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Automation systems and integration — Core vocabulary for industrial data

Systèmes d'automatisation et intégration — Vocabulaire de base pour les données industrielles

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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 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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This document was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 4, *Industrial data*.

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

The terms and definitions in this document are applicable to all ISO/TC 184/SC 4 standards. Depending upon the standard, these terms can be implemented as classes, relationships, properties or other types of model or ontology element. The core terms can be used in the documentation of the links between the different standardized data models, ontologies and software applications that need to work together to produce a digital twin for an industrial activity. The terms in the set can also help with data integrity by making sure we are talking about the same thing.

This document:

— provides a vocabulary that is not only understandable by ISO/TC 184/SC 4 experts, but also by domain engineers and by business decision makers;

NOTE 1 Many of the terms and definitions can already exist in the Oxford English Dictionary or in standards, but the definition of an integration layer requires their selection and so even these terms are included.

— enables the development of reference data that are equally applicable to all ISO/TC 184/SC 4 standards;

NOTE 2 Domain experts will produce detailed taxonomies that specialise generic items identified by terms in the set. The domain experts will not need detailed knowledge of any particular ISO/TC 184/SC 4 standard or of any particular top-level ontology.

— defines an interface to reference data developed outside ISO/TC 184/SC 4, and thereby enables its use by all ISO/TC 184/SC 4 standards.

NOTE 3 This document is intended to be analogous in the industrial domain to the Dublin Core in the document management domain. The original Dublin Core metadata set consisted of only 15 terms. This initial set has since been expanded to 55 terms. This document is of a similar size.

The role of this document in the development of reference data libraries is shown informally in Figure 1.

