, by reducing *waste* generation and by means such as recycling and reuse, and *treatment*, with due consideration for secondary as well as primary *waste*. See also *pretreatment*; *treatment*; *volume reduction*.

**mining and milling waste (MMW).** See *waste, mining and milling*.

**mixed oxide (MOX) fuel.** See *fuel, mixed oxide*.

**mixed waste.** See *waste, mixed*.

**model.** A representation of a system and the ways in which phenomena occur within that system, used to simulate or assess the behaviour of the system for a defined purpose.

**model, computational.** A calculation tool that implements a *mathematical model*.

**model, conceptual.** A set of qualitative assumptions used to describe a system.

**model, mathematical.** A set of mathematical equations designed to represent a *conceptual model*.

**model, pathways.** A mathematical representation used to simulate the transport of *radionuclides* from a *source* to a receptor.

**model, transport.** A mathematical representation of mechanisms controlling the movement of finely dispersed or dissolved substances in fluids.

**model calibration.** See *calibration, model*.

**model validation.** See *validation, model*.

**model verification.** See *verification, model*.

**monitoring.** Continuous or periodic measurement of radiological and other parameters or determination of the status of a system.

**monitoring, environmental.** The measurement and evaluation of external *dose* rates due to *sources* in the environment or of *radionuclide* concentrations in the environmental media.

**multiple barriers.** See *barriers, multiple*.

**natural analogue.** A situation in nature that allows conclusions relevant for making a judgement upon the safety of an existing or planned *nuclear facility*.

**natural barrier.** See *barrier*.

**natural uranium.** See *uranium, natural*.

**naturally occurring radioactive material (NORM).** Material containing no significant amounts of *radionuclides* other than *naturally occurring radionuclides*. The exact definition of ‘significant amounts’ would be a regulatory decision. Materials in which the *activity* concentrations of the *naturally occurring radionuclides* have been changed by human made processes are included. These are sometimes referred to as technically enhanced NORM or TENORM.

**naturally occurring radionuclides.** *Radionuclides* that occur naturally in significant quantities on earth. The term is usually used to refer to the primordial *radionuclides* potassium-40, uranium-235, uranium-238 and thorium-232 (the decay product of primordial uranium-236), their radioactive decay products, and tritium and carbon-14 generated by natural *activation* processes.

**near field.** The excavated area of a *repository* near or in contact with the *waste packages*, including filling or sealing materials, and those parts of the *host medium/rock* whose characteristics have been or could be altered by the *repository* or its content. See also *far field*.

**near surface disposal.** See *repository, near surface*.

**near surface repository.** See *repository, near surface*.

**non-fixed contamination.** See *contamination, non-fixed*.

**NORM.** See *naturally occurring radioactive material*.

**NORM waste.** See *waste, NORM*.

**normal exposure.** See *exposure, normal*.

**nuclear application waste.** See *waste, nuclear application*.

**nuclear facility.** A facility and its associated land, buildings and equipment in which radioactive materials are produced, processed, used, handled, stored or disposed of on such a scale that consideration of safety is required.

**nuclear fuel.** See *fuel, nuclear*.

**nuclear fuel cycle.** See *fuel cycle*.

**nuclear installation.** A nuclear fuel fabrication plant, nuclear reactor (including sub-critical and critical assemblies), research reactor, nuclear power plant, *spent fuel storage facility*, enrichment plant or *reprocessing facility*. This is essentially any authorized *facility* that is part of the *nuclear fuel cycle* except for *radioactive waste management facilities*.

**nuclear material.** Plutonium except that with isotopic concentration exceeding 80% in plutonium-238; uranium-233; *uranium* enriched in the isotope 235 or 233; uranium containing the mixture of isotopes occurring in nature other than in the form of ore or ore residue; any material containing one or more of the foregoing [5].

**nuclear waste.** See *waste, radioactive*.

**off-gas.** The gas streams which are discharged from a *facility*. Typical processes in *radioactive waste management facilities* such as dissolution, *evaporation, incineration, vitrification*, bituminization and cementation, will generate process off-gases which contain water and acid vapours, aerosols, radioactive and gaseous chemical constituents. The *treatment* of these streams is an important consideration. See also *discharge; effluent*.

**off-site.** Outside the physical boundary of a *site*.

**on-site.** Within the physical boundary of a *site*.

**on-site disposal.** See *disposal, on-site*.

**once through fuel cycle.** See *fuel cycle, once through*.

**operating organization.** The organization (and its contractors) which undertakes the *siting, design, construction, commissioning* and/or *operation* of a *nuclear facility*.

**operation.** All the activities performed to achieve the purpose for which a *facility* was constructed.

**operational period.** The period during which a *nuclear facility* (e.g. a *repository*) is being used for its intended purpose until it is decommissioned or is submitted for permanent *closure*.

**operations area.** See *area, operations*.

**operations boundary.** See *area, operations*.

**operator.** Synonymous with *operating organization*.

**optimization.** The process of determining what level of protection and safety makes *exposures*, and the probability and magnitude of *potential exposures*, ‘as low as reasonably achievable, economic and social factors being taken into account’ (ALARA).

