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

Part 5: Nuclear reactors

Énergie nucléaire, technologies nucléaires, et radioprotection — Vocabulaire —
Partie 5: Réacteurs nucléaires

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Contents

Page

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by ISO/TC 85, *Nuclear energy, nuclear technologies, and radiological protection*.

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

Introduction

This document provides terms and definitions for main concepts in the whole area of nuclear reactor science, technology, engineering, projects and operations, excluding quantitative data. Terminological data are taken from ISO standards developed by TC 85/SC 6, from other technically validated documents issued by international organizations, especially IAEA and IEC, while a number of definitions have been drafted by WG 1 experts on the basis of their experience and after detailed discussions on concept characteristics, the best wording for their designations and definitions, as well as the most important links between concepts.

In most cases, international consensus exists among the communities of nuclear reactor specialists world-wide, on the most relevant concepts in the nuclear reactor area. Nevertheless, clear and unambiguous terms for these concepts are also needed.

The foregoing needs also to be considered together with the fact that a large number of people are involved in the broad nuclear reactor area, having different scopes and levels of scientific and technical knowledge and frequently having very specific activities within that broad field. Thus, there can be different understandings and assumptions about concepts. Hence, the result could be a poor communication that might lead into unexpected, different risky situations or consequences, if a conceptual difference is behind.

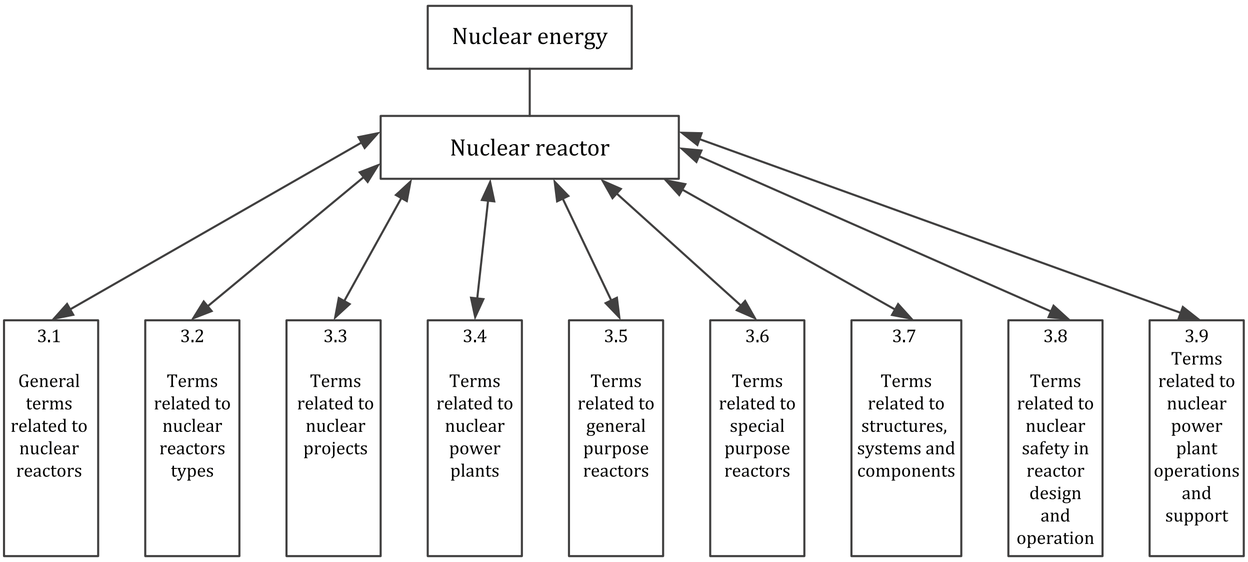
Conceptual arrangement of terms and definitions is based on concepts systems that show corresponding relationships among nuclear reactors concepts. Such arrangement provides users with a structured view of the nuclear energy sector and will facilitate common understanding of all related concepts. Besides, 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.

