BS ISO 12749-3:2015

BSI Standards Publication

Nuclear energy, nuclear technologies, and radiological protection — Vocabulary

Part 3: Nuclear fuel cycle

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National foreword

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Nuclear energy, nuclear technologies, and radiological protection — Vocabulary —

Part 3:
Nuclear fuel cycle

Énergie nucléaire, technologies nucléaires et protection radiologique — Vocabulaire —

Partie 3: Cycle de combustibles nucléaires

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary Information

The committee responsible for this document is ISO/TC 85, *Nuclear energy, nuclear technologies, and radiological protection.*

This first edition cancels and replaces ISO 921:1997, of which it forms the subject of a technical revision.

ISO 12749 consists of the following parts, under the general title *Nuclear energy, nuclear technologies, and radiological protection*:

— *Part 2: Radiological protection*

— *Part 3: Nuclear fuel cycle*

— *Part 4: Dosimetry for radiation processing*

The following parts are under preparation:

— *Part 5: Reactors*

Introduction

This part of ISO 12749 will provide terms and definitions for nuclear fuel cycle concepts dealing with specific subjects such as fuel fabrication, fuel characteristics, and nuclear criticality safety and with transport and radioactive waste related topics, excluding reactors operations. Terminological data are taken from ISO standards developed by TC 85/SC 5 and other technically validated documents issued by international organizations.

Unambiguous communication of nuclear energy concepts is crucial taking into account the relevant implications that may arise from misunderstandings with regard to equipment and materials involved in the standards dealing with any subject regarding nuclear energy activities. Nuclear fuels for different power reactors are produced according to different designs. However, several concepts are present in all of them and need to be designated by common terms and described by harmonized definitions in order to avoid misunderstandings. In another nuclear fuel technology subfield, difficulties arise due to the wide variety of units employed to measure the fuel burnout level. Thus, to enhance comprehension, it is advisable to adopt unified measure units.

Conceptual arrangement of terms and definitions is based on concepts systems that show corresponding relationships among nuclear energy concepts. Such arrangement provides users with a structured view of the nuclear energy sector and will facilitate common understanding of all related concepts. Besides, concepts systems and conceptual arrangement of terminological data will be helpful to any kind of user because it will promote clear, accurate, and useful communication.

Nuclear energy, nuclear technologies, and radiological protection — Vocabulary —

Part 3: Nuclear fuel cycle

1 Scope

This part of ISO 12749 lists unambiguous terms and definitions related to nuclear fuel cycle concepts in the subject field of nuclear energy, excluding reactor operations. It is intended to facilitate communication and promote common understanding.

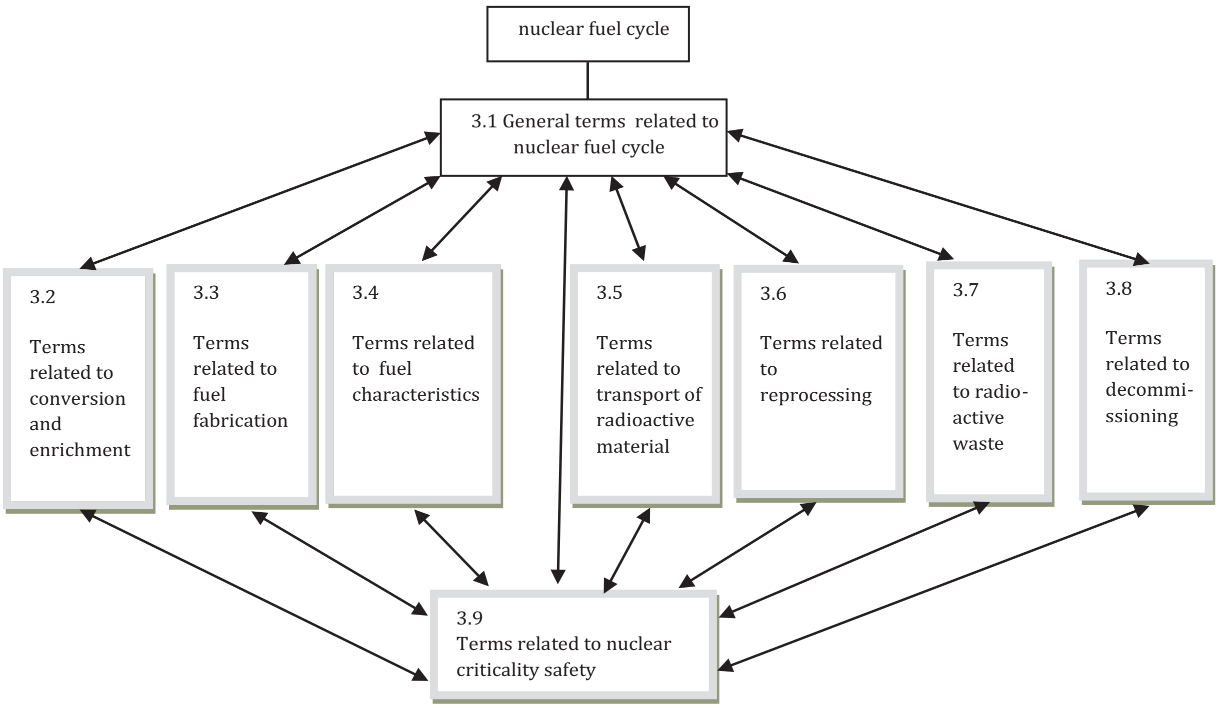
2 Structure of the vocabulary

The terminology entries are presented in the conceptual order of the English preferred terms. The structure of each entry is in accordance with ISO 10241-1:2011.

All the terms included in this part of ISO 12749 deal exclusively with nuclear fuel cycle. When selecting terms and definitions, special care has been taken to include the terms that need to be defined, that is to say, either because the definitions are essential to the correct understanding of the corresponding concepts or because some specific ambiguities need to be addressed.

The notes appended to certain definitions offer clarification or examples to facilitate understanding of the concepts described. In certain cases, miscellaneous information is also included, for example, the units in which a quantity is normally measured, recommended parameter values, references, etc.

According to the title, the vocabulary deals with concepts belonging to the general ***nuclear energy*** subject field within which concepts in the **nuclear fuel cycle** sub-subject field are taken into account. See Annex A for the methodology used to develop the vocabulary.



3 Terms and definitions

3.1 General terms related to nuclear fuel cycle

3.1.1
nuclear fuel
fissionable nuclear material used in a reactor core or intended for use in a reactor core

3.1.1.1
nuclear fuel cycle
operations associated with the production of nuclear energy

Note 1 to entry: The nuclear fuel cycle includes the following stages:

a) mining and processing of uranium or thorium ores;

b) conversion;

c) enrichment of uranium;

d) manufacture of *nuclear fuel* (3.1.1);

e) uses of the nuclear fuel;

f) *reprocessing* (3.1.1.1.2.2) and *recycling* (3.1.1.1.2.3) of spent fuel;

g) temporary *radioactive material storage* (3.1.1.1.2.1)of spent fuel and *radioactive waste* (3.7.1) from *fuel fabrication* (3.1.1.1.1.3) and reprocessing (3.1.1.1.2.2) and disposal of *spent nuclear fuel* (3.1.1.1.5) [*open fuel cycle* (3.1.1.7)] or high-level waste (*closed fuel cycle* (3.1.1.8)];

h) any related research and development activities;

i) transport of radioactive material;

j) all *waste management* (3.7.7) activities [including *decommissioning* (3.8.1]) relating to operations associated with the production of nuclear energy.

Note 2 to entry: Reactor operation and other activities at a reactor site are not addressed in this part of ISO 12749, but are to be addressed in ISO 12749-5.

[SOURCE: Adapted from IAEA Safety Glossary, 2007 Edition, modified — By splitting the definition into a definition and a note.]

3.1.1.1.1
front end
steps of the *nuclear fuel cycle* (3.1.1.1) ending with fuel introduction into the reactor core

3.1.1.1.1.1
nuclear material conversion
modification of the chemical composition of nuclear material so as to facilitate its further use or processing; in particular, to provide feed material for enrichment of isotopes of interest and/or reactor *fuel fabrication* (3.1.1.1.1.3)

Note 1 to entry: To produce material for *fuel fabrication* (3.1.1.1.1.3), the following are examples of conversion that can be carried out: U_3O_8 or UF_6 to uranium dioxide (UO_2), U or Pu nitrate to oxide, or U or Pu oxides to metal.

[SOURCE: IAEA Safeguards Glossary, 2001 Edition, modified — By splitting the definition into a definition and note 1 to entry.]

3.1.1.1.1.2
isotope enrichment
isotope separation process by which the fractional abundance of a specified isotope in an element is increased such as increasing the abundance of ^{235}U relative to *natural uranium* (3.1.1.2) or increasing the abundance of the D_2O in water

Note 1 to entry: Usually, the term will be "enrichment".

3.1.1.1.1.2.1
enriched fuel
fuel made with uranium that has been modified by increasing the abundance of the fissile isotope ^{235}U

3.1.1.1.1.3
fuel fabrication
process for manufacturing *fuel elements* (3.3.6) or other reactor components containing nuclear material

Note 1 to entry: Manufacturing process includes *nuclear material conversion* (3.1.1.1.1.1), storage, and physic-chemical analyses of materials.

[SOURCE: IAEA Safeguards Glossary, 2001 Edition]

3.1.1.1.2
back end
steps of the *nuclear fuel cycle* (3.1.1.1) beginning with the final removal of the fuel from the reactor core

Note 1 to entry: The processes can include *radioactive material storage* (3.1.1.1.2.1)at or away from reactor, *reprocessing* (3.1.1.1.2.2), *recycling* (3.1.1.1.2.3), conditioning and disposal.

[SOURCE: IAEA-TECDOC-1613 "Nuclear fuel cycle information system", 2009, modified — By splitting the definition into a definition and note 1 to entry.]

