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

Part 3: Nuclear installations, processes and technologies

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Foreword

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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 document 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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This document was prepared by Technical Committee ISO/TC 85.

This second edition cancels and replaces the first edition (ISO 12749-3:2015), which has been technically revised.

The main changes are as follows:

— addition of new concepts;

— modification of definitions;

— change of sources.

A list of all parts in the ISO 12749 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document will provide terms and definitions for concepts associated with nuclear installations, processes, and technologies. These include specific subjects such as the nuclear fuel cycle; ex-reactor nuclear criticality safety, analytical methodologies, transport of radioactive materials, characterization of materials, radioactive waste management, and decommissioning of nuclear installations. Excluded topics are specific enabling technologies and techniques for non-peaceful applications, sealed sources, radiation processing, nuclear power plants and research reactors (with regard to nuclear criticality safety while fuel is loaded in the reactor core). Terminological data are taken from ISO standards developed by ISO/TC 85/SC 5 and other technically validated documents issued by the International Atomic Energy Agency (IAEA) or other international organizations.

Unambiguous communication of concepts associated with nuclear installations, processes, and technologies is crucial to prevent misunderstandings or misinterpretations of terms used in documents developed by ISO/TC 85/SC 5. In line with the international demand for harmonization of terminology regarding nuclear and radiological activities, this document will contribute by providing terms and definitions to meet the requirements of users and industry. It will also improve promotion, knowledge and use of international standards dealing with nuclear installations, processes and technologies and will help experts developing technical standards to avoid overlapping and contradiction.

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. Difficulties can also arise due to the wide variety of units of measure employed. Thus, to enhance comprehension as well as comparability, it is advisable to adopt unified units of measure.

Arrangement of terms and definitions is based on concepts systems that show corresponding relationships among the various concepts. Such arrangement provides users with a structured view of the nuclear installations, processes, and technologies sector and will facilitate common understanding of all related concepts. In addition, 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 installations, processes and technologies

1 Scope

This document deals with the terminological data used in the standards regarding the standardization and promotion of good practices associated with the planning, design, construction, operation and decommissioning of installations, processes and technologies involving radioactive materials.

The vocabulary of nuclear installations, processes and technologies includes fuel cycle, ex-reactor nuclear criticality safety, analytical methodologies, transport of radioactive materials, materials characterization, radioactive waste management and decommissioning.

NOTE See Annex A for the methodology used to develop the vocabulary.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 Terms related to nuclear materials

3.1.1
nuclear material
material containing one or more of the following: plutonium except that with isotopic concentration exceeding 80 % in ^{238}Pu; uranium enriched in the isotope 235 or 233; uranium containing the mixture of isotopes as occurring in nature other than in the form of ore or ore residue

[SOURCE: IAEA. IAEA Nuclear Safety and Security Glossary. Terminology Used in Nuclear Safety, Nuclear Security, Radiation Protection and Emergency Preparedness and Response. Vienna: IAEA, 2022. 246 p. ISBN: 978-92-0-141822-7 By deleting the phrase “uranium enriched in the isotope 235 or 233”]

3.1.2
critical
having an effective neutron multiplication factor equal to unity

[SOURCE: ISO 1709:2018, 3.1]

3.1.3
nuclear criticality
state of a nuclear chain reacting medium when the *nuclear chain reaction* (3.1.9) is just self-sustaining (or *critical* (3.1.2)), i.e. when the reactivity is zero

[SOURCE: IAEA. IAEA Nuclear Safety and Security Glossary. Terminology Used in Nuclear Safety, Nuclear Security, Radiation Protection and Emergency Preparedness and Response. Vienna: IAEA, 2022. 246 p. ISBN: 978-92-0-141822-7]

3.1.4
radionuclide
nuclide which is in an unstable state due to excess of internal energy and which will attain a stable state by emitting radiation

Note 1 to entry: *Radionuclides* (3.1.4) are either naturally occurring, such as ^{40}K, ^{235}U, ^{238}U, ^{232}Th and their radioactive decay products, or produced by activation or other artificial means.