Structure of the vocabulary

The terminology entries are presented in the conceptual order of the English preferred terms. Both a systematic index and an alphabetical index are included at the end of the standard. The structure of each entry is in accordance with ISO 10241-1. See also Annex A for the methodology used in the development of the vocabulary.

All the terms included in this document deal exclusively with nuclear reactor technology. 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. According to the title, the vocabulary deals with concepts belonging to the general ***nuclear energy*** field within which concepts in the **nuclear reactors** sub-field are taken into account.

Looking for an easier presentation of the required large number of defined concepts, the content of this document has been split into nine headings as shown below, which makes easier any search of terms or relationships between concepts.


Nuclear energy
Nuclear reactor
3.1 General terms related to nuclear reactors
3.2 Terms related to nuclear reactors types
3.3 Terms related to nuclear projects
3.4 Terms related to nuclear power plants
3.5 Terms related to general purpose reactors
3.6 Terms related to special purpose reactors
3.7 Terms related to structures, systems and components
3.8 Terms related to nuclear safety in reactor design and operation
3.9 Terms related to nuclear power plant operations and support

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

Part 5: Nuclear reactors

1 Scope

This document encompasses the collection of terms, definitions, notes and examples corresponding to nuclear reactors, excluding quantitative data. It provides the minimum essential information for each nuclear reactor concept represented by a single term. Full understanding of concepts requires background knowledge of the nuclear field. It is intended to facilitate communication and promote common understanding.

The scope of this document covers the whole field of nuclear reactors at a broad surface level.

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 terminological databases for use in standardization at the following addresses:

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

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

3.1 General terms related to nuclear reactors

3.1.1
nuclear fission
process by which a nucleus undergoes a partition in two, infrequently in three, main fission fragments, releasing energy

Note 1 to entry: There are two types of nuclear fission: "spontaneous" and "induced" ones.

Note 2 to entry: The nucleus usually has a high mass number A, together with an intermediate or low average-binding-energy-per-nucleon; hence, an inherent instability exists, and the fission fragments are usually highly unstable.

Note 3 to entry: According to their capability for undergoing fission, a nucleus and its associated nuclide can be qualified as fissionable or eventually fissile.

3.1.1.1
induced nuclear fission
nuclear fission (3.1.1) initiated by a nucleus when an external colliding particle is absorbed

Note 1 to entry: The absorption of the external colliding particle, usually a neutron, generates a strong increase in the compound nucleus internal energy and, hence, increases the compound nucleus instability, favouring a large energy release by means of a nucleus partition.

3.1.1.2
spontaneous nuclear fission
nuclear fission (3.1.1) produced in a nucleus, having an inherent instability, that develops itself in a purely stochastic way and without intervention of any external colliding particle

3.1.2
fissionable nuclide
nuclide capable of undergoing fission by interaction with a neutron of some energy

Note 1 to entry: The definition may be restricted to significant capability, e.g. to a nuclide that is capable of supporting a self-sustaining *nuclear chain reaction* (3.1.9).

3.1.3
prompt fission neutron
neutron released out from a fission fragment in a stochastic way, with high kinetic-energy just following initiation of a *nuclear fission* (3.1.1) process

Note 1 to entry: The number of prompt neutrons released per fission, is stochastic as indicated, with an average value in the range 2,5 to 3 for most of concerned nuclides.

Note 2 to entry: Prompt fission neutron kinetic-energies form a continuum, between 0 and around 10 MeV, for a population of prompt fission neutrons released, with an average value usually close to 2 MeV.

3.1.4
prompt fission radiation
gamma and/or beta radiations released in a stochastic way, out from each decaying fission fragment just following initiation of a *nuclear fission* (3.1.1)

Note 1 to entry: These gamma and beta radiations are released in cascades, reflecting the high internal energy level of most of fission fragments just after fission initiation.