**orphan source.** See *source, orphan*.

**osmosis, reverse.** Movement of a solvent out of a solution under pressure through a semipermeable membrane into pure solvent or a less concentrated solution at lower pressure. This process can be used to increase the *radionuclide* concentration in a solution.

**overpack.** A secondary (or additional) outer container for one or more *waste packages*, used for handling, transport, *storage* or *disposal*.

**package, spent fuel.** Conditioned *spent fuel* in a form suitable for transport, *storage* and/or *disposal*.

**package, waste.** The product of *conditioning* that includes the *waste form* and any container(s) and internal *barriers* (e.g. absorbing materials and *liners*), prepared in accordance with the *requirements* for handling, transport, *storage* and/or *disposal*.

**particulates.** Solid aerosols or particles carried in process *off-gases* or airstreams, or suspended in the air.

**partitioning.** Separation, usually by chemical methods, of minor actinides from the *reprocessing* stream, for the purpose of appropriate further *processing*, *storage* and/or *disposal*.

**pathways model.** See *model*, *pathways*.

**performance assessment.** See *assessment*, *performance*.

**performance confirmation test.** See *test*, *performance confirmation*.

**permeability,  $k$ .** The ability of a porous medium to transmit fluid. Permeability  $k$  is a function of the medium only and has dimensions  $L^2$ . The permeability  $k$  and *hydraulic conductivity*  $K$  of a porous medium are related in the following way:

$$K = k\rho g/\mu$$

where the fluid density  $\rho$  and the dynamic viscosity  $\mu$  are functions of the fluid alone and  $g$  is the acceleration due to gravity.

**phased decommissioning.** See *decommissioning*, *phased*.

**physisorption.** See *sorption*.

**plume.** The spatial distribution of a release of airborne or waterborne material as it disperses in the environment.

**plutonic rock.** See *rock*, *plutonic*.

**porosity.** The ratio of the aggregate volume of interstices in *rock*, soil or other porous media to its total volume.

**post-closure period.** The period of time following the *closure* of a *repository* and *decommissioning* of related surface facilities. Some type of *surveillance* or control will probably be maintained in this period, particularly for *near surface repositories*. See also *closure*; *preclosure period*.

**potential exposure.** See *exposure*, *potential*.

**practice.** Any human activity that introduces additional *sources* of *exposure* or *exposure pathways* or extends *exposure* to additional people or modifies the network of *exposure pathways* from existing *sources*, so as to increase the *exposure* or the likelihood of *exposure* of people or the number of people exposed.

**precipitation, chemical.** A standard chemical method that can be used in the *treatment* of liquid *wastes* where *radionuclides* are removed from the liquid by either forming or being carried by the insoluble product of a chemical reaction made to occur within the liquid.

**preclosure period.** The period of time spanning the construction and *operation* of a *repository* up to and including the *closure* and *decommissioning* of related surface *facilities*. See also *closure*; *post-closure period*.

**predisposal.** Any *radioactive waste management* steps carried out prior to *disposal*, such as *pretreatment*, *treatment*, *conditioning*, *storage* and transport activities. *Decommissioning* is considered to be a part of predisposal management of *radioactive waste*.

**pretreatment.** Any or all of the operations prior to *waste treatment*, such as collection, *segregation*, chemical adjustment and *decontamination*.

**primary/raw waste.** See *waste, primary/raw*.

**probabilistic analysis.** See *analysis, probabilistic*.

**processing.** Any operation that changes the characteristics of *waste*, including *pretreatment*, *treatment* and *conditioning*.

**Purex process.** The *reprocessing* of *spent fuel* by dissolving it in nitric acid and separating the uranium and plutonium from fission and activation products by extraction with an organic solvent. See *solvent extraction*.

**quality assurance (QA).** Planned and systematic actions necessary to provide adequate confidence that an item, process or service will satisfy given *requirements* for quality, for example those specified in the *licence*.

**quality control (QC).** The part of *quality assurance* intended to verify that systems and components correspond to predetermined *requirements*.

**radiation damage.** Changes in the physical or chemical properties of a material resulting from *exposure*. This term is normally not used for biological systems.



**radiation stability.** The capability of a material to withstand the effects of radiation without a change in its physical or molecular characteristics.

**radioactive contamination.** See *contamination*.

**radioactive discharges.** See *discharges, radioactive*.

**radioactive effluent.** See *effluent*.

**radioactive half-life.** See *half-life, radioactive*.

**radioactive material.** Material designated in national law or by a *regulatory body* as being subject to *regulatory control* because of its *radioactivity*. Some States use the term radioactive substance for this regulatory purpose.

**radioactive source term.** See *source term*.

**radioactive substances.** See *radioactive material*.

**radioactive waste.** See *waste, radioactive*.

**radioactive waste management.** See *waste management, radioactive*.

**radioactivity.** The phenomenon whereby atoms undergo spontaneous random disintegration, usually accompanied by the emission of radiation.

**radiological survey.** See *survey, radiological*.

**radiolysis.** Change in chemical composition of materials induced by ionizing radiation.

**radionuclide.** A nucleus (of an atom) that possesses properties of spontaneous disintegration (*radioactivity*). Nuclei are distinguished by their mass and atomic number.