3.1.1.1.2.1
radioactive material storage
holding of radioactive sources, *spent nuclear fuel* (3.1.1.1.5), or *radioactive waste* (3.7.1) in a facility that provides for containment with the intention of retrieval

[SOURCE: IAEA Safety Glossary 2007]

3.1.1.1.2.2
reprocessing
process or operation of extracting *fission products* (3.1.5) from *spent nuclear fuel* (3.1.1.1.5) to enable reuse of the *nuclear fuel* (3.1.1)in a reactor

3.1.1.1.2.3
recycling
use, for the fabrication of *nuclear fuel* (3.1.1), of *fissionable materials* (3.1.3) separated from *spent nuclear fuel* (3.1.1.1.5)

3.1.1.1.2.3.1
mixed oxide fuel
MOX fuel
mixture of oxides of different fissionable elements

Note 1 to entry: In the *nuclear fuel cycle* (3.1.1.1), MOX is interpreted as mixed uranium and plutonium oxides unless otherwise specified.

3.1.1.1.2.4
encapsulation
encasement of radioactive contaminants in a suitable material for final disposal

3.1.1.1.3
burnup
average energy released by a defined region of the fuel during its irradiation

Note 1 to entry: This region could be a complete *fuel assembly* (3.3.6.1) or some part of the assembly. Burnup is commonly expressed as energy released per mass of initial fissionable *actinides* (3.1.8) (uranium only for this part of ISO 12749). Units commonly used are expressed in megawatt day per metric ton of initial uranium (MWd/t) or gigawatt day per metric ton of initial uranium (GWd/t).

[SOURCE: ISO 27468:2011, 3.4]

3.1.1.1.4
used nuclear fuel
fuel that has been activated in the fission process of a nuclear reactor core

3.1.1.1.5
spent nuclear fuel
fuel that has been burned in the core of a nuclear reactor and is no longer efficient to maintain its specific nuclear service

3.1.1.2
natural uranium
elemental uranium containing the naturally occurring uranium isotopes (approximately 99,28% ^{238}U, 0,72% ^{235}U by mass, and small amount of ^{234}U)

[SOURCE: Adapted from IAEA Safety Glossary, 2007]

3.1.1.2.1
depleted uranium
uranium containing ^{235}U fractional abundance less than that of *natural uranium* (3.1.1.2)

Note 1 to entry: Depleted uranium is the complement product to *enriched uranium* (3.1.1.2.2) where in the former, ^{238}U mass fraction is higher than that of *natural uranium* (3.1.1.2).

[SOURCE: Adapted from IAEA Safety Glossary, 2007]

3.1.1.2.2
enriched uranium
uranium containing a greater mass fraction or percentage of ^{235}U than in *natural uranium* (3.1.1.2)

[SOURCE: IAEA Safety Glossary, 2007 Edition, modified — By adding “fraction or” before “percentage” and replacing “0,72%” with “in natural uranium”.]

3.1.1.3
uranium concentrate
product with a high concentration in uranium obtained by physical and chemical treatments of the ores requiring further refinement before it is suitable for nuclear use

[SOURCE: ISO 921:1997, modified — The word “abundance” has been changed to “concentration”.]

EXAMPLE Yellowcake, concentrated crude oxide U_3O_8.

3.1.1.4
nuclear criticality
state of a nuclear chain reacting medium when the chain reaction is just self-sustaining

[SOURCE: IAEA Safety Glossary 2007, modified — The phrase “(or *critical*), i.e. when the reactivity is zero” has been removed as being unnecessary to the definition and not defined in ISO 12749.]

3.1.1.5
nuclear criticality safety
protection against the consequences of a *nuclear criticality accident* (3.1.1.6) preferably by prevention of the accident and responses to such accidents should they occur

3.1.1.6
nuclear criticality accident
nuclear criticality excursion
release of energy as a result of accidentally producing a self-sustaining or divergent fission chain reaction

[SOURCE: LA— 11627-MS DE90 000884, Glossary of Nuclear Criticality Terms]

3.1.1.7
open fuel cycle
once-through fuel cycle
nuclear fuel cycle (3.1.1.1) excluding *recycling* (3.1.1.1.2.3) of *actinide* (3.1.8) nuclides from *used nuclear fuel* (3.1.1.1.4)

3.1.1.8
closed fuel cycle
nuclear fuel cycle (3.1.1.1) including *recycling* (3.1.1.1.2.3) of *actinide* (3.1.8) nuclides from *used nuclear fuel* (3.1.1.1.4)

Note 1 to entry: The fuel cycle can be "closed" in various ways, for example, by the recycling of *enriched uranium* (3.1.1.2.2) and plutonium through thermal reactors (thermal recycle) by the re-enrichment of the uranium recovered as a result of spent fuel *reprocessing* (3.1.1.1.2.2)or by the use of plutonium in a fast breeder reactor.

3.1.2
fissile nuclide
nuclide capable of undergoing fission by interaction with any energy neutrons

3.1.3
fissionable material
material capable of undergoing fission by interaction with neutrons of some neutron energy range

3.1.4
fertile nuclide
nuclide which is not itself fissile, but can be converted into a *fissile nuclide* (3.1.2) by irradiation in a reactor

Note 1 to entry: There are two basic fertile nuclides, uranium-238 and thorium-232. When these fertile nuclides capture neutrons, they are converted into fissile plutonium-239 and uranium-233, respectively.

3.1.5
fission product
nuclide produced from nuclear fission or from subsequent radioactive decay of such a nuclide

[SOURCE: ISO 27468:2011, 3.9, modified — By adding "or from subsequent radioactive decay of such a nuclide" in the definition.]

3.1.6
moderator
material that has high potential for significantly reducing the energy of a free neutron

Note 1 to entry: A moderator may be important for different reasons, e.g. increasing the fission probability [of *fissile nuclide* (3.1.2)], increasing the neutron absorption probability (non-fissile *actinide* (3.1.8) nuclides and many other nuclides), and for obtaining a specific neutron energy spectrum for irradiation.

3.1.7
nuclear grade
material of a quality adequate for use in nuclear application

3.1.8
actinide
element with atomic number in the range from 89 to 103

Note 1 to entry: Many actinides are produced during the irradiation due to neutron capture and/or decay of other actinides. The corresponding nuclides are all neutron producers and some are net (considering neutron production and absorption) neutron producers in a slow neutron energy spectrum.

3.2 Terms related to conversion and enrichment

3.2.1
nuclear material conversion
see 3.1.1.1.1.1

3.2.2
isotope enrichment
see 3.1.1.1.1.2

3.2.3
empty UF_6 cylinder
UF_6 cylinder containing a *heel* (3.2.8) in quantities equal to or less than those specified in the documents in force

[SOURCE: Adapted from ISO 7195:2005, 3.3]

3.2.4
maximum allowable working pressure
MAWP
maximum value of UF_6 cylinder design gauge pressure (rounded up to two significant figures) at the maximum value of UF_6 cylinder design temperature

[SOURCE: ISO 7195:2005, 3.5]

3.2.5
minimum design metal temperature
minimum value of design metal temperature at the maximum value of UF_6 cylinder design pressure to meet ASME Code requirements

[SOURCE: ISO 7195:2005, 3.6]

3.2.6
tare mass
mass of the cleaned UF_6 cylinder including its service equipment and its permanently attached structural features

Note 1 to entry: The standard value of the mass tolerance is ±0,1 %.

[SOURCE: Adapted from IAEA TECDOC 608 (1991)]

3.2.7
effective threads
threads that are capable of providing reasonable engagement in mating threads; the first effective thread at a run out begins one thread length below the run out scratch

[SOURCE: ISO 7195:2005, 3.2]

3.2.8
heel
residual amount of UF_6 and non-volatile reaction products of uranium, uranium daughters (if the UF_6 cylinder has contained irradiated uranium) *fission products* (3.1.5), and transuranic elements

[SOURCE: ISO 7195:2005, 3.4]

3.3 Terms related to fuel fabrication

3.3.1
fuel fabrication
see 3.1.1.1.1.3

3.3.2
presintering
<fuel pellet> heating of a *compact* (3.3.3.1) at a temperature below the normal final sintering temperature, for example, to increase the ease of handling or shaping the compact or to remove a lubricant or *binder* (3.3.3.2) before *sintering* (3.3.3)

3.3.2.1
sinterable powder
<fuel pellet> powder in which the bonding of adjacent surfaces of particles can be accomplished by heating

3.3.3
sintering
<fuel pellet> process to form a metallic bond among particles and characterization of sintered *compacts* (3.3.3.1)

[SOURCE: ASTM B243-11]

Note 1 to entry: The objective is to increase the density, the grain size, and the mechanical strength of the *fuel pellets* (3.3.4).

3.3.3.1
compact
briquet
object produced by the compression of a powder, generally while confined in a die, eventually with the addition of a *binder* (3.3.3.2)

3.3.3.2
binder
cementing medium

Note 1 to entry: The binder is either a material added to the powder to increase the strength of the *compact* (3.3.3.1) and that is expelled during *sintering* (3.3.3) or a material (usually of relatively low melting point) added to a powder mixture for the specific purpose of cementing together powder particles that alone would not sinter into a strong body.

[SOURCE: ASTM B243–04a, modified — By splitting the description into a definition and a note.]

3.3.4
fuel pellet
small body of fuel, often cylindrical, formed by powder metallurgy processes

Note 1 to entry: The pellet may or may not have been sintered following compaction.

3.3.5
cladding
external layer of material applied to *nuclear fuel* (3.1.1) or other material to contain radioactive products

Note 1 to entry: Material also provides protection from a chemically reactive environment.

3.3.6
fuel element
nuclear fuel (3.1.1), its *cladding* (3.3.5), and any associated components necessary to form a structural entity

Note 1 to entry: Commonly referred to as “fuel rod” in light water reactors.

3.3.6.1
fuel assembly
set of *fuel elements* (3.3.6) and associated components which are loaded into and subsequently removed from a reactor core as a single unit

[SOURCE: IAEA Safety Glossary, 2007]

3.3.7
scrap
residues that contain sufficient quantities of nuclear material to be worthy of recovery

3.3.8
burnable absorber
burnable poison
neutron absorbing nuclides added to the *fuel assembly* (3.3.6.1)

Note 1 to entry: Burnable absorbers are used as an additive with the purpose of reducing the reactivity of the fresh *nuclear fuel* (3.1.1).