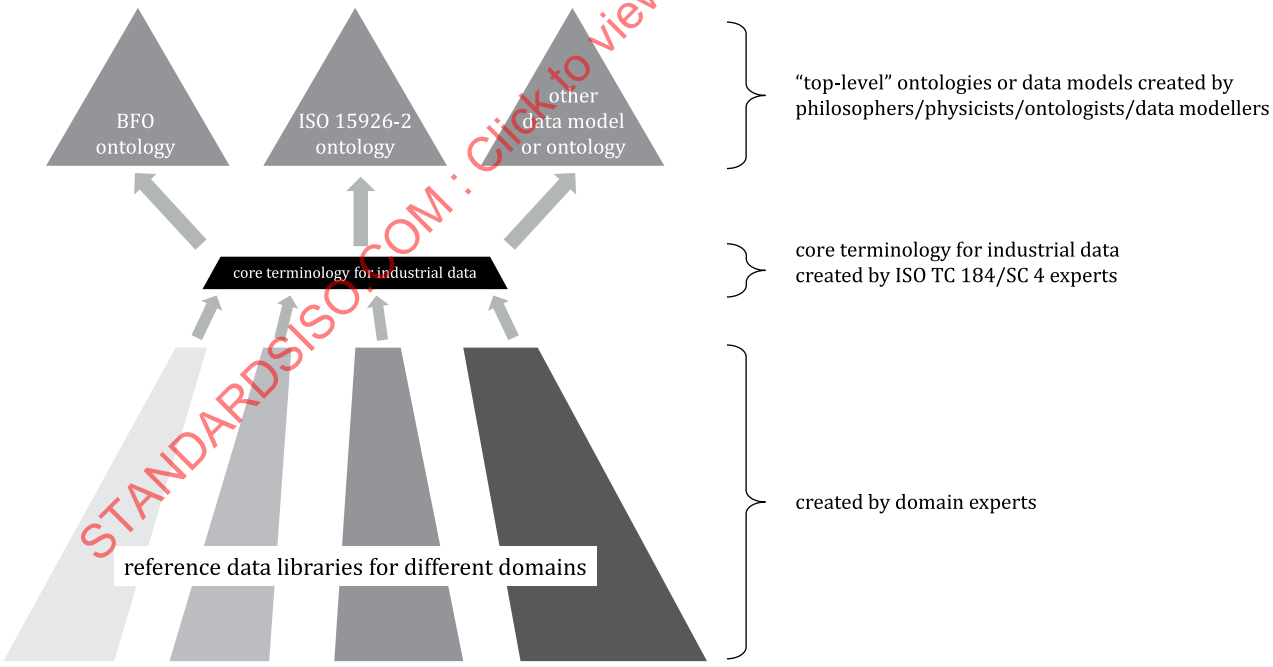

Figure 1 — Role of this document in the development of reference data libraries

A top-level ontology in Figure 1 addresses generic issues such as the representation of whole-part relationships, change over time, and the distinction between actual objects, requirements and plans.

At present ISO 10303 does not contain a top-level ontology. However, the Integrated Resource data models can be regarded as containing an informal top-level ontology. ISO 15926-2 is a top-level ontology.

The reference data libraries for different domains in Figure 1 are shown as independent. In practice there are large overlaps. This document shows which reference data items are specialisations of the same generic item, and therefore make the overlaps easier to manage.

The approach used to develop the content of this document and to define its scope is described in Annex A "Development methodology".

The guidance on groups of terms and their motivation is contained in Annex B "Guidance on groups of terms".

NOTE 1 The methodology followed in the development of this document has been to:

a) define a thing about which industrial data is held using natural language;

b) assign a preferred term consisting of one or more English language words to the thing.

Because the things and their definitions are primary with terms assigned to them, this document can also be called a "thesaurus".

NOTE 2 In this document the preferred terms are unique. In some cases, admitted terms are also given, which are not necessarily unique.

NOTE 3 Where possible the terms are taken from international standards.

NOTE 4 The terms can be used in the text definitions and descriptions of entities and attributes in industrial data models, and of classes and relationships in industrial ontologies. The terms can be used in the text definitions and descriptions of items within industrial data libraries for particular industrial domains.

Automation systems and integration — Core vocabulary for industrial data

1 Scope

This document specifies a vocabulary for industrial data that defines generic terms for things that exist in more than one industrial domain.

The following are within the scope of this document:

— definition of terms for generic types of industrial thing;

EXAMPLE 1 Definitions of the terms “material object”, “artefact” and “product” are within the vocabulary.

— definition of terms relevant to assemblies, systems and their breakdown structures;

— definition of terms relevant to activities and participation in activities;

— definition of terms relevant to positions and roles in organizations;

— definition of terms relevant to behaviour, capability and function;

— definition of terms relevant to state and condition;

— definition of terms relevant to specifications, designs and plans;

— definition of terms relevant to versions, alternatives and configurations for specifications, designs and plans;

— definition of terms relevant to signals and other carriers of information and to devices that process signals and information;

— definition of terms relevant to physical quantities and properties.

The following are outside the scope of this document:

— definition of terms that are relevant to data themselves, rather than the things that data are about;

EXAMPLE 2 Definitions of the terms “data” and “information” are not within the vocabulary.

— definition of terms that are relevant to representations.

EXAMPLE 3 Definitions of the terms “representation” and “model” are not within the vocabulary.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 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

3.2 Terms related to particular and kind

3.2.1
particular
individual
thing existing in space and time

EXAMPLE 1 The pump with serial number "X12345", which was supplied by Fred Bloggs and Co. to UGE Inc. on 2019-09-27, is a *particular* pump.

EXAMPLE 2 The computer file http://www.uge.com/annual-report/2019.docx is a *particular* computer file. It was created at a *particular* time and may be deleted in the future. It exists on a *particular* server somewhere.

Note 1 to entry: The term "individual" is used in ISO/TS 10303-1164:2023, 4.3.1, and ISO 15926-2:2003, 3.1.6.

Note 2 to entry: IEC 81346-1:2022, 3.16 defines the term "product individual" with the same meaning as particular *product* (3.3.3).

Note 3 to entry: The term *particular* is used as a qualifier of another term.