**radionuclide transport.** See *transport, radionuclide*.

**ramp.** See *shaft*.

**reactor waste.** See *waste, reactor*.

**records.** A set of documents, such as instrument charts, certificates, log books, computer printouts and magnetic tapes for each *nuclear facility*, organized in such

a way that it provides past and present representations of facility *operations* and activities including all phases from *design* through *closure* and *decommissioning* (if the facility has been decommissioned). Records are an essential part of *quality assurance*.

**redox potential.** Quantitative measure of the oxidizing/reducing state of an aqueous solution.

**regulatory body.** An authority or a system of authorities designated by the government of a State as having legal authority for conducting the regulatory process, including issuing *authorizations*, and thereby for regulating the *siting*, *design*, construction, *commissioning*, *operation*, *closure*, *decommissioning* and, if required, subsequent *institutional control* of the *nuclear facilities* (e.g. *near surface repositories*) or specific aspects thereof.

**regulatory control.** See *control*, *regulatory*.

**rehabilitation.** See *cleanup*.

**release.** See *discharge*.

**remedial action.** Action taken when a specified action level is exceeded, to reduce a radiation *dose* that might otherwise be received, in an intervention situation involving chronic *exposure*. Examples are: (a) actions which include *decontamination*, *waste* removal and environmental restoration of a *site* during *decommissioning* and/or *closure* efforts; (b) actions taken beyond stabilization of *tailings impoundments* to allow for other uses of the area or to restore the area to near pristine conditions.

**remediation.** See *cleanup*.

**repository.** A *nuclear facility* where *waste* is emplaced for *disposal*.

**repository, geological.** A *facility* for *disposal* of *radioactive waste* located underground (usually several hundred metres or more below the surface) in a geological formation to provide *long term* isolation of *radionuclides* from the *biosphere*.

**repository, near surface.** A *facility* for *disposal* of *radioactive waste* located at or within a few tens of metres from the earth's surface.

**reprocessing.** A process or *operation*, the purpose of which is to extract radioactive isotopes from *spent fuel* for further use [3].

**requirement.** A condition defined as necessary to be met by a product, material or process. See also *criteria; specifications*.

**restoration.** See *cleanup*.

**restricted use.** See *use, restricted*.

**resuspension.** The remobilization of particles from terrestrial surfaces by wind or other mechanical action. This physical process can also occur inside buildings, i.e. from contaminated surfaces or during accident conditions, particularly in fires. Similarly, remobilization of particles from the beds of rivers, lakes or seas can occur by the action of water movement.

**retardation.** A reduction in the rate of *radionuclide* movement through the soil due to the interaction (e.g. by *sorption*) with an immobile *matrix*.

**retardation coefficient,  $R_d$ .** A measure of capability of porous media to impede the movement of a particular *radionuclide* being carried by fluid. Assuming equilibrium conditions, the term  $1 + (\rho_b/n)K_d$  is referred to as the *retardation coefficient*, where  $\rho_b$  is the bulk mass density of the porous medium,  $n$  is the *porosity* and  $K_d$  is the *distribution coefficient*.

**retrievability.** The ability to remove *waste* from where it has been emplaced.

**reverse osmosis.** See *osmosis, reverse*.

**risk.** A multiattribute quantity expressing hazard, danger or chance of harmful or injurious consequences associated with actual or *potential exposures*. It relates to quantities such as the probability that specific deleterious consequences may arise and the magnitude and character of such consequences. [2]

**risk analysis.** See *analysis, risk*.

**risk assessment.** See *assessment, risk*.

**rock.** In geology, any mass of *mineral* matter, whether consolidated or not, which forms part of the earth's crust. Rocks may consist of only one *mineral* species,

in which case they are called monomineralic but they usually consist of several *mineral* species.

**rock, crystalline.** A generic term for *igneous rocks* and *metamorphic rocks* as opposed to *sedimentary rocks*. See also *granite*; *rock, plutonic*.

**rock, host.** A geological formation in which a *repository* is located.

**rock, igneous.** *Rock* or *mineral* that solidified from molten or partly molten material, i.e. from magma. *Igneous rocks* constitute one of the three main classes of *rocks*, the others being metamorphic and sedimentary. See also *basalt*.

**rock, metamorphic.** Any type of *rock* formed from pre-existing *rocks* by mineralogical, chemical and/or structural changes. These changes are caused by changes in temperature, pressure, shearing stress and/or the chemical environment when the *rock* is deep within the earth's crust. Metamorphic rocks constitute one of the three main classes of *rocks*, the others being igneous and sedimentary. See also *schist*.

**rock, plutonic.** Intrusive *igneous rock* formed at considerable depth beneath the surface of the earth by cooling of magma. Also called 'intrusive *igneous rock*' and '*crystalline rock*'. See also *granite*.

**rock, sedimentary.** A type of *rock* resulting from the consolidation of loose material that has accumulated in layers. The layers may be built up mechanically or by chemical precipitation. Generally, the material that accumulates has originated from the weathering of other *rocks* or from secretions of living organisms. Sedimentary rocks constitute one of the three main classes of *rocks*, the others being igneous and metamorphic.