3.4 Terms related to fuel characteristics

3.4.1
particle size
controlling linear dimension of an individual particle as determined by analysis with sieves or other suitable means

[SOURCE: ASTM B243-11]

3.4.1.1
particle size distribution
percentage by weight or by number of each fraction into which a powder sample has been classified with respect to sieve number or micrometres

[SOURCE: ASTM B243-11]

3.4.2
theoretical density
density of a material calculated from the number of atoms per unit cell and measurement of the lattice parameters

3.4.3
bulk density
mass of a quantity of a bulk solid divided by its total volume

[SOURCE: ASTM D653-11]

3.4.4
tap density
density of a powder in a container that has been tapped under specified conditions

[SOURCE: ISO 9161:2004, 3.2]

3.4.5
apparent density
density of a powder obtained by free pouring under specified conditions

[SOURCE: ISO 9161:2004, 3.1]

3.4.6
equivalent boron content
EBC
concentration of natural boron affording the same neutron absorption as the specific impurity element

3.4.6.1
equivalent boron content factor
EBC factor
product of ratio of the atomic mass of natural boron to that of a specified impurity element and ratio of the thermal neutron absorption cross section of the impurity to that of boron

$$\mathrm{EBCfactor} = \left(\frac{A_B}{A_t}\right)\left(\frac{\sigma_i}{\sigma_B}\right)$$

where

A_B is the atomic mass of boron;

A_i is the atomic mass of impurity;

σ_B is the thermal neutron absorption cross section of boron;

σ_i is the thermal neutron absorption cross section of impurity.

[SOURCE: ASTM C1233-09]

3.4.7
total equivalent boron content
TEBC
sum of the individual *equivalent boron content* (3.4.6) (EBC) values

3.4.8
working reference material
WRM
reference material with documented traceability used routinely as a calibration standard, as a measurement control standard, or for the qualification of a measurement method

3.4.9
certified reference material
CRM
reference material accompanied by documentation issued by an authoritative body and providing one or more specified property values with associated uncertainties and traceabilities using valid procedure

[SOURCE: JCGM 200:2012, International vocabulary of metrology – Basic and general concepts and associated terms (VIM)]

3.4.10
porosity
ratio of the volume of voids to the total volume of a material

Note 1 to entry: Porosity is usually expressed as a percentage.

3.4.11
specific surface
surface area of one gram of powder usually expressed in square centimetres

[SOURCE: ASTM B243–11]

3.4.12
autoradiography
image that is produced by the radiation emitted from radioactive material and recorded on a photographic film, plate, emulsion, or solid-state detector

3.4.13
pyrohydrolysis
decomposition of material by the combined action of heat and water vapour

3.5 Terms related to transport of radioactive material

3.5.1
packaging
<transport> one or more receptacles and any other components or materials necessary for the receptacles to perform the containment and other safety functions

[SOURCE: UN Recommendations on the transport of dangerous good, 17th Revised edition, 2011]

3.5.1.1
protective packaging
<transport> outer *packaging* (3.1.8)or device used to provide additional protection to an inner container during transport

3.5.2
package
complete product of the packing operation consisting of the *packaging* (3.5.1) and its contents prepared for transport

[SOURCE: Adapted from IAEA Transport Regulations SSR-6 – 2012 Edition and UN Recommendations on the transport of dangerous good, 18th Revised edition, 2013]

3.5.3
trunnion
cylindrically shaped projection on a *packaging* (3.5.1) attached by various means and used for lifting, *tie-down* (3.5.8), supporting, or tilting *packages* (3.5.2) from horizontal and vertical modes

[SOURCE: ISO 10276:2010, 3.1.26]

3.5.3.1
welded trunnion
cylindrically shaped projection on a *packaging* (3.5.1) directly secured to the packaging by welding

[SOURCE: ISO 10276:2010, 3.1.30]

3.5.4
trunnion system
assembly of *trunnion* (3.5.3) and components to the *packaging* (3.5.1) including the *trunnion attachment components* (3.5.5.1) to the packaging and the internal threads in the *packaging* (3.5.1) body as appropriate

[SOURCE: ISO 10276:2010, 3.1.29, modified]

3.5.4.1
primary trunnion system
trunnion system (3.5.4) provided as a primary means for the *tie-down* (3.5.8), supporting, or lifting of *packages* (3.5.2)

[SOURCE: ISO 10276:2010, 3.1.12]

3.5.4.2
secondary trunnion system
trunnion system (3.5.4) provided as an additional or alternative means for the *tie-down* (3.5.8), supporting, or lifting of *packages* (3.5.2)

[SOURCE: ISO 10276:2010, 3.1.17]

3.5.5
trunnion attachment
method of attaching the *trunnion* (3.5.3) (e.g. welding, bolting, interference fitting and bolting, or any combination of these methods)

[SOURCE: ISO 10276:2010, 3.1.27]

3.5.5.1
trunnion attachment components
trunnion attachment (3.5.3) components excluding the *trunnion* (3.5.3), e.g. bolts, threads in the packaging body, baseplates, etc.

[SOURCE: ISO 10276:2010, 3.1.28]

3.5.6
removable trunnion
cylindrically shaped projection on a *package* (3.5.2) secured by non-permanent methods, e.g. bolting

[SOURCE: ISO 10276:2010, 3.1.14]

3.5.7
transport cycle
complete round-trip journey of a *package* (3.5.2) between two successive loadings

[SOURCE: ISO 10276:2010, 3.1.24]

3.5.8
tie-down
securing of the *package* (3.5.2) to the transport conveyance

[SOURCE: IAEA Safety Glossary, 2007.]

3.5.9
trans-shipment
change of conveyance at any time during transport

3.5.10
gross mass
<transport> <lifting> maximum mass of a *package* (3.5.2) fitted including the ancillaries (shock absorbers, neutron shields, covers, transport frame as appropriate, etc.), as presented fully laden for transport

[SOURCE: IAEA Transport Regulations SSR-6 – 2012 Edition and UN Recommendations on the transport of dangerous good, 18th Revised edition, 2013]

3.5.11
maintenance schedule
maintenance document that gives, in appropriate detail, the applicable frequency/periodicity of maintenance items and details of methods to be employed

[SOURCE: ISO 10276:2010, 3.1.15]

3.5.12
periodic inspection
<trunnions> inspection of the *trunnion system* (3.5.4) at predetermined intervals during the "in-service" life of the *packaging* (3.5.1)

[SOURCE: ISO 10276:2010, 3.1.9]

3.5.13
periodic testing
<trunnions> testing at predetermined intervals of the *trunnion system* (3.5.4) provided as a primary means for the lifting, *tie-down* (3.5.8), supporting, or lifting of *packages* (3.5.2)

[SOURCE: ISO 10276:2010, 3.1.10]

3.5.14
independent competent organization
<package> organization administratively and managerially separate from the designers, manufacturers, or users of the subject *package* (3.5.2) constituted of specialized experts or an insurance organization used to verify, oversee, witness, or check

[SOURCE: ISO 10276:2010, 3.1.3]

3.6 Terms related to reprocessing

3.6.1
reprocessing
see 3.1.1.1.2.2

3.6.2
reprocessing plant
installation for the chemical separation of nuclear material from *fission products* (3.1.5) following dissolution of spent fuel

3.6.3
PUREX process
chemical process used in a *reprocessing plant* (3.6.2) to separate plutonium and uranium from *fission products* (3.1.5) and from each other by means of *solvent extraction* (3.6.4) with tributylphosphate (TBP)

[SOURCE: ISO 921:1997]

3.6.4
solvent extraction
process used to selectively extract *actinide* (3.1.8)elements from aqueous medium

3.7 Terms related to radioactive waste

3.7.1
radioactive waste
material for which no further use is foreseen that contains or is contaminated with radionuclides

[SOURCE: Adapted from IAEA Safety Glossary, 2007 Edition]

Note 1 to entry: For legal and regulatory purposes, waste is considered to be radioactive if the concentrations or activities are greater than clearance levels as established by the regulatory body.

3.7.2
waste generator
operating organization of a facility or activity that generates waste

[SOURCE: Adapted from IAEA Safety Glossary 2007, modified — By simplifying the definition.]

Note 1 to entry: For convenience, the scope of the term waste generator is sometimes extended to include whoever currently has the responsibilities for the waste.

3.7.3
waste acceptance criteria
quantitative or qualitative criteria specified by the regulatory body or specified by an operator and approved by the regulatory body for *radioactive waste* (3.7.1) to be accepted by the operator of a *repository* (3.7.9.1) for disposal or by the operator of a storage facility for *radioactive material storage* (3.1.1.1.2.1)

Note 1 to entry: Waste acceptance criteria might include, for example, restrictions on the activity concentration or total activity of particular radionuclides (or types of radionuclide) in the waste or criteria concerning the *waste form* (3.7.6) or *packaging* (3.5.1) of the waste.

[SOURCE: Adapted from IAEA Safety Glossary 2007, modified — By splitting the wording into a definition and a note.]

3.7.4
radioactive waste characterization
determination of the physical, chemical, and radiological properties of the waste to establish the need for further adjustment, treatment or conditioning, or its suitability for further handling, processing, *radioactive material storage* (3.1.1.1.2.1), or disposal

[SOURCE: IAEA Safety Glossary 2007]

3.7.4.1
representative sample
sample which reflects the characteristics of the population from which it was drawn

3.7.4.2
composite sample
mixture of samples from different containers such that the mass ratio of the samples is equal to the ratio of the *radioactive waste* (3.7.1)masses contained in the containers

[SOURCE: ISO 921:1997, modified]

EXAMPLE Series of samples taken over a given period of time and weighted by collection rate or a combined sample consisting of a series of discrete samples taken over a given period of time and mixed according to a specified weighting factor such as stream flow or collection rate.

[SOURCE: ISO 21238:2007, 2.6]

3.7.4.3
reference source
radionuclide sealed in a suitable containment of which the radioactive characteristics are determined by comparison with a reference material

[SOURCE: ISO 14850-1:2004, 2.1]

3.7.4.4
scaling factor
factor to calculate the radioactivity of a *difficult-to-measure nuclides* (3.7.4.6) through measurement of a *key nuclide* (3.7.4.5) serving as a surrogate

Note 1 to entry: The factor is derived through independent experimental determinations and/or through mathematical construct relating the radioactive properties of the nuclides.

3.7.4.5
key nuclide
gamma-emitting nuclide whose radioactivity is correlated with that of *difficult-to-measure nuclides* (3.7.4.6) and can be readily measured directly by non-destructive assay means

Note 1 to entry: Also called “easy-to-measure nuclide” or “marker nuclide”.