[SOURCE: ISO 12749-1:2020, 3.1.8]

3.1.5
radioactivity
stochastic process whereby nuclei undergo spontaneous disintegration, usually accompanied by the emission of subatomic particles, or photons

[SOURCE: ISO 12749-1:2020, 3.1.1]

3.1.6
nuclear installation
any nuclear facility subject to authorization that is part of the *nuclear fuel cycle* (3.3.1), except facilities for the mining or processing of uranium ores or thorium ores and disposal facilities for *radioactive waste* (3.6.1)

[SOURCE: IAEA. IAEA Nuclear Safety and Security Glossary. Terminology Used in Nuclear Safety, Nuclear Security, Radiation Protection and Emergency Preparedness and Response. Vienna: IAEA, 2022. 246 p. ISBN: 978-92-0-141822-7]

3.1.7
fissionable nuclide
<neutrons> nuclide capable of undergoing fission by interaction with neutrons of some energy

[SOURCE: LA-11627-MS, Glossary of Nuclear Criticality Terms. Los Alamos National Laboratory, 1989]

Note 1 to entry: Fissionable nuclides include ^{238}U, ^{240}Pu, and others with neutron-energy fission thresholds, in addition to those nuclides that are fissile.

3.1.8
fissile nuclide
nuclide capable of undergoing fission by interaction with neutrons of any energy

[SOURCE: ISO 1709:2018, 3.4]

Note 1 to entry: The term is usually applied to fission predominantly with slow neutrons. The interpretation of "slow" may vary but the properties of fissile nuclides are clearly distinct from other *fissionable nuclides* (3.1.7).

Note 2 to entry: Particular examples are 233U, 235U, 239Pu and 241Pu.

3.1.9
nuclear chain reaction
series of nuclear reactions in which one of the agents necessary to the series is itself produced by the same reactions

[SOURCE: ISO 1709:2018, 3.8]

3.1.10
fission product
radionuclide (3.1.4) produced by nuclear fission

[SOURCE: IAEA. IAEA Nuclear Safety and Security Glossary. Terminology Used in Nuclear Safety, Nuclear Security, Radiation Protection and Emergency Preparedness and Response. Vienna: IAEA, 2022. 246 p. ISBN: 978-92-0-141822-7]

3.1.11
burnup
loss of fissile material by the fission process that is usually described in terms of the number of fissioned atoms or on the total energy liberated in unit volume or mass

Note 1 to entry: Burnup *fission product* (3.1.10) as energy released by fissions is commonly used for NPP

Note 2 to entry: Burnup as number of fissions per unit volume or mass is commonly used for fuel behaviour modelling and neutronic calculations

Note 3 to entry: Burnup as number of fissions is commonly used for experimental reactors

3.1.12
subcriticality
having or involving a chain reaction that is not self-sustaining

3.1.13
subcriticality limit
limit value of *subcriticality dimension* (3.1.14) which is respected in order to ensure *subcriticality* (3.1.12) of a unit

[SOURCE: ISO 21391:2019, 3.8]

3.1.14
subcriticality dimension
controlled geometrical dimension (item dimension or layout dimension) controlled for which a limit shall be respected to ensure *subcriticality* (3.1.12) of a unit

3.1.15
neutron leakage
neutrons leaving a fissile system boundary such that they no longer interact with that system

Note 1 to entry: For an array of fissile units, neutron leakage from one unit may or may not interact with other units.

[SOURCE: ISO 1709:2018, 3.7]

3.1.16
neutron absorber
material with which neutrons interact significantly by reactions resulting in their disappearance as free particles

[SOURCE: ISO 1709:2018, 3.6]

3.1.17
over batching
unintended increase in the quantity of a material that is controlled for *nuclear criticality safety* (3.4.1) such that one or more extra discrete quantities are present

[SOURCE: ISO 1709:2018, 3.13]

3.1.18
permeation
passage of a fluid through a solid permeable barrier (even if there are no *leaks* (3.5.17)) by adsorption-diffusion-desorption mechanisms

Note 1 to entry: Permeation should not be considered as a release of activity unless the fluid itself is radioactive. In this document, permeation is applied only to gases.