**rock mulch.** In mining and *milling*, a mixture of broken *rock* and soil materials, which is randomly spread on a surface to resist erosion. It should resist normal forces from rainfall and wind but is not intended to resist concentrated water flows. In many cases vegetation will develop over a rock mulch, which should aid against erosion.

**root uptake.** See *uptake*.

**safe enclosure.** See *enclosure, safe*.

**safety analysis.** See *analysis, safety*.

**safety assessment.** See *assessment, safety*.

**safety case.** An integrated collection of arguments and evidence to demonstrate the safety of a *facility*. This will normally include a *safety assessment*, but could also typically include information (including supporting evidence and reasoning) on the robustness and reliability of the *safety assessment* and the assumptions made therein.

**safety culture.** The assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, protection and safety issues receive the attention warranted by their significance.

**safety indicator.** A quantity used in *assessments* as a measure of the radiological impact of a *source* or *practice*, or of the performance of protection and safety provisions, other than a prediction of *dose* or *risk*. Such quantities are most commonly used in situations where predictions of *dose* or *risk* are unlikely to be reliable, for example long term *assessments* of *repositories*. These are normally either (a) illustrative calculations of *dose* or *risk* quantities, used to give an indication of the possible magnitude of *doses* or *risks* for comparison with criteria, or (b) other quantities, such as *radionuclide* concentrations or fluxes, that are considered to give a more reliable indication of impact, and that can be compared with other relevant data.

**safety report.** A document required from the *operating organization* by the *regulatory body* containing information concerning a *nuclear facility* (e.g. a *repository*), the site characteristics, *design*, operational procedures, etc., together with a *safety analysis* and details of any provisions needed to restrict *risk* to personnel and the public.

**safety standards (IAEA Safety Series).** Standards of safety issued pursuant to Article III(A)(6) of the Statute of the International Atomic Energy Agency [6]. Safety Standards issued since 1997 in the IAEA Safety Standards Series are designated as Safety Fundamentals, Safety Requirements or Safety Guides. Some Safety Standards issued prior to 1997 in the IAEA Safety Series were designated Safety Standards, Codes, Regulations or Rules.

**salt dome.** See *salt formation*.

**salt formation.** A geological formation resulting from the evaporation of sea water. Salt formations occur as bedded or domal (salt dome) deposits. In a bedded formation the salt is still in a similar shape as it was when deposited. A salt dome results from an uplift within a bedded salt formation.

**sands.** In mining and *milling*, the fraction of ground ore or *tailings* which is generally granular and sandy. Such particles will settle readily in an aqueous slurry and the settled material can drain relatively easily. The sand material will normally have a significant proportion consisting of particles larger than about 40  $\mu\text{m}$ .

**saturated zone.** See *zone, saturated*.

**scenario.** A postulated or assumed set of conditions and/or events. They are most commonly used in *analysis* or *assessment* to represent possible future conditions and/or events to be modelled, such as possible accidents at a *nuclear facility*, or the possible future evolution of a *repository* and its surroundings.

**schist.** A *metamorphic rock* which has a tendency to split on account of the presence of folia or flaky and elongated *minerals*, such as mica, talc and chlorite; formed from original *sedimentary rock* or *igneous rock* by the action of regional metamorphosis.

**screening.** A type of *analysis* aimed at eliminating from further consideration factors that are less significant for the purpose of the *analysis*, in order to concentrate on the more significant factors. Screening is usually conducted at an early stage in order to narrow the range of factors needing detailed consideration in an *analysis* or *assessment*.

**scrubber.** Equipment used in the removal of desired particulants from gaseous *effluent* by passing them through a body, stream or spray of water. See also *HEPA filter*.

**seal.** Engineered *barriers* placed in passages within and leading to a *repository* to isolate the *waste* and to prevent seepage leakage of water into or *radionuclide migration* from the *repository* area. Sealing is performed as part of *repository closure*.

**sealed source.** See *source, sealed*.

**secondary waste.** See *waste, secondary*.

**sedimentary rock.** See *rock, sedimentary*.

**segregation.** An activity where *waste* or materials (radioactive and exempt) are separated or are kept separate according to radiological, chemical and/or physical properties which will facilitate *waste* handling and/or *processing*. For example, it may be possible to segregate radioactive from exempt material and thus reduce the *waste* volume.

**self-assessment.** A routine and continuing process conducted by management at all levels to evaluate the effectiveness of performance in all areas of their responsibility. Self-assessment activities include review, *surveillance* and discrete checks, which are focused on preventing, or identifying and correcting, management problems that hinder the achievement of the organization's objectives, particularly safety objectives.

**sensitivity analysis.** See *analysis, sensitivity*.

**shaft.** A near vertical access for humans, materials or ventilation from the earth's surface to underground facilities. For an inclined or near horizontal access the term ramp is used.

**shale.** A consolidated *clay* rock which possesses closely spaced, well defined laminae.

**shielding.** A material interposed between a *source* of radiation and persons, or equipment or other objects, in order to absorb radiation and thereby reduce radiation exposure.