EXAMPLE ^{60}Co and/or ^{137}Cs.

[SOURCE: ISO 21238:2007, 2.2]

3.7.4.6
difficult-to-measure nuclide
nuclide whose radioactivity is difficult to measure directly from the outside of the *waste packages* (3.7.5) by non-destructive assay means

EXAMPLE Alpha emitting nuclides, beta emitting nuclides, and characteristic X-ray emitting nuclides.

[SOURCE: ISO 21238:2007, 2.1]

3.7.4.7
source volume
volume in m^3 taken up by the matrix (or by the waste) in which the radioactivity is distributed

[SOURCE: ISO 14850-1:2004, 2.2]

3.7.5
waste package
product of conditioning that includes the *waste form* (3.7.6) and any container(s) and internal *barriers* (3.7.6) (e.g. absorbing materials and liner) as prepared for handling, transport, storage, and/or disposal

[SOURCE: Adapted from IAEA Safety Glossary 2007]

3.7.5.1
overpackaging
secondary (or additional) outer container for one or more *waste packages* (3.7.5) used for handling, transport, *radioactive material storage* (3.1.1.1.2.1), and/or disposal

[SOURCE: IAEA Safety Glossary 2007]

3.7.5.2
outermost container
outer shell of a *waste package* (3.7.5)

[SOURCE: ISO 6962:2004, 3.4]

Note 1 to entry: The vessel into which the *waste form* (3.7.6) is placed for handling, transport, *radioactive material storage* (3.1.1.1.2.1), and/or eventual disposal; also, the outer *barrier* (3.7.9.2) protecting the waste from external intrusions. The waste container is a component of the *waste package* (3.7.5). For example, molten high-level waste glass would be poured into a specially designed container (canister) where it would cool and solidify. Note that the term waste canister is considered to be a specific term for a container for spent fuel or vitrified high-level waste.

[SOURCE: IAEA Safety Glossary 2007]

3.7.5.3
radioactive waste mockup
package (3.5.2) consisting of a container and of well-characterized materials representative of a matrix

[SOURCE: ISO 14850-1:2004, 2.5]

3.7.5.4
reference package
mockup containing *reference sources* (3.7.4.3) in a well-defined configuration

[SOURCE: ISO 14850-1:2004, 2.6]

3.7.6
waste form
waste in its physical and chemical form after treatment or conditioning prior to *packaging* (3.5.1) and which is a component of the *waste package* (3.7.5)

[SOURCE: ISO 6962:2004, 3.3]

3.7.6.1
dry active waste
solid waste generated in various waste streams in nuclear facilities including protective clothing, replaced equipment, parts, plastics, polyvinyl chloride sheets, and high-efficiency particulate air filters removed during plant operation and maintenance

[SOURCE: ISO 21238:2007, 2.11]

3.7.6.2
homogeneous waste
radioactive waste (3.7.1) that shows an essentially uniform distribution of activity and physical contents

[SOURCE: ISO 21238:2007, 2.12]

3.7.6.3
heterogeneous waste
radioactive waste (3.7.1) that does not meet the definition of *homogeneous waste* (3.7.6.2) including solid components and mixtures of solid components such as *dry active waste* (3.7.6.1) and cartridge filters

[SOURCE: ISO 21238:2007, 2.13]

3.7.6.4
waste waters
liquids from a nuclear plant or other nuclear installation the activity of which is lower than the levels permitted by the regulatory body

3.7.7
waste management
all administrative and operational activities involved in the handling, pretreatment, treatment, conditioning, transport, *radioactive material storage* (3.1.1.1.2.1), and disposal of *radioactive waste* (3.7.1)

[SOURCE: IAEA Safety Glossary, 2007]

3.7.8
waste predisposal
any *waste management* (3.7.7) steps carried out prior to disposal such as pretreatment, treatment, conditioning, *radioactive material storage* (3.1.1.1.2.1), and transport activities

Note 1 to entry: Predisposal is used as a contraction of "pre-disposal radioactive *waste management* [(3.7.7)]" not a form of disposal.

[SOURCE: IAEA Safety Glossary 2007]

3.7.8.1
durability
<radioactive waste> ability of a material to exist for a long period of time while retaining its original qualities and properties

[SOURCE: ISO 16797:2004, 2.3]

3.7.8.2
alteration
<radioactive waste> superficial chemical modification of a material due to surrounding agents

[SOURCE: ISO 16797:2004, 2.1]

3.7.9
waste disposal
emplacement of waste in an appropriate facility without the intention of retrieval

Note 1 to entry: Some countries use the term disposal to include discharges of effluents to the environment.

[SOURCE: IAEA Safety Glossary 2007]

3.7.9.1
repository
nuclear facility where *radioactive waste* (3.7.1) is emplaced for disposal

[SOURCE: IAEA Radioactive Waste Management Glossary 2003 Edition]

3.7.9.2
barrier
physical obstruction that prevents or delays the movement of radionuclides or other material between components in a system, for example, a *waste repository* (3.7.9.1)

Note 1 to entry: In general, a barrier can be an engineered barrier which is constructed or a natural (or geological) barrier.

Note 2 to entry: Barriers can also comprise *spent nuclear fuel* (3.1.1.1.5)containers and other qualified *packaging* (3.5.1), stocks, and *radioactive material storage* (3.1.1.1.2.1) facilities used to confine nuclear material and nuclear waste.

3.7.9.3
confinement
barrier (3.7.9.2) 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

Note 1 to entry: Confinement is similar in meaning to containment, but confinement is typically used to refer to the *barriers* (3.7.9.2) 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.

3.7.10
waste processing
any operation that changes the characteristics of *radioactive waste* (3.7.1) including pretreatment, treatment, and conditioning

[SOURCE: IAEA Safety Glossary 2007]

3.7.11
waste pretreatment
any or all of the operations prior to radioactive waste treatment (3.7.1.2) such as collection, *segregation* (3.7.11.1), chemical adjustment, and *decontamination* (3.7.11.2)

[SOURCE: IAEA Safety Glossary 2007]

3.7.11.1
segregation
activity where types of *radioactive waste* (3.7.1) or material (radioactive or exempt) are separated or are kept separate on the basis of radiological, chemical, and/or physical properties to facilitate waste handling and/or processing

[SOURCE: IAEA Safety Glossary 2007]

3.7.11.2
decontamination
complete or partial removal of radioactive contamination by a deliberate physical, chemical, or biological process

[SOURCE: IAEA Safety Glossary 2007]

3.7.12
waste treatment
chemical or physical processing, or both, of *radioactive waste* (3.7.1) for interim or ultimate disposal

3.7.13
waste conditioning
operations that produce a *radioactive waste* (3.7.1) package suitable for handling, transport, *radioactive material storage* (3.1.1.1.2.1), and/or disposal

Note 1 to entry: Conditioning may include the conversion of the *radioactive waste* (3.7.1) to a *solid waste form* (3.7.6), enclosure of the waste in containers and, if necessary, provision of an overpack.

[SOURCE: IAEA Safety Glossary, 2007]

3.7.13.1
immobilization
prevention of the potential for migration or dispersion of radionuclides by conversion into a stable solid form

Note 1 to entry: The aim of immobilization is to reduce the potential for migration or dispersion of radionuclides during handling, transport, *radioactive material storage* (3.1.1.1.2.1), and/or disposal.

3.7.13.2
solidification
immobilization (3.7.13.1) 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

Note 1 to entry: Calcination, drying, cementation, bituminization, and *vitrification* (3.7.13.3) are some of the typical ways of solidifying liquid waste.

3.7.13.3
vitrification
process of incorporating *radioactive waste* (3.7.1) into a glass or glass-like form

Note 1 to entry: Vitrification is commonly applied to the *solidification* (3.7.13.2) of liquid high-level *radioactive waste* (3.7.1) from the *reprocessing* (3.1.1.1.2.2) of spent fuel.

[SOURCE: IAEA Radioactive Waste Management Glossary 2003 Edition]

3.7.13.4
waste matrix
non-radioactive material used to immobilize waste

EXAMPLE Bitumen, cement, various polymers, glass.

[SOURCE: Adapted from IAEA Radioactive Waste Management Glossary, 2003.]

3.8 Terms related to decommissioning

3.8.1
decommissioning
administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility

Note 1 to entry: This does not apply to a *repository* (3.7.9.1) or to certain nuclear facilities used for mining and milling of radioactive materials for which *closure* (3.8.1.2.1) is used.

[SOURCE: IAEA Radioactive Waste Management, Glossary 2003 Edition]

3.8.1.1
decommissioning option
one of various decommissioning strategies which can be considered when *decommissioning* (3.8.1) is being planned

Note 1 to entry: A variety of factors such as timing and the availability of technologies will influence which decommissioning strategy is ultimately chosen.

[SOURCE: IAEA Radioactive Waste Management, Glossary 2003 Edition]

3.8.1.1.1
dismantling
disassembly and removal of any structure, system, or component during *decommissioning* (3.8.1) of a nuclear facility

Note 1 to entry: Dismantling can be performed immediately after permanent retirement of a nuclear facility or it can be deferred.

[SOURCE: IAEA Radioactive Waste Management, Glossary, 2003]

3.8.1.1.1.1
immediate dismantling
part of the *decommissioning* (3.8.1) strategy that implies the *dismantling* (3.8.1.1.1) activities shortly after the *permanent shutdown* (3.8.1.3)

3.8.1.1.1.2
deferred dismantling
part of the *decommissioning* (3.8.1) strategy that implies the process or *radioactive material storage* (3.1.1.1.2.1) of parts of a facility containing radioactive contaminants in such a condition that they can be safely stored and maintained until they can subsequently be decontaminated and/or dismantled

3.8.1.2
decommissioning plan
full documentation describing the complete *decommissioning* (3.8.1) technical activities and managing processes

3.8.1.2.1
closure
administrative and technical actions directed at a *repository* (3.7.9.1) at the end of its operating lifetime

EXAMPLE Covering the disposed waste (for a near surface repository), backfilling and/or sealing, (for a geological *repository* (3.7.9.1) and the passages leading to it) and termination and completion of activities in any associated structures.