3.1.5
fission product
nuclide produced from *nuclear fission* (3.1.1) or from subsequent radioactive decay of such a nuclide

[SOURCE: ISO 12749-3:2015, 3.1.5]

3.1.5.1
fast neutron
neutron with kinetic energy greater than its surroundings when released during fission

3.1.5.1.1
delayed fission neutron
neutron emitted in few particular *fission product* (3.1.5) decays, typically with half-lives roughly in the range 0,1 s to 1 min, following initiation of a *nuclear fission* (3.1.1)

Note 1 to entry: Such decay occurs between two energy levels of a fission product-namely precursor-favouring a neutron release, hence, the emitted neutron will have a quite defined kinetic-energy at its release, typically below 1 MeV.

Note 2 to entry: In a fission neutron population, since delayed neutrons have kinetic evolutions dictated by those rather long periods, as compared to the extremely fast evolutions of prompt neutrons, the first ones provide an important contribution to the kinetic control of that neutron population.

3.1.5.1.1.1
thermal neutron
neutron that has, by collision with other particles, reached an energy state equal to that of its surroundings

Note 1 to entry: on the order of 0,025 eV (electron volts).

[SOURCE: United States Nuclear Regulatory Commission Glossary (Retrieved: 8 August 2017) https://www.nrc.gov/reading-rm/basic-ref/glossary.html], modified.

3.1.5.2
delayed fission radiation
gamma and/or beta, in certain cases also alpha radiations released in a stochastic way, from a radioactive *fission product* (3.1.5)

Note 1 to entry: Every possible fission product decay has extremely diverse half-lives, covering the range around 0.1 s up to more than a billion years.

Note 2 to entry: These "delayed" released gamma, beta and alpha radiations, after interactions with neighbouring atoms, are mainly absorbed by the surrounding materials and then finally converted into heat: they are the source of what is designated as decay-power or decay-heat or residual-heat.

3.1.6
fissile nuclide
nuclide capable of undergoing fission by interaction with neutrons

[SOURCE: ISO 12749-3:2015, 3.1.2]

3.1.7
fertile nuclide
nuclide that after absorbing a neutron becomes a *fissile nuclide* (3.1.6)

Note 1 to entry: In practice, the main fertile nuclides are: ^{238}U (producing the fissile ^{239}Pu), ^{240}Pu (producing the fissile ^{241}Pu) and ^{232}Th (producing the fissile ^{233}U), in all cases after the absorption of one neutron and the fast emission of some gamma photons.

3.1.8
fission energy
energy released in the fission process, which is primarily in the form of the kinetic energy of the fission fragments

3.1.9
nuclear chain reaction
<nuclear reactors> successive generations of *induced nuclear fissions* (3.1.1.1) by neutrons, these mainly released, in turn, in previous fissions in *fissionable nuclides* (3.1.2)

Note 1 to entry: The free neutron population in a system is multiplied by fissions releasing several neutrons per fission, compensating partially or totally, or exceeding the total neutron losses by capture and leakage from the system.

Note 2 to entry: A nuclear chain reaction can be initiated by a pre-existent small neutron population (like that resulting from photo-neutrons in particular materials for this purpose), or by neutrons released by spontaneous fissions, or by a specific "neutron source" emitting neutrons.

3.1.9.1
controlled nuclear chain reaction
chain reaction for which there are adequate and reliable physical means or systems to safely govern the value of the *effective neutron multiplication factor* (3.1.11) at any time, and under all possible circumstances

Note 1 to entry: The just mentioned physical means and/or systems form the available *reactivity* (3.1.12) control elements, which are usually parts of the *reactor regulation system* (3.7.2.1.2). Other systems and elements can assist this one for safety aspects.

Note 2 to entry: A *nuclear chain reaction* (3.1.9) is controlled by taking advantage of the delayed fraction of fission neutrons. This fraction depends on the properties of the *fissionable nuclides* (3.1.2) in the system. An uncontrolled chain reaction may be non-destructive due to negative contributions from the initial energy increase. The delayed neutrons allow more time for such negative feedback.