**short lived waste.** See *waste, short lived*.

**site.** The area containing, or under investigation for its suitability for, a *nuclear facility* (e.g. a *repository*). It is defined by a boundary and is under effective control of the *operating organization*.

**site characterization.** See *characterization, site*.

**site confirmation.** The final stage of the *siting* process for a *repository*. Site confirmation is based on detailed investigations on the preferred *site* which provide *site* specific information needed for *safety assessment*. This stage includes the finalization of the *repository design* and the preparation and submission of a *licence* application to the *regulatory body*.

**site selection.** See *siting*.

**siting.** The process of selecting a suitable *disposal site*. The process comprises the following stages: concept and planning; *area survey*; *site characterization*; *site confirmation*.

**solidification.** *Immobilization* of gaseous, liquid or liquid-like materials by conversion into a solid *waste form*, usually with the intent of producing a physically stable material that is easier to handle and less dispersible. *Calcination*, drying, *cementation*, *bituminization* and *vitrification* are some of the typical ways of solidifying liquid *waste*. See also *conditioning*; *immobilization*.

**solidified waste.** See *waste, solidified*.

**solubility.** The amount of a substance that will dissolve in a given amount of another substance. The solubility of a *waste form* or a *radionuclide* is an important factor in determining the potential *migration* of *radionuclides* from a *disposal* area.

**solvent extraction.** A method of separation in which a generally aqueous solution is mixed with an immiscible solvent to transfer one or more components into the solvent. An example is the separation of uranium and plutonium from the other transuranic elements and fission products in fuel *reprocessing* (i.e. the *Purex process*).

**sorption.** The interaction of an atom, molecule or particle with the surface of a solid. A general term including absorption (sorption taking place largely within the pores of a solid) and adsorption (surface sorption with a non-porous solid). The processes involved may also be divided into chemisorption (chemical bonding with the substrate) and physisorption (physical attraction, for example by weak electrostatic forces).

**source.** (1) Anything that may cause radiation *exposure*, such as by emitting ionizing radiation or by releasing *radioactive substances* or materials. (2) More specifically, *radioactive material* used as a source of radiation.

**source, disused.** A *source* no longer in use or intended to be used.

**source, natural.** A naturally occurring *source* of radiation, such as the sun and stars (*sources* of cosmic radiation) and *rocks* and soil (terrestrial *sources* of radiation).



**source, orphan.** A *source* which poses sufficient radiological hazard to warrant *regulatory control*, but which is not under *regulatory control* because it has never been so, or because it has been abandoned, lost, misplaced, stolen or otherwise transferred without proper *authorization*.

**source, sealed.** *Radioactive material* that is permanently sealed in a capsule, or closely bonded and in a solid form.

**source, spent.** A *source* that is no longer suitable for its intended purpose as a result of radioactive decay.

**source, unsealed.** A *source* that does not meet the definition of a *sealed source*.

**source term.** A mathematical expression used to denote information about the actual or potential release of radiation or *radioactive material* from a given *source*, which may include further *specifications*, for example the composition, the initial amount, the rate and the mode of release of the material.

**speciation.** A process that determines the chemical form(s), valency and properties of elements, including *radionuclides*, under a particular set of conditions (pH, *Eh*, ligands, *ionic strength*, *redox potential*, etc.).

**specific activity.** See *activity*, *specific*.

**specifications.** Detailed *requirements* to be satisfied by a product, a service, a material or process, indicating the procedure by means of which it may be determined whether the specified *requirements* are satisfied. See also *criteria*; *requirement*.

**spent fuel.** See *fuel*, *spent*.

**spent fuel management.** All *activities* that relate to the handling or *storage* of *spent fuel*, excluding *off-site* transportation. It may also involve *discharges*. [3]

**spent fuel package.** See *package*, *spent fuel*.

**spent source.** See *source*, *spent*.

**storage.** The holding of *spent fuel* or of *radioactive waste* in a *facility* that provides for its *containment*, with the intention of retrieval [3]. Storage is by definition an interim measure, and the term interim storage would therefore be

appropriate only to refer to short term temporary storage when contrasting this with the longer term fate of the *waste*. Storage as defined above should not be described as interim storage.

**storage, dry.** The placement of *spent fuel* or solidified *heat generating waste* in a facility that allows for the removal of decay heat through the convection of air (passive or active).

**storage, interim.** See *storage*.

**storage, surge.** A holding area capable of accepting a temporary excess of materials during equipment outages or a period of restricted handling capacity.

**storage, wet.** The placement of *spent fuel* or solidified *heat generating waste* in a water filled pool storage facility, either at the *site* of a nuclear reactor or away from the reactor.

**subseabed disposal.** See *disposal, subseabed*.

**subsurface water.** All water in both *saturated zones* and *unsaturated zones* beneath the surface of the land. See *groundwater*.

**surface water.** Water which fails to penetrate into the soil and flows along the surface of the ground, eventually entering a lake, a river or the sea.