[SOURCE: ISO 12807:2018, 3.14]

3.1.19
permeation rate
quantity of gases passing through permeable walls per unit time

[SOURCE: ISO 12807:2018, 3.15]

3.1.20
attenuation
physical process based on interaction between a radiation source and matter placed in the path of the radiation that results in a decrease in the intensity of the emitted radiation

Note 1 to entry: Attenuation experienced in non-destructive analysis (NDA) of *waste packages* (3.6.12) includes self-attenuation by the radioactive material itself as well as attenuation effects in the *waste matrix* (3.6.14), internal barrier(s) and external container(s).

[SOURCE: ISO 19017:2015, 2.2]

3.1.21
attenuation correction factor
used to correct (compensate) for the effect of *attenuation* (3.1.20) within an NDA measurement equal to the ratio between the un-attenuated and the attenuated radiation flux

Note 1 to entry: After attenuation correction the measured quantity is considered to be representative of the unattenuated activity of the radioactive substance assayed.

[SOURCE: ISO 19017:2015, 2.3]

Note 2 to entry: A subcritical dimension is a different term, usually referring to a fissile material dimension that relies on single-parameter control to avoid making a unit critical. Examples are *subcritical cylinder* (3.5.6) diameter, subcritical slab thickness and subcritical volume.

Note 3 to entry: The *subcriticality* (3.1.12) of a unit may be ensured by other types of controls in addition to dimensional controls (e.g. mass control, density control).

[SOURCE: ISO 21391:2019, 3.7, modified — Delete the second instance of the word “controlled” in the definition.]

3.2 Terms related to nuclear fuels

3.2.1
nuclear fuel
fissionable *nuclear material* (3.1.1) in the form of fabricated elements for loading into the reactor core of a civil nuclear power plant or research reactor

[SOURCE: ISO 12749-1:2020, 3.2.5]

3.2.2
cladding
external layer of material that houses *nuclear fuel* (3.2.1) and provides the containment (means of confinement) of *radionuclides* (3.1.4) produced during fission

Note 1 to entry: Material also provides structural support and protection from chemically reactive conditions (e.g., corrosion).

[SOURCE: IAEA. IAEA Nuclear Safety and Security Glossary. Terminology Used in Nuclear Safety, Nuclear Security, Radiation Protection and Emergency Preparedness and Response. Vienna: IAEA, 2022. 246 p. ISBN: 978-92-0-141822-7, modified — Change "tube of pellets" with "external layer of" and delete "tube of" and "material" and add Note 1 to entry.]

3.2.3
nuclear fuel pellet
nuclear fuel (3.2.1) in ceramic form and with a cylindrical shape

3.2.4
fuel element
nuclear fuel (3.2.1), its *cladding* (3.2.2) and any associated components necessary to form a structural entity

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

[SOURCE: IAEA. IAEA Nuclear Safety and Security Glossary. Terminology Used in Nuclear Safety, Nuclear Security, Radiation protection and EMERGENCY Preparedness and Response. Vienna: IAEA, 2022. 246 p. ISBN: 978-92-0-141822-7 modified — Delete the term "rod".]

Note 2 to entry: In some countries "fuel element" is used as a synonym for *"fuel assembly"* (3.2.5)

3.2.5
fuel assembly
set of *fuel elements* (3.2.4) and associated components which are loaded into and subsequently removed from a reactor core as a single unit

[SOURCE: IAEA. IAEA Nuclear Safety and Security Glossary. Terminology Used in Nuclear Safety, Nuclear Security, Radiation Protection and Emergency Preparedness and Response. Vienna: IAEA, 2022. 246 p. ISBN: 978-92-0-141822-7.]

Note 1 to entry: In light water reactors "fuel elements" in the definition should be replaced with "fuel rods".

Note 2 to entry: In some countries "fuel element" is used as a synonym for "fuel assembly".

Note 3 to entry: In some countries "fuel bundle" is used as a synonym for "fuel assembly".

3.2.6
sinter
increase the bonding in a mass of powder or a compact by heating below the melting point of the main constituent

[SOURCE: ASTM B243-22]

3.2.7
specific surface
surface area of one gram of powder, usually expressed in square centimetres

[SOURCE: ASTM B243–22]

3.2.8
theoretical density
density of a material calculated from the number of atoms per unit cell and from the measurement of the lattice parameters

3.2.9
apparent density
loose bulk density
dry mass per unit volume of a powder obtained by free pouring under specified conditions

[SOURCE: ISO 9161:2019, 3.1]