[SOURCE: Adapted from IAEA Radioactive Waste Management, Glossary, 2003]

3.8.1.2.1.1
activated material
components of a nuclear facility that contains products that have become radioactive by irradiation

3.8.1.2.2
entombment
strategy by which radioactive contaminants are encased in a structurally long-lived material until radioactivity decays to a level permitting the unrestricted release of the facility or release with restrictions imposed by the regulatory body

[SOURCE: IAEA Safety Standards Series N° WS-R-5, Decommissioning of facilities using radioactive material, Safety requirements.]

3.8.1.3
permanent shutdown
permanent state of a reactor when the operations have ceased

3.8.1.4
residual radioactivity
late removal of radioactivity remaining after the end of each *decommissioning* (3.8.1) stage

3.8.1.5
environmental remediation
removal of pollution or contaminants from environmental media such as soil, groundwater, sediment, or surface water for future reuse or release

3.8.1.6
post operational clean-up
removal of residual radioactive materials at the end of the operational life of a nuclear facility

3.9 Terms related to nuclear criticality safety

3.9.1
nuclear criticality safety
see 3.1.1.5

3.9.1.1
criticality safety controls
mechanisms which provide a high level of assurance that the probability of occurrence of a critical excursion is acceptably low

Note 1 to entry: An engineered feature (active or passive) or administrative requirement that establishes constraints on the range of values that process parameters can assume with a given reliability (i.e. failure frequency), thereby, providing a *barrier* (3.7.9.2) to a criticality accident.

[SOURCE: DOE-STD-3007-2007]

3.9.1.2
accident scenario
set of credible, postulated conditions under which a fissile material containing facility/process develops one or more fault conditions such that it is likely to exceed the critical state and thus, to result in a criticality accident

[SOURCE: ISO 27467:2009, 3.1]

3.9.1.3
effective multiplication factor
k_{eff}
mean number of fission neutrons produced by a neutron during its life within the chain reacting system

Note 1 to entry: It follows that $k_{eff} = 1$, if the system is critical, $k_{eff} < 1$, if the system is subcritical, $k_{eff} > 1$ if the system is super critical.

[SOURCE: LA— 11627-MS DE90 000884, Glossary of Nuclear Criticality Terms, modified — By splitting the definition in a definition and a note.]

3.9.1.4
criticality validation
process of quantifying the error sources (i.e. estimating biases and bias uncertainties) of a calculation method for use in *nuclear criticality safety* (3.1.1.5) analysis

3.9.1.5
depletion calculation
calculation to estimate the fuel properties after being irradiated (depleted or burned) in a reactor

Note 1 to entry: The fuel properties may refer to a detailed fuel nuclide inventory or to integral fuel nuclear properties (e.g. macroscopic atomic cross-sections) as needed to determine the neutron multiplication factor in a specific configuration.

3.9.1.6
end effect
impact on k_{eff} of the less irradiated parts of the *fuel assembly* (3.3.6.1) (upper and lower ends of the assembly)

Note 1 to entry: The end effect is commonly defined as the difference between the k_{eff} for the two following systems.

— A system containing irradiated fuel assemblies having a constant fuel composition corresponding to the average *burnup* (3.1.1.1.3) and irradiation energy spectrum of the fuel.

— The same system containing irradiated fuel assemblies having an axially varying fuel composition corresponding to the modelled *axial burnup profile* (3.9.1.10) with consideration of the neutron energy spectrum during irradiation.

[SOURCE: Adapted from ISO 27468:2011, 3.8, modified — By changing the note 1 to entry wording arrangement.]

3.9.1.7
critical mass
mass of fissile material that would be critical in a specific geometrical arrangement of specified materials including the fissile material

3.9.1.7.1
minimum critical mass
within specified ranges of conditions, the smallest mass of a *fissionable material* (3.1.3) that could become critical

3.9.1.8
loosely coupled system
system in which two or more regions with high "local" values of k_{eff} are separated by regions with low k_{eff} importance

Note 1 to entry: Convergence problems can occur when a Monte Carlo method is used for the k_{eff} calculation of such systems where neutron interaction between the highly fissile regions is weak.

[SOURCE: ISO 27468:2011, 3.10]

3.9.1.9
burnup credit
margin of reduced k_{eff} for an evaluated system due to the irradiation of fuel in a reactor as determined with the use of a structured evaluation process

[SOURCE: ISO 27468:2011, 3.5]

3.9.1.10
axial burnup profile
real or modelled axial distribution of the *burnup* (3.1.1.1.3) in the *fuel assembly* (3.3.6.1)

Note 1 to entry: The axial distribution of the burnup is caused by axial neutron leakage, axial variations in the fuel enrichment, *moderator* (3.1.6) temperature rise through the core, non-full length *burnable poison* (3.3.8), and partial insertion of control rods.

[SOURCE: ISO 27468:2011, 3.2]

Annex A
(informative)

Methodology used in the development of the vocabulary

A.1 General

The specific character of the nuclear fuel cycle concepts contained in this part of ISO 12749 requires the use of

— clear technical descriptions, and

— a coherent and harmonized vocabulary that is easily understandable by all potential users.

Concepts are not independent of one another and an analysis of the relationships between concepts within the field of energy fuel cycle and the arrangement of them into concept systems is a prerequisite of a coherent vocabulary. Such an analysis was used in the development of the vocabulary specified in this part of ISO 12749. Since the concept diagrams employed during the development process can be helpful in an informative sense, they are reproduced in A.3.

A.2 Concept relationships and their graphical representation

A.2.1 General

In terminology work, the relationships between concepts are based on the three primary forms of concept relationships indicated in this Annex: the hierarchical generic (A.2.2), partitive (A.2.3), and the non-hierarchical associative (A.2.4).

A.2.2 Generic relation

Subordinate concepts within the hierarchy inherit all the characteristics of the superordinate concept and contain descriptions of these characteristics which distinguish them from the superordinate (parent) and coordinate (sibling) concepts, e.g. the relation of mechanical mouse, optomechanical mouse, and optical mouse to computer mouse.

Generic relations are depicted by a fan or tree diagram without arrows (see Figure A.1).

Example from ISO 704:2009, (5.5.2.2.1).

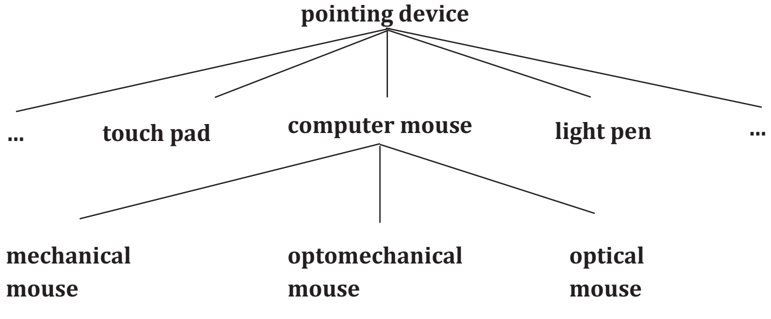


Figure A.1 — Graphical representation of a generic relation

A.2.3 Partitive relation

Subordinate concepts within the hierarchy form constituent parts of the superordinate concept, e.g. mouse button, mouse cord, infrared emitter, and mouse wheel can be defined as parts of the concept optomechanical mouse. In comparison, it is inappropriate to define red cord (one possible characteristic of mouse cord) as part of an optomechanical mouse.

Partitive relations are depicted by a rake without arrows (see Figure A.2). Singular parts are depicted by one line, multiple parts by double lines.

Example from ISO 704:2009, (5.5.2.3.1).

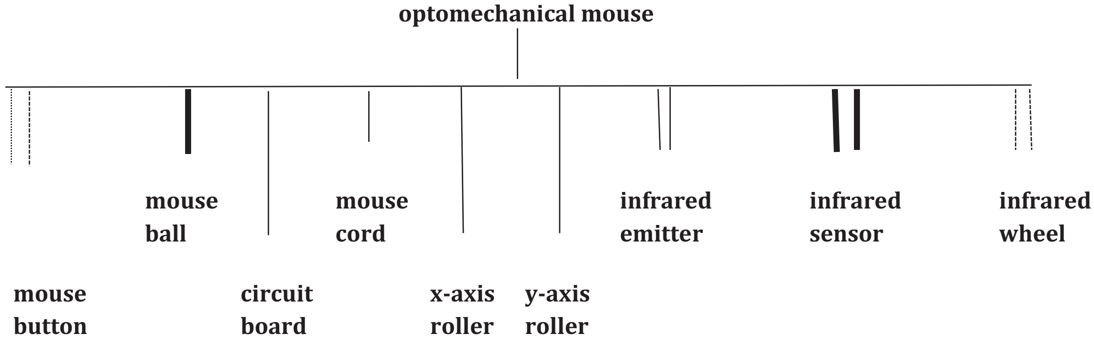


Figure A.2 — Graphical representation of a partitive relation

A.2.4 Associative relation

Associative relations cannot provide the economies in description that are present in generic and partitive relations, but are helpful in identifying the nature of the relationship between one concept and another within a concept system, e.g. cause and effect, activity and location, activity and result, tool and function, and material and product. Besides, associative relations are the most commonly encountered in terminology practical work as they correspond to the concepts relations established in the real world.

Associative relations are depicted by a line with arrowheads at each end (see Figure A.3).

Example from ISO 704:2009, (5.6.2).

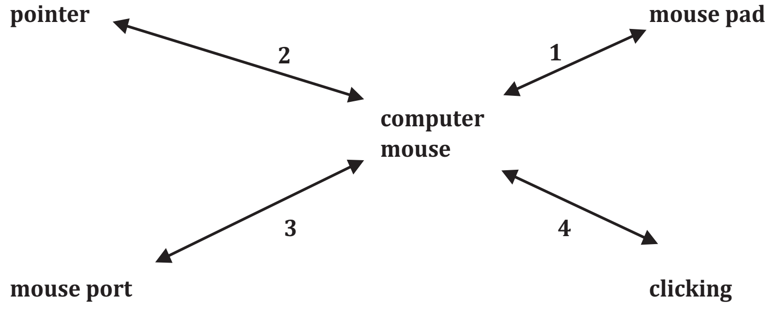


Figure A.3 — Graphical representation of an associative relation

A.3 Concept diagrams

Figures A.4 to A.12 show the concept diagrams on which the thematic groups of the nuclear fuel cycle vocabulary are based.

Notations in the following diagrams show the position of each concept according to generic, partitive, and associative relationships.