Note 4 to entry: In this document, the term *particular* is not used on its own, except where the qualified term is understood.

Note 5 to entry: "Realized" is a natural term where qualified term is *product* (3.3.3), but less natural where the qualified term is *person* (3.10.2).

Note 6 to entry: The term "individual" is used on its own in OWL to mean an object within the domain. In OWL DL (OWL statements following specified syntactic restrictions that are interpreted using the OWL 2 Direct Semantics) an OWL individual cannot also be an OWL class. In OWL-Full (which need not follow the above semantic restrictions and is interpreted using the OWL 2 RDF-Based Semantics) an OWL individual can also be an OWL class.

Note 7 to entry: The space and time within which a *particular* thing exists can be unknown.

Note 8 to entry: Some ontological approaches describe plans for the future or scenarios in terms of *particular* things that exist in possible worlds. The vocabulary defined here neither prescribes nor precludes such approaches.

Note 9 to entry: ISO 10303 allows a *particular* thing to be either actually existing or planned for the future. A *particular* thing that is actually existing is also called "realized".

Note 10 to entry: In ISO/TS 10303-4000:2023 and in the Application Reference Model of ISO 10303-242:2022, term "product" is replaced by "part" so that the following terms are used: "individual part", "planned individual part" and "realized individual part".

3.2.2
kind
class
type
things that have something in common

EXAMPLE 1 Pump is a *kind* of *material object* (3.3.2). Each *particular* (3.2.1) *material object* of this *kind* is intended to add mechanical energy to a fluid. This is a generic *kind* of *material object*.

EXAMPLE 2 The "Fred Bloggs and Co. model A-101 pump" is a *kind* of *material object*. Each *particular* pump of this *kind* has a rated power of 1 kW. There are many other quantitative properties possessed by each *particular* pump of this *kind*. This is a specific *kind* of *material object*.

Note 1 to entry: The term "class" is used in ISO 15926-2:2003, 3.1.1, and ISO/TS 10303-54:2005, 3.2.1.

Note 2 to entry: The terms "type" and "class" are used in IEC 81346-1:2022, 3.17 and 3.20, with meanings which are both similar to *kind*.

Note 3 to entry: The term *kind* is a qualifier of another term, usually in the form "kind of". In this document, the term *kind* is not used on its own as a noun, except where the qualified term is understood.

Note 4 to entry: Depending on the what all things of a *kind* have in common, a *kind* can be "generic" or "specific". A generic *kind* is one that is defined in sources used throughout industry, such as standards. A specific *kind* is often defined by an *organization* as part of a *specification*.

Note 5 to entry: What things of the same *kind* have in common can be specified.

Note 6 to entry: "Class" and "type" are possible synonyms for *kind*. "Class" is used in ISO 15926-2:2003, 3.1.1 with a meaning that is close to "set" in mathematics. The uses of these terms in ontologies or data modelling languages is not necessarily consistent with the less formal use here.

Note 7 to entry: ISO 10303 mostly uses the term "class". The usage of this term is defined in ISO/TS 10303-1114:2019, 4.3.1 defines the entity Classification_assignment to be "the assignment of a Class to product or activity data for their classification".

Within ISO 10303, a "part" can be a *kind* of thing. ISO/TS 10303-1022:2014, 3.1.2.2 defines a *part* to be "discrete object that can come into existence as a consequence of a manufacturing process".

Within ISO 10303, a "concept" is a *kind* of thing. ISO/TS 10303-1060:2004, 4.1.2 defines the entity Product_concept to be "an identification of a set of similar products that were, are or will be proposed to customers".

Within ISO 10303 the term "type" is used in some circumstances. ISO/TS 10303-1240:2004, 4.2.2 defines the entity Organization_type to be a "recognized kind of organization". ISO/TS 10303-1245:2004, 4.3.1 defines the entity Type_of_person to be a "type of person".