**surge storage.** See *storage, surge*.

**surveillance.** Activities performed to ensure that conditions at a *nuclear facility* remain within the *authorized limits*. For a *near surface repository*, surveillance normally continues past the periods of *operation* and *closure*. See also *closure*.

**survey, area.** An early stage of the *siting* process for a *repository*, during which a broad region is examined to eliminate unsuitable areas and to identify other areas which may contain suitable *sites*. See also *siting*.

**survey, radiological.** An evaluation of the radiological conditions and potential hazards associated with the production, use, transfer, release, *disposal*, or presence of *radioactive material* or other *sources* of radiation.

**tailings.** (1) Mill tailings, which are the residues resulting from processing the ore in a mill to extract the metal values. (2) Heap leach residues, which result from treatment of ore by *heap leaching*.

**tailings impoundment.** A structure in which the *tailings* and the *tailings solution* are deposited, including all their elements such as embankment walls, *liners* and cover layers.

**tailings pile.** A deposit of *tailings* material.

**tailings seepage.** Seepage of liquid from a *tailings impoundment*.

**tailings solution.** Liquid associated with the *tailings* as they are deposited in the *tailings impoundment*.

**tailings stabilization.** In the context of mill *tailings impoundments*, the actions needed to physically and chemically stabilize the *tailings* and the containment *barriers*. Such actions may include dewatering the *tailings*, building/repairing dams and covering the *tailings*.

**TENORM.** See *naturally occurring radioactive material*.

**test, accelerated.** A procedure, normally one for which a standard protocol has been developed that is used in a laboratory to produce in a reasonably short time (days or months) representative data for effects that would otherwise be observed only over much longer times (decades to hundreds of years). Generally this requires adjusting parameters such as temperature, pressure and *radioactive dose* rate that affect the kinetics of a chemical reaction in such a way that the natural process is well represented.

**test, performance confirmation.** Tests carried out at a *repository*, usually after *waste* emplacement but prior to *licence* termination, to confirm that the *repository* is performing as anticipated when emplacement of *wastes* was authorized.

**thermal gradient.** See *gradient, thermal*.

**thermal loading.** The thermal power of a quantity of heat generating materials over a given area or in a given volume; the units are power per unit area or per unit volume, respectively.

**tomography.** The technique of making radiographs of plane sections of a body or an object to show detail in a selected plane while blurring the images of structures in other planes.

**transfer coefficient.** In *compartment* modelling, a constant expressing the amount of a substance moving from one *compartment* to another as a fraction of the content of the source *compartment*.

**transmissivity, hydraulic.** The rate at which water is transmitted through a unit width of a water conducting feature (e.g. an *aquifer*) under a unit *hydraulic gradient*.

**transmutation.** The conversion of one element into another. Transmutation is under study as a means of converting longer lived *radionuclides* into shorter lived or stable *radionuclides*. The term actinide burning is used in some countries.

**transport, radionuclide.** The movement (*migration*) of *radionuclides* in the environment, for example radionuclide transport by *groundwater*. This could include processes such as *advection*, *diffusion*, *sorption* and *uptake*. This usage does not include intentional transport of radioactive materials by humans (transport of radioactive *wastes* in *casks*, etc). See also *migration*.

**transport model.** See *model*, *transport*.

**transuranic waste.** See *waste*, *transuranic*.

**treatment.** Operations intended to benefit safety and/or economy by changing the characteristics of the *waste*. Three basic treatment objectives are: *volume reduction*, removal of *radionuclides* from the *waste* and change of composition. Treatment may result in an appropriate *waste form*.

**TRU.** See *waste*, *transuranic*.

**tuff.** A *rock* composed of compacted volcanic ash. A tuff that has been consolidated and welded together by heat, pressure and possibly the introduction of cementing materials is referred to as welded tuff.

**uncertainty analysis.** See *analysis*, *uncertainty*.

**underground disposal.** See *repository*, *near surface*; *repository*, *geological*.

**underground research laboratory (URL).** See *in situ testing*.

**unrestricted use.** See *use, unrestricted*.

**unsaturated flow.** See *flow, unsaturated*.

**unsaturated zone.** See *zone, unsaturated*.

**uptake.** A general term for the processes by which *radionuclides* enter one part of a biological system from another. Used in a range of situations, particularly in describing the overall effect when there are a number of contributing processes, for example *root uptake*, the transfer of *radionuclides* from soil to plants through the plant roots.

**uranium, depleted.** Uranium containing a lesser mass percentage of uranium-235 than in *natural uranium*. [7]

**uranium, enriched.** Uranium containing a greater mass percentage of uranium-235 than 0.72%. [7]

**uranium, highly enriched (HEU).** Enriched uranium with a proportion of uranium-235 high enough for use in nuclear weapons, typically over 90% by mass.

**uranium, low enriched (LEU).** Enriched uranium containing a lesser mass percentage of uranium-235 than 20%.

**uranium, natural.** Chemically separated uranium containing the naturally occurring distribution of uranium isotopes (approximately 99.28% uranium-238 and 0.72% uranium-235 by mass). [7]

**URL.** See *in situ testing*.

**use, authorized.** Use of *radioactive materials* or radioactive objects from an authorized *practice* in accordance with an *authorization*.