3.1.10
neutron multiplicative configuration
geometrical disposition of materials, one or more containing *fissionable nuclides* (3.1.2), the whole configuration being capable of maintaining a multiplicative chain reaction of neutron-*induced nuclear fissions* (3.1.1.1)

3.1.11
effective neutron multiplication factor
k_{eff}
<nuclear reactors> ratio between current to previous generation of neutron population in multiplicative medium

Note 1 to entry: The total number of produced neutrons per unit time includes all prompt and delayed neutrons released in fissions; while, the total number of lost neutrons are the sum of all absorbed neutrons (in fission and capture reactions), plus all leaking neutrons escaping.

Note 2 to entry: There are three possible circumstances:

a) $k_{eff} > 1$: fission power increases in time;

b) $k_{eff} = 1$: fission power remains constant in time;

c) $k_{eff} < 1$: fission power decreases in time.

When $k_{eff} > 1$, system is called supercritical; when $k_{eff} = 1$, system is called critical; and finally when $k_{eff} < 1$, then system is called subcritical.

3.1.12
reactivity
ρ
measure of the deviation from criticality of a nuclear chain reacting medium:

$$\rho = 1 - 1/k_{eff}$$

where k_{eff} is the ratio between the number of fissions in two succeeding generations (later to earlier) of the chain reaction

Note 1 to entry: A measure of the reactivity is typically defined such that a positive value corresponds to a supercritical state and a negative value corresponds to a subcritical state.

[SOURCE: INTERNATIONAL ATOMIC ENERGY AGENCY. “IAEA Safety Glossary: Terminology used in nuclear safety and radiation protection. 2016 Edition”. IAEA, Vienna, 2016. (Retrieved: 11 August 2016). p. 219, http://www-ns.iaea.org/downloads/standards/glossary/iaea-safety-glossary-rev2016.pdf[11], modified — Addition at the beginning of the definition of the wording stated in one comment.]

3.1.13
poison
substance used to reduce *reactivity* (3.1.12), typically in a *reactor core* (3.1.23.1), by virtue of its high neutron absorption cross-section

[SOURCE: INTERNATIONAL ATOMIC ENERGY AGENCY. “IAEA Safety Glossary: Terminology used in nuclear safety and radiation protection. 2016 Edition”. IAEA, Vienna, 2016. (Retrieved: 11 August 2016). p. 219, http://www-ns.iaea.org/downloads/standards/glossary/iaea-safety-glossary-rev2016.pdf]

3.1.14
nuclear reactor kinetics
time evolution of the neutron population in a *reactor core* (3.1.23.1)

3.1.15
nuclear criticality
state of a nuclear chain reacting system when the chain reaction is just self-sustaining

[SOURCE: ISO 12749-3:2015, 3.1.1.4]

3.1.16
nuclear chain reaction extinction
action that terminates a *nuclear chain reaction* (3.1.9)

Note 1 to entry: Termination is caused by an operator-decided and manually executed action, or by automatic signal trips, normally provoking in both cases a significant insertion of neutron absorbers inside the *reactor core* (3.1.23.1).

3.1.17
nuclear reactor installation
set of a *nuclear reactor* (3.1.22), its authorities, *operation* (3.9.1)-*maintenance* (3.9.12), administrative-support staff, associated and dedicated plants, buildings, systems and all surrounding infra-structure and services, up to the installation perimeter fences

Note 1 to entry: Frequently, the concept is oriented to provide some specific products, like electric energy, radioactive isotopes, irradiation services, infra-structure for research and development.

Note 2 to entry: Usually, reactor systems, dedicated plants and associated infra-structure are very specially designed according to the reactor purposes.

Note 3 to entry: The most important buildings in a nuclear reactor installation are: the *containment* (3.7.5) building, that houses the *nuclear reactor* (3.1.22) and the *primary coolant* (3.1.23.4) system equipment, the turbine building (only present in *nuclear power plants* (3.2.5) or nuclear reactors coupled to a turbine-generator) that houses the *turbine generator* (3.4.4), the auxiliary building that houses support equipment and sometimes emergency equipment, the diesel generator building, that houses the diesel generator and the fuel building, where the spent fuel is stored.

3.1.18
radiation protection organization
installation staff sector that has radiation protection functions and duties both regarding site personnel, visitors and the public

Note 1 to entry: The radiation protection organization performs its duties with the aid of a number of check-stations, a large and well distributed gamma or other radiation detector network for radiation surveillance, appropriate radiation protection laboratory, personal dose management system, and implements the process of optimization of protection for plant personnel.