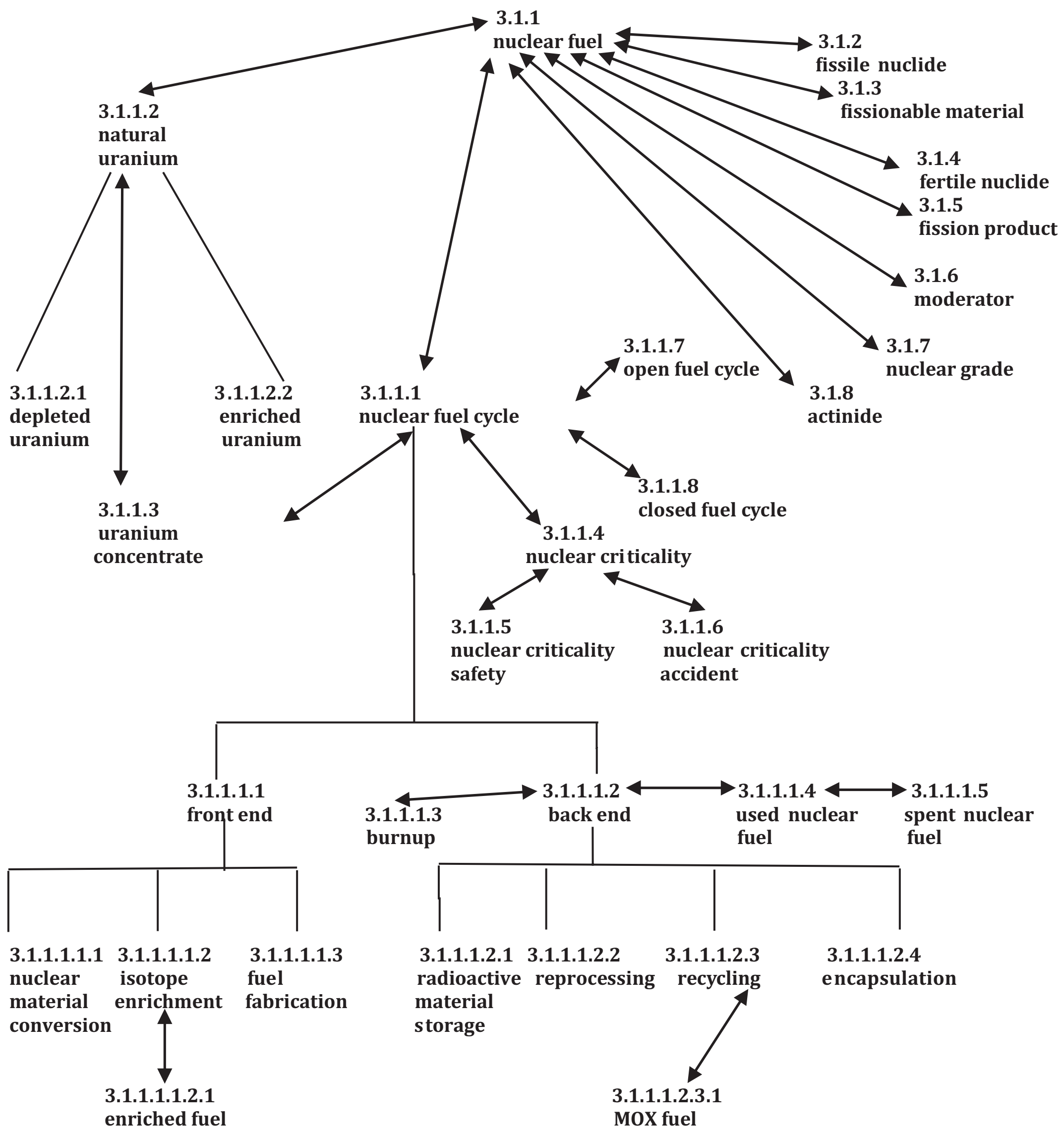


Figure A.4 — 3.1 General terms related to nuclear fuel cycle

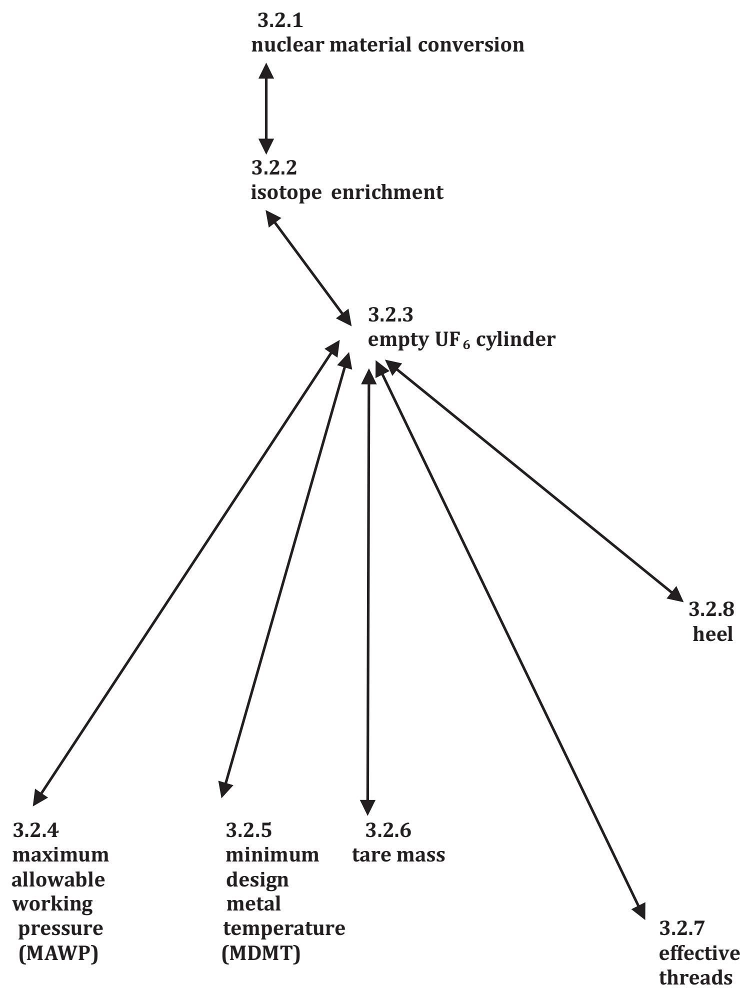


Figure A.5 — 3.2 Term related to conversion and enrichment

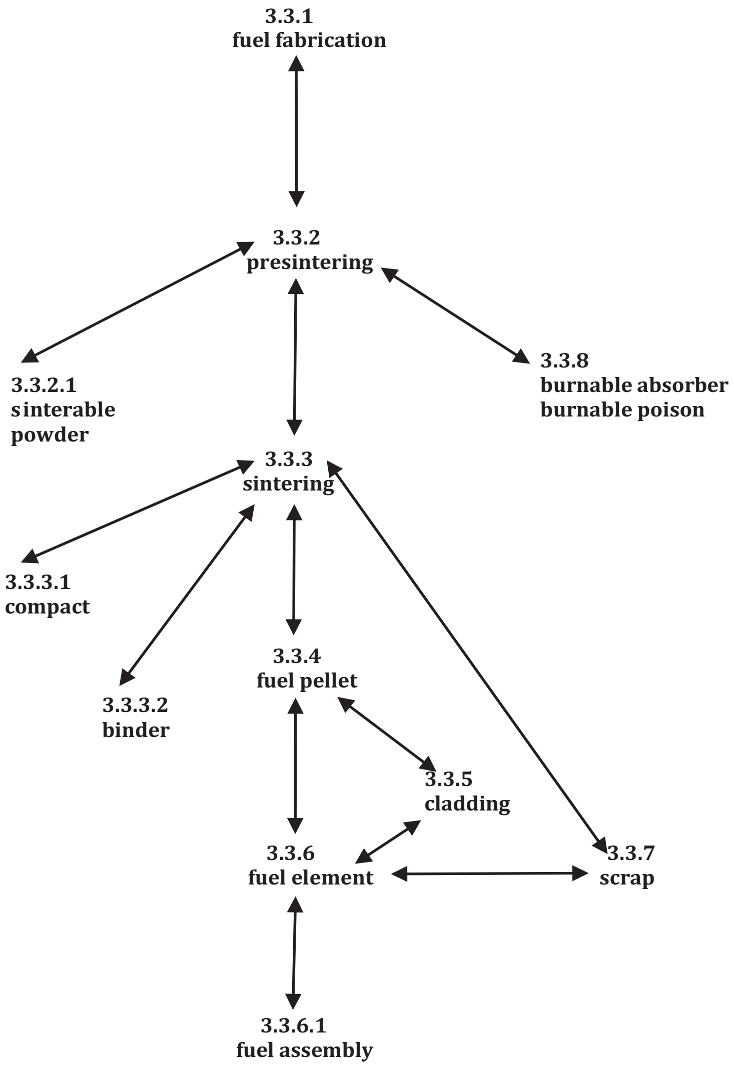


Figure A.6 — 3.3 Terms related to fuel fabrication

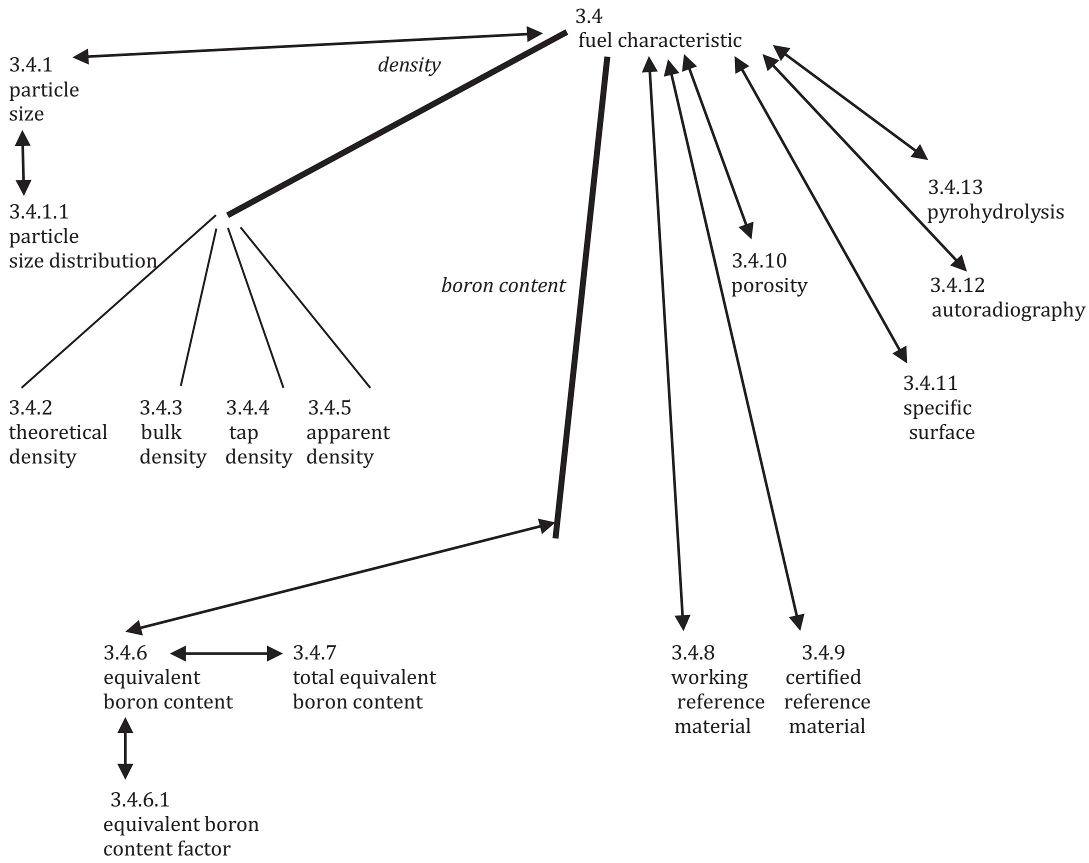


Figure A.7 — 3.4 Terms related to nuclear fuel characteristics