**use, restricted.** The use of equipment, materials, buildings or the *site*, subject to restrictions imposed for reasons of radiation protection and safety. See also *use, unrestricted*.

**use, unrestricted.** The use of equipment, materials, buildings or the *site* without any radiologically based restrictions. See also *use, restricted*.

**validation, model.** In *radioactive waste management*, the process of building confidence that a *model* adequately represents a real system for a specific purpose.

**vault.** An above ground or below ground reinforced concrete structure containing an array of storage cavities, each of which could hold one or more *spent fuel packages* or *waste packages*.

**verification, model.** The process of determining whether a *computational model* correctly implements the intended *conceptual model* or *mathematical model*.

**very low level waste (VLLW).** See *waste, very low level*.

**viscosity.** The tendency of a fluid to resist relative motion within itself; the stresses induced dissipate energy in the fluid. A highly viscous liquid drags in a molasses-like manner. The SI units of viscosity are N·s/m<sup>2</sup>.

**vitrification.** The process of incorporating materials into a *glass* or glass-like form. Vitrification is commonly applied to the *solidification* of liquid *high level waste* from the *reprocessing* of *spent fuel*. See also *glass*.

**vitrified waste.** See *waste glass*.

**VLLW.** See *waste, very low level*.

**volume reduction.** A *treatment* method that decreases the physical volume of a *waste*. Volume reduction is employed because it is economical and facilitates subsequent handling, *storage*, transport and *disposal* of the *waste*. Typical volume reduction methods are mechanical *compaction*, *incineration* and *evaporation*. Volume reduction of a given *waste* results in a corresponding increase in *radionuclide* concentration. The total volume of *waste* may also be reduced through *decontamination* (with subsequent *exemption*) or through the avoidance of *waste* generation. See also *minimization, waste*.

**waste.** Material in gaseous, liquid or solid form for which no further use is foreseen.

**waste, alpha bearing.** *Radioactive waste* containing one or more alpha emitting *radionuclides*. Alpha bearing waste can be short lived or long lived.

**waste, cladding.** *Radioactive waste* comprised of fragmented cladding hulls, endcaps, grid spacers and other hardware from *spent fuel* assemblies. It is generated in *spent fuel reprocessing*.

**waste, exempt.** *Waste* released from *regulatory control* in accordance with *exemption* principles. See also *clearance levels; exemption*.

**waste, heat generating.** *Radioactive waste* which is sufficiently radioactive that the decay heat significantly increases its temperature and the temperature of its surroundings. In practice, heat generating waste is normally *high level waste*, although some types of *intermediate level waste* may qualify as heat generating waste.

**waste, high level (HLW).** The radioactive liquid containing most of the *fission products* and actinides present in *spent fuel* — which forms the residue from the first solvent extraction cycle in *reprocessing* — and some of the associated *waste streams*; this material following solidification; *spent fuel* (if it is declared a *waste*); or any other *waste* with similar radiological characteristics. Typical characteristics of HLW are thermal powers above about 2 kW/m<sup>3</sup> and long lived *radionuclide* concentrations exceeding the limitations for *short lived waste*. [8]

**waste, intermediate level (ILW).** See *waste, low and intermediate level*.

**waste, long lived.** *Radioactive waste* that contains significant levels of *radionuclides* with *half-lives* greater than 30 years. Typical characteristics are long lived *radionuclide* concentrations exceeding limitations for *short lived waste*. [8]

**waste, low and intermediate level (LILW).** *Radioactive waste* with radiological characteristics between those of *exempt waste* and *high level waste*. These may be *long lived waste* (LILW-LL) or *short lived waste* (LILW-SL). Typical characteristics of LILW are activity levels above *clearance levels* and thermal powers below about 2 kW/m<sup>3</sup> [8]. Many States subdivide this class in other ways, for example into *low level waste* (LLW) and *intermediate level waste* (ILW) or *medium level waste* (MLW), often on the basis of *waste acceptance requirements* for *near surface repositories*.

**waste, low level (LLW).** See *waste, low and intermediate level*.

**waste, medium level (MLW).** See *waste, low and intermediate level*.

**waste, mining and milling (MMW).** *Waste* from mining and *milling*. This includes *mill tailings*, residues from *heap leaching*, *waste rock*, sludges, filter cakes, scales and a variety of *effluents*.

**waste, mixed.** *Radioactive waste* that also contains non-radioactive toxic or hazardous substances.

**waste, NORM.** *NORM* that has been declared to be *waste*.

**waste, nuclear application.** *Radioactive waste* from the production and application of radioisotopes, for example in medicine, agriculture and industry.

**waste, primary/raw.** *Waste* unchanged from the form and quantity in which it was generated — *waste* that has not been processed. See also *treatment*.

**waste, radioactive.** For legal and regulatory purposes, *waste* that contains or is contaminated with *radionuclides* at concentrations or *activities* greater than *clearance levels* as established by the *regulatory body*. It should be recognized that this definition is purely for regulatory purposes and that material with *activity* concentrations equal to or less than *clearance levels* is radioactive from a physical viewpoint — although the associated radiological hazards are considered negligible.