3.1.19
controlled area
defined area in which specific protection measures and safety provisions are or could be required for controlling exposures or preventing the spread of contamination in normal working conditions, and preventing or limiting the extent of potential exposures

[SOURCE: INTERNATIONAL ATOMIC ENERGY AGENCY. "IAEA Safety Glossary: Terminology used in nuclear safety and radiation protection. 2016 Edition". IAEA, Vienna, 2016. (Retrieved: 28 November, 2016). p. 219, http://www-ns.iaea.org/downloads/standards/glossary/iaea-safety-glossary-rev2016.pdf]

3.1.20
radiation shield
material interposed between a source of radiation and persons, or equipment or other objects, in order to attenuate the radiation

Note 1 to entry: The radiation shield is designed either as fixed or movable installation *structures* (3.7.1) or elements, and placed between large plant radioactive inventories and the authorized personnel working in a *controlled area* (3.1.19), or the off-site public and the environment, or some sensitive equipment.

3.1.21
radiation monitoring
<nuclear reactors> measurement and surveillance of the main radiation types, neutrons, gamma and beta, and their amounts

Note 1 to entry: The main radiation types are neutrons, gamma and beta rays; sometimes also their energy distribution is monitored.

Note 2 to entry: The radiation monitoring is performed around and near the *nuclear reactor* (3.1.22) (especially neutrons), as well as in all *controlled areas* (3.1.19) and other locations inside and even beyond plant borders (by means of an extended detector network).

3.1.22
nuclear reactor
special device having an inventory of nuclear fuel material containing *fissionable nuclides* (3.1.2) and often neutron moderating, neutron absorbing and cooling materials, all of them geometrically arranged in a particular *neutron multiplicative configuration* (3.1.10) designed and built for having the capability of initiating, maintaining and extinguishing a controlled, self-sustaining *nuclear fission* (3.1.1) chain reaction, under adequate safety conditions

3.1.23
nuclear island
part of the *nuclear power plant* (3.2.5) that consists of the *containment* (3.7.5), auxiliary and fuel building

[SOURCE: IAEA NUCLEAR ENERGY SERIES, No. NP-T-2.5. Construction technology for nuclear power plants – Vienna: International Atomic Energy Agency, 2011]

3.1.23.1
reactor core
part of a *nuclear reactor* (3.1.22), where the *fissionable nuclides* (3.1.2) sustaining the fission chain are located

Note 1 to entry: In most cases, *moderator* (3.1.23.1.2) and coolant are also included in the *reactor core* (3.1.23.1).

3.1.23.1.1
core reflector
material placed around the *reactor core* (3.1.23.1), totally or partially enveloping it, in order to scatter most of leaking neutrons back into the core, improving neutron economy

Note 1 to entry: Since most of *nuclear reactors* (3.1.22), have a preferred vertical cylinder geometry, they have 3 different reflectors: upper axial, lower axial and radial.

Note 2 to entry: The most used materials as reflectors in front of:

a) slow-or *thermal-neutrons* (3.1.5.1.1.1), are: H_2O (light or ordinary water), D_2O (heavy water), Be (beryllium), C (carbon, graphite);

b) *fast-neutrons* (3.1.5.1), are: SS (stainless steel).

3.1.23.1.2
moderator
material capable of slowing down *fast neutrons* (3.1.5.1) and, in this process, absorbing a relatively low amount of neutrons

EXAMPLE The most preferred moderators have been up to now:

— ^{1}H (A = 1, or ordinary H);

— ^{2}H (A = 2, or deuterium);

— ^{12}C (A = 12, or graphite).

The two first are respectively employed as:

a) “ordinary or light water”, using the symbols “LW or H_2O”;

b) “heavy water”, using the symbols “HW or D_2O”.