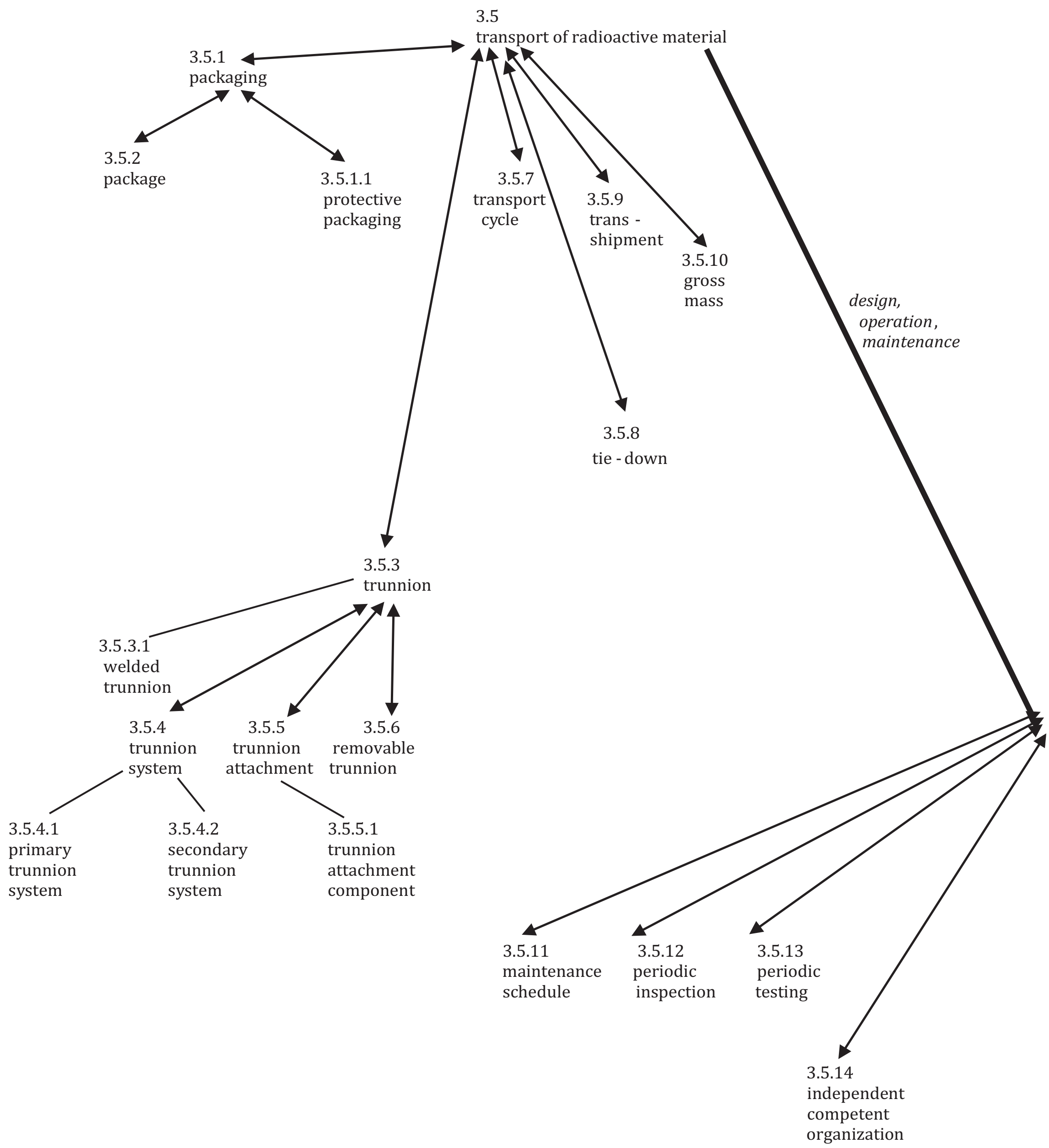


Figure A.8 — 3.5 Terms related to transport of radioactive material

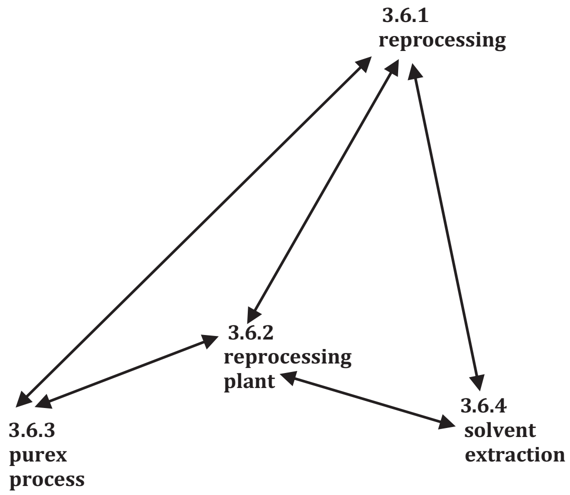


Figure A.9 — 3.6 Terms related to processing

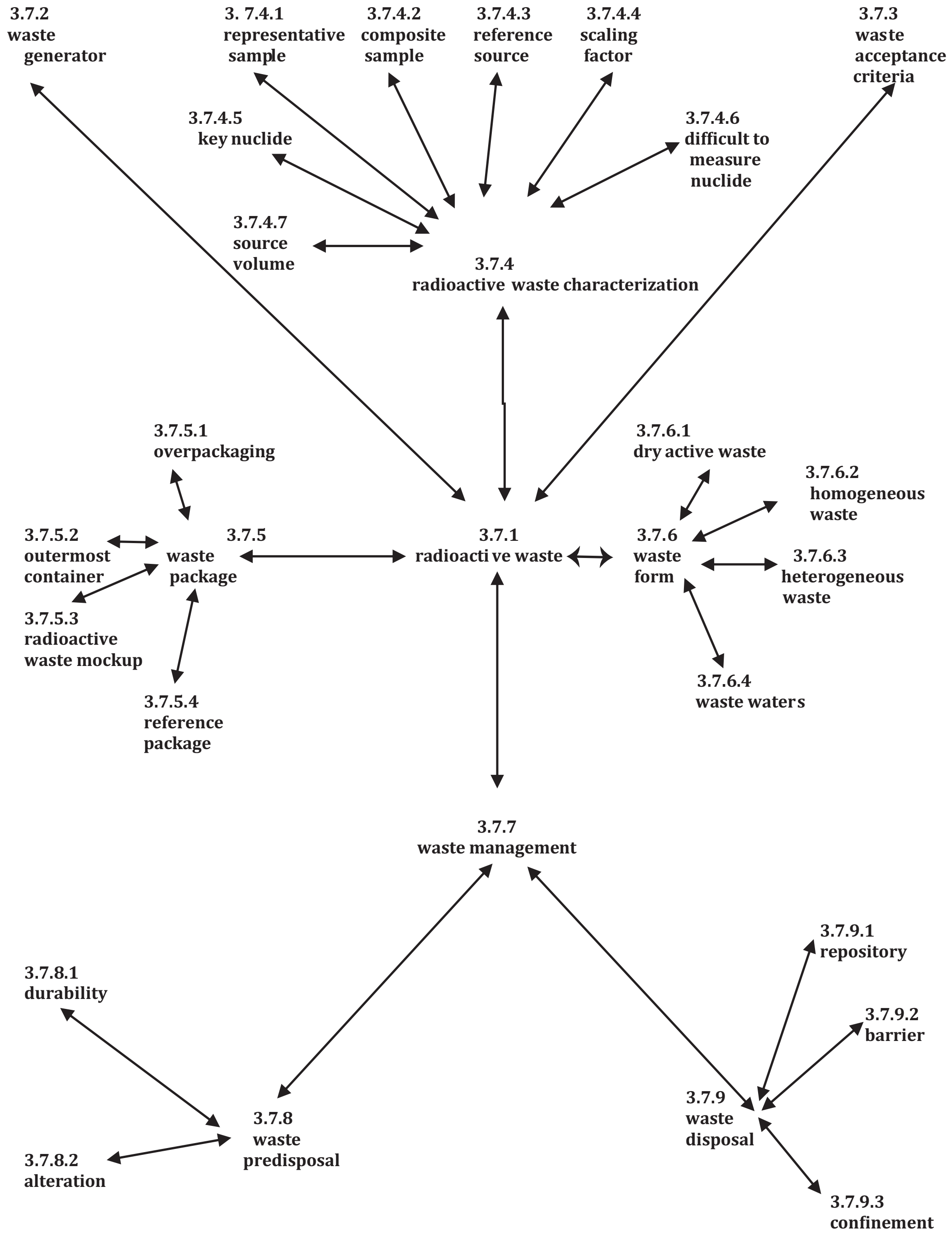


Figure A.10a — 3.7 Terms related to radioactive waste

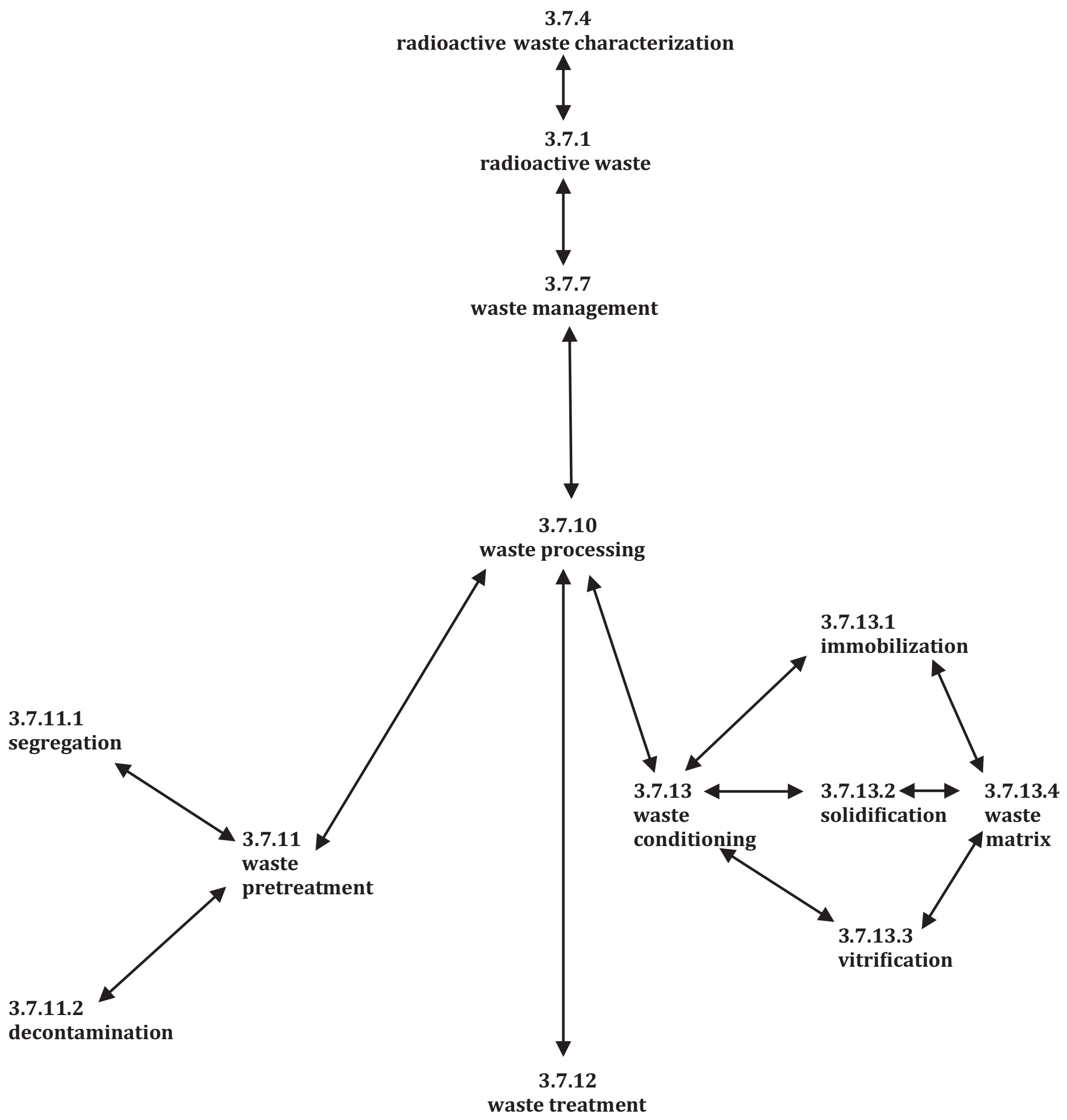


Figure A.10b — 3.7 Terms related to radioactive waste