**waste, reactor.** *Waste* from the *operation* of a nuclear reactor.

**waste, secondary.** A form and quality of *waste* that results as a by-product from *processing* of *waste*.

**waste, short lived.** *Radioactive waste* that does not contain significant levels of *radionuclides* with *half-lives* greater than 30 years. Typical characteristics are restricted long lived *radionuclide* concentrations (limitation of long lived *radionuclides* to 4000 Bq/g in individual *waste packages* and to an overall average of 400 Bq/g per *waste package*); see paras 324 and 325 of Ref. [8].

**waste, solidified.** Liquid *waste* that has been converted into a solid *waste form*. This may be done by *calcination* or drying or by incorporation into a solid *matrix* such as glass, cement, bitumen or polymer. See also *conditioning*; *immobilization*; *solidification*.

**waste, transuranic (TRU).** *Alpha bearing waste* containing nuclides with atomic numbers above 92, in quantities and/or concentrations above *clearance levels*.

**waste, very low level (VLLW).** *Radioactive waste* considered suitable by the *regulatory body* for authorized *disposal*, subject to specified conditions, with ordinary *waste* in facilities not specifically designed for radioactive waste disposal.

**waste, vitrified.** See *waste glass*.



**waste acceptance requirements.** Quantitative or qualitative criteria specified by the *regulatory body*, or specified by an *operator* and approved by the *regulatory body*, for *radioactive waste* to be accepted by the *operator* of a *repository* for *disposal*, or by the *operator* of a storage facility for *storage*. Waste acceptance requirements might include, for example, restrictions on the *activity* concentration or the total *activity* of particular *radionuclides* (or types of *radionuclide*) in the *waste* or *requirements* concerning the *waste form* or *waste package*.

**waste arisings.** The quantity of *waste* generated by any stage in the nuclear *fuel cycle*, by research reactors and by the production and utilization of radioisotopes.

**waste canister.** See *container, waste*.

**waste characterization.** See *characterization, waste*.

**waste classification system.** A method used to group various types of *radioactive waste* according to their physical characteristics. The IAEA Safety Series 111-G-1.1 [8] recommends the following two main *radioactive waste* classes above *exempt waste*: *low and intermediate level waste*, and *high level waste*. This classification system is organized to take into account matters considered of prime importance for *disposal* safety. A number of issues related to waste classification are currently under review. However, in national classification systems, many other terms are in use, for example *very low level waste*, *low level waste*, *intermediate level waste* and *medium level waste*.

**waste concentrate.** The product resulting from *treatment* (e.g. by *evaporation* or *chemical precipitation*) of a liquid *waste* solution. See also *treatment*.

**waste conditioning.** See *conditioning*.

**waste container.** See *container, waste*.

**waste disposal.** See *disposal*.

**waste disposal system.** Refers to the disposal environment as a whole, including the geological surroundings, the engineering system of a *repository* (e.g. *barriers*) and the *waste packages*.

**waste form.** *Waste* in its physical and chemical form after *treatment* and/or *conditioning* (resulting in a solid product) prior to packaging. The waste form is a component of the *waste package*.

**waste generator.** The *operating organization* of a *facility* or activity that generates *waste*. See also *operator*.

**waste glass.** The vitreous product that results from incorporating waste into a *glass matrix*. See also *glass*.

**waste handling.** Physical manipulation (sorting, moving, etc.) of *waste* or *waste packages*.

**waste immobilization.** See *immobilization*.

**waste inventory.** Quantity, *radionuclides*, *activity* and *waste form* characteristics of *wastes* for which an operator is responsible.

**waste management, radioactive.** All activities, administrative and operational, that are involved in the handling, *pretreatment*, *treatment*, *conditioning*, transport, *storage* and *disposal* of *radioactive waste*.

**waste minimization.** See *minimization*, *waste*.

**waste package.** See *package*, *waste*.

**waste package specifications.** The set of quantitative *requirements* to be satisfied by the *waste package* for handling, transport, *storage* and *disposal*.

**waste pretreatment.** See *pretreatment*.

**waste processing.** See *processing*.

**waste rock.** *Rock* debris remaining from mining activities which does not have a sufficient uranium or thorium content to be useful as ore.

**waste segregation.** See *segregation*.

**waste treatment.** See *treatment*.

**water table.** The upper surface of a zone of *groundwater* saturation.

**wet storage.** See *storage*, *wet*.

**zeolite.** A generic term for a group of hydrated aluminosilicates of sodium, calcium, barium, strontium and potassium characterized by their easy and reversible loss

of water of hydration. Many are also characterized by a significant *ion exchange* capacity.

**zone, saturated.** A subsurface zone in which all the interstices are filled with water. This zone is separated from the *unsaturated zone*, i.e. the zone of aeration, by the *water table*. See also *zone, unsaturated*.

**zone, unsaturated.** A subsurface zone in which at least some interstices contain air or water vapour, rather than liquid water. Also referred to as the 'zone of aeration'. See also *zone, saturated*.

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### **Consultants Meeting**

Vienna, Austria: 19–23 November 2001