3.1.23.2
reactor internals
any of the different structural parts inside the *nuclear reactor* (3.1.22), covering various functions, either as part of the nuclear reactor itself or as part of reactor-associated systems

Note 1 to entry: Some of these functions are:

a) to support and provide adequate alignment to fuel assemblies (FAs), the *reactor core* (3.1.23.1) as a whole and one or more *core reflectors* (3.1.23.1.1);

b) to direct inlet and outlet *primary coolant* (3.1.23.4) flow and its distribution among all reactor heat sources, similar *structures* (3.7.1) for other fluids inside the reactor (like liquid *moderator* (3.1.23.1.2) and/or reflectors);

c) to provide in-core locations and protection for *in-core instrumentation* (3.7.6.1.1) and for elements and *components* (3.7.3) related to *reactivity* (3.1.12)/power control and *safety systems* (3.7.2.7) for *fast reactor* (3.2.3.1) extinction.

3.1.23.3
reactor vessel
enveloping *structure* (3.7.1) for harboring all elements of a *nuclear reactor* (3.1.22)

Note 1 to entry: Main elements usually allocated inside the reactor vessel, are as follows:

a) the *reactor core* (3.1.23.1) and its reflectors;

b) all *structures* (3.7.1) and tubes of *reactor internals* (3.1.23.2).

Note 2 to entry: The reactor vessel additionally serves as confining structure for the *primary coolant* (3.1.23.4). Moreover, in most cases this vessel is also part of a high-pressure boundary for the primary coolant, mainly encompassing the *reactor core* (3.1.23.1) and the *primary heat transport system* (3.7.2.5); in these cases, it is called “reactor pressure vessel or RPV”.

3.1.23.4
primary coolant
fluid circulating through the *reactor core* (3.1.23.1), in order to cool all fuel assemblies, receiving all their fission power

Note 1 to entry: The primary coolant normally removes instantaneous fission and decay powers generated in the *reactor core* (3.1.23.1) and is able for removing abnormal excessive heat. It circulates within the *primary heat transport system* (3.7.2.5), and transfers all reactor thermal power to a final heat sink. Such thermal power transfer can be either “direct”, or more usually “indirect”, by means of chained circuits circulating appropriate fluids, between the *nuclear reactor* (3.1.22) and that final heat sink.

Note 2 to entry: The primary or main coolant is always a fluid and then it can be, either: a liquid in single phase, or a boiling two-phase fluid, or a gas. The most widely employed are:

a) liquid-state ordinary or light water (H_2O) at atmospheric or high pressure;

b) liquid-state heavy water (D_2O) at atmospheric or high pressure;

c) boiling H_2O at high pressure;

d) CO_2 or He gases.

Note 3 to entry: The final heat sink usually can be either: the atmosphere, a river, a lake, a sea or an ocean. In a *nuclear power plant* (3.2.5) one of such sinks shares its function with a *turbine-generator* (3.4.4) set, where part of the total thermal power is converted to kinetic power and immediately to electric power.

3.2 Terms related to nuclear reactors types

3.2.1
nuclear reactor
(See 3.1.22)

3.2.1.1
power reactor
nuclear reactor (3.1.22) conceived to produce electrical power

3.2.1.2
multiple-purpose reactor
nuclear reactor (3.1.22) conceived for fulfilling several main purposes together, providing different services, except electric energy supply

EXAMPLE Reactors that produce radioisotopes, provide irradiation boxes and positions, irradiated material studies, neutron beams for research and development work, personnel training, etc.

3.2.1.3
special-purpose reactor
nuclear reactor (3.1.22) conceived with a particular target

EXAMPLE *Prototype reactors* (3.6.1.3), *demonstration reactors* (3.6.1.2), naval propulsion reactors, *desalination reactors* (3.6.1.5), *material testing reactors* (3.5.1.5), hydrogen *production reactors* (3.5.1.3).