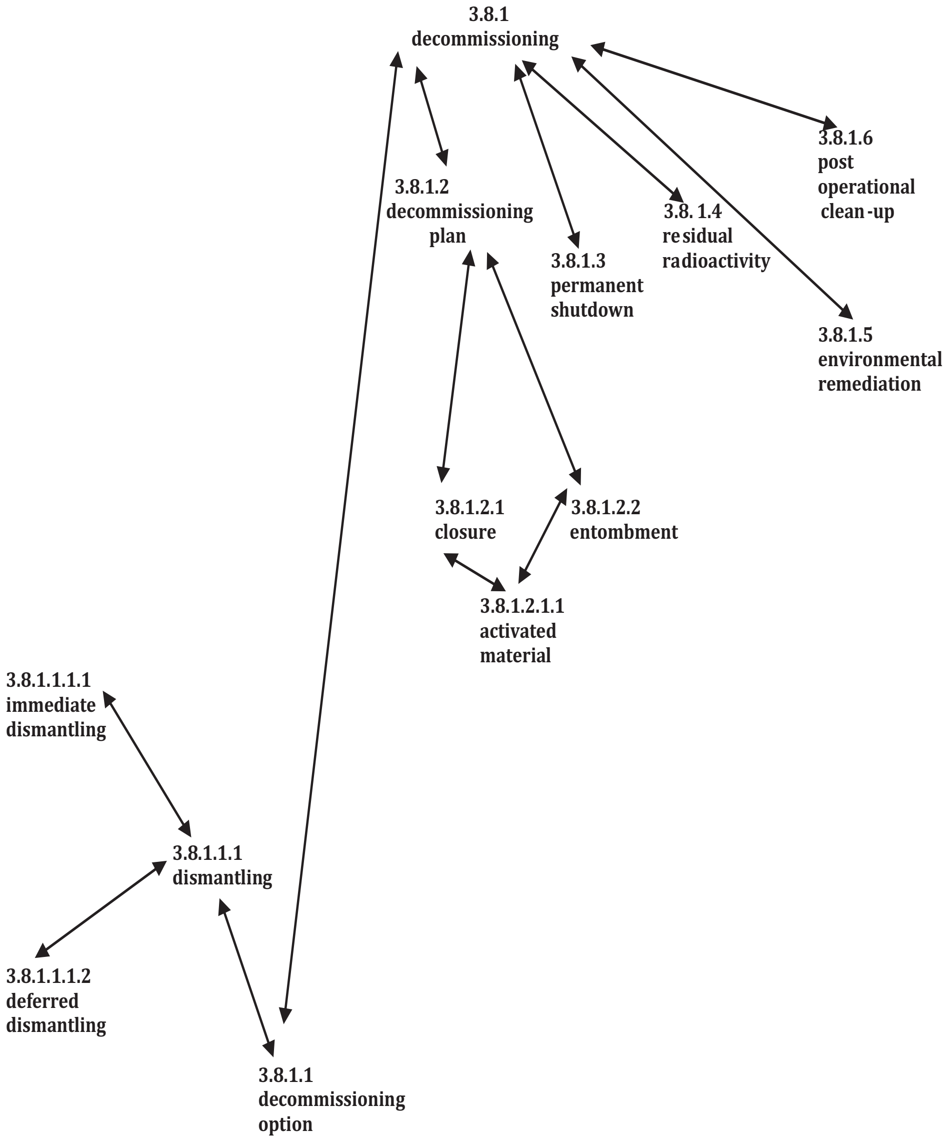


Figure A.11 — 3.8 Terms related to decommissioning

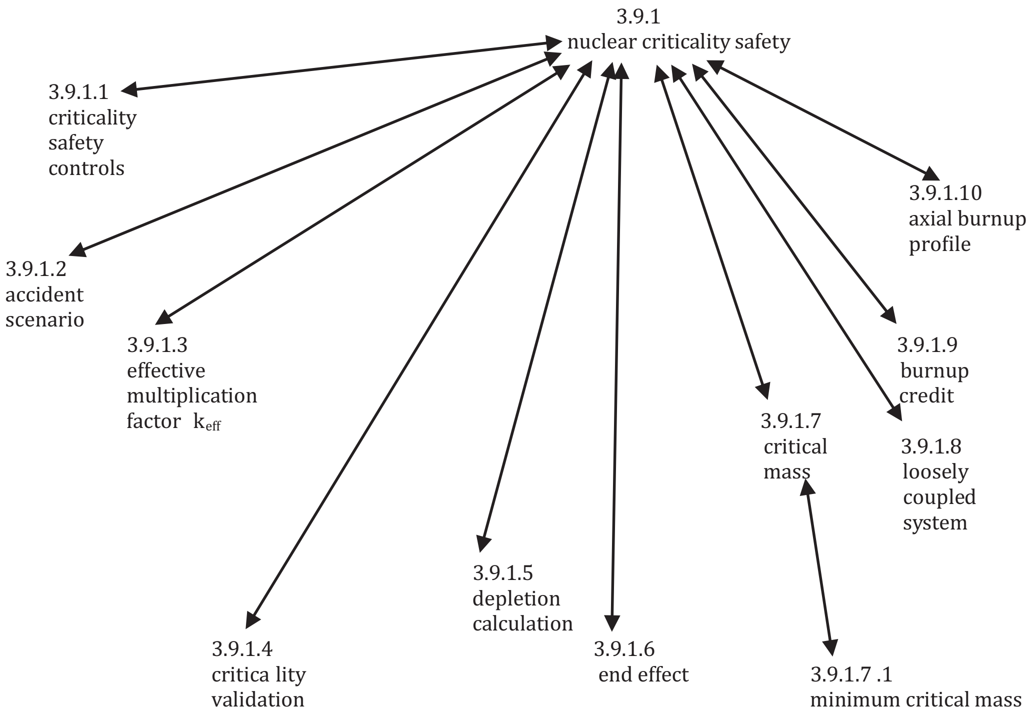


Figure A.12 — 3.9 Terms related to nuclear criticality safety

Annex B
(informative)

Alphabetical index

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BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

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