3.2.2.1
breeder reactor
nuclear reactor (3.1.22) conceived for producing more *fissile nuclides* (3.1.6) than it uses, being the conversion ratio greater than one

3.2.2.2
converter reactor
nuclear reactor (3.1.22) conceived for producing less *fissile nuclides* (3.1.6) than it uses, being the conversion ratio smaller than one

3.2.2.3
transmutation reactor
nuclear reactor (3.1.22) conceived for the purpose of eliminating partially the radioactive wastes contained in other reactors spent nuclear fuel

3.2.3.1
fast reactor
nuclear reactor (3.1.22) designed and operated mainly using a predominantly *fast neutron* (3.1.5.1) energy spectrum

Note 1 to entry: The main contribution to fission power typically from neutrons with energies above 100 keV.

3.2.3.2
thermal reactor
nuclear reactor (3.1.22) designed and operated mainly using a predominantly *thermal neutron* (3.1.5.1.1.1) energy spectrumNote 1 to entry: The main contribution to fission power typically from neutrons with energies below 1 eV.

3.2.4.1
gas-cooled reactor
GCR
nuclear reactor (3.1.22) that uses gas as *primary coolant* (3.1.23.4)

Note 1 to entry: A gas cooled reactor can be either a thermal gas-cooled reactor or a gas cooled *fast reactor* (3.2.3.1).

Note 2 to entry: The gas is usually helium (He) or carbon dioxide (CO_2).

3.2.4.2
light water reactor
LWR
thermal *nuclear reactor* (3.1.22) cooled and moderated by light water

3.2.4.2.1
boiling water reactor
BWR
nuclear reactor (3.1.22) with water as a coolant and as a *moderator* (3.1.23.1.2), boiling in the core

Note 1 to entry: In a boiling water reactor the generated heat is removed from the core by evaporation.

[SOURCE: Koelzer, Winfried. "Glossary of Nuclear Terms". Karlsruher Institut für Technologie, Karlsruhe, 2013. ISBN 3-923704-32-1. (Retrieved: 26 aug 2016). p. 180, http://www.euronuclear.org/info/encyclopedia/pdf/Nuclear_Glossary-%202013-02-13.pdf and GOST 23082-1978, modified.]

3.2.4.2.2
pressurized water reactor
PWR
power *nuclear reactor* (3.1.22) in which the heat is dissipated from the core using highly pressurized water

[SOURCE: Koelzer, Winfried. "Glossary of Nuclear Terms". Karlsruher Institut für Technologie, Karlsruhe, 2013. ISBN 3-923704-32-1. (Retrieved: 26 aug 2016). 180p. http://www.euronuclear.org/info/encyclopedia/pdf/Nuclear_Glossary-202013-02-13.pdf]

Note 1 to entry: The coolant in form of pressurized water serves also a *moderator* (3.1.23.1.2).

3.2.4.3
heavy water reactor
nuclear reactor (3.1.22) cooled and/or moderated with heavy water (D_2O)

[SOURCE: Koelzer, Winfried. "Glossary of Nuclear Terms". Karlsruher Institut für Technologie, Karlsruhe, 2013. ISBN 3-923704-32-1. (Retrieved: 26 aug 2016). 180p. http://www.euronuclear.org/info/encyclopedia/pdf/Nuclear_Glossary-202013-02-13.pdf]

3.2.4.3.1
pressurized heavy water reactor
PHWR
thermal *nuclear reactor* (3.1.22) cooled and moderated by heavy water (D_2O), having a pressurized D_2O coolant to be kept permanently in the liquid state

3.2.4.4
liquid metal reactor
liquid metal fast reactor
LMFR
fast *nuclear reactor* (3.1.22) using as coolant a liquid metal, like sodium, lead, or some alloy

3.2.4.4.1
sodium fast reactor
fast *nuclear reactor* (3.1.22) cooled by liquid sodium

Note 1 to entry: For the fact that sodium becomes active in the presence of a neutron field, these reactors may possess an intermediate heat transport system.

Note 2 to entry: The reactor is commonly fueled with mixed plutonium-uranium oxides (MOX), with an enrichment in the fissile isotope of the order of 15 %; although ^{232}Th-^{233}U based fuels have also been used.

3.2.4.4.2
lead fast reactor
fast *nuclear reactor* (3.1.22) cooled by liquid lead