3.3 Terms related to artefact, product and material object

3.3.1
artefact
thing that is a result of human activity

EXAMPLE 1 The noise of vented steam from plant UGE-1 on 2020-03-17 is an *artefact*.

EXAMPLE 2 The footprints of Neil Armstrong on the moon are *artefacts*.

3.3.2
material object
thing that occupies space and possesses rest mass

EXAMPLE 1 A washer is stamped from a sheet of steel. The sheet of steel is a *material object* and a *product* (3.3.3). The stamping process creates two new *material objects* and *products*:

— the washer;

— a disc of waste steel that is removed to make the hole in the washer.

The original sheet of steel continues to exist but now has a hole in it. The washer is a *product* intended for sale or use, whilst the disc of waste steel and the steel sheet with hole in it may be waste *products*.

EXAMPLE 2 The batch of liquid B-101 is stored in tank A. The batch B-101 is a *material object*. The contents of tank A are then divided so that some goes into tank B and some into tank C. The contents of tanks B and C are two different *material objects*. We can say that the contents of tanks B and C came from *batch* B-101 for traceability, but it is an administrative decision whether the *material objects* in tanks B and C are regarded as parts of *material object* B-101 which continues but now as two separate parts, or whether the *material object* B-101 ceased to exist when it was transferred out of tank A and divided.

Note 1 to entry: A *material object* can be a discrete solid quantity of material, or a part of a larger quantity of solid material. A *material object* can be a quantity of fluid material, or a part of a large quantity of fluid material.

Note 2 to entry: The beginning or end of the life or existence of a *material object* can be an arbitrary administrative decision. A *material object* can be deemed to come into existence at a stage of a manufacturing process. A *material object* can be deemed to have ended its life at a stage of a dismantling or recycling process.

Note 3 to entry: The matter that a *material object* consists of can exist before the *material object* begins. This matter is other *material objects*. Similarly, the matter a *material object* consists of can continue to exist after the *material object* ends. This matter is also another *material object*.

3.3.3
product
thing that is intended to be either sold, or delivered, or used as input to another human activity, or transferred to the environment as waste

Note 1 to entry: This definition encompasses the following:

— sales product: This is something produced or extracted for sale. It is not necessarily an *artefact* (3.3.1), because it can be raw material or agricultural produce. It is not necessarily a *material object* (3.3.2), because it can be software.

— intermediate product: This is something that has been produced and that is intended for further processing before end use.

— waste product: This is something that has been produced, but is unwanted by its producer. It can be input to other processes or transferred to the environment.

Note 2 to entry: A *product* is distinguished from a *service* (3.11.2) in this document. The term "product and service" is used for things that are a combination of the two.

Note 3 to entry: A *product* can be raw material extracted from the ground, timber from a forest, or agricultural produce.

Note 4 to entry: A *product* can be intangible, such as software or a product design.

Note 5 to entry: A *product* can be energy, such as a supply of electricity or heat.

3.3.4
material product
product (3.3.3) that is a *material object* (3.3.2)

Note 1 to entry: A *material product* can be an unfinished *product* that is produced by a materials supplier, and that is input to other manufacturing *processes* (3.11.1).

3.4 Terms related to part and component

3.4.1
part
thing that is a part of a whole

EXAMPLE 1 The front offside wheel of the vehicle with registration "DV 58 HUK" is a *part* of the vehicle. It is not arbitrary, but an *assembly element* (3.5.3). It is also a *material object* (3.3.2). The material that is the front offside wheel can change from time to time during the life of the vehicle.

EXAMPLE 2 The compartment "P-13" of the ship Arctic Queen is a *part* of the ship. It is not arbitrary, but a *breakdown element* (3.7.4) of a spatial breakdown of the ship.

Note 1 to entry: Each thing is always a *part* of many other things. Therefore, calling a thing a "part" conveys no information other than that there is a part-whole relationship of interest.

Note 2 to entry: A *part* can be an arbitrary division of the whole. A *part* can also be not arbitrary. A *part* that is not arbitrary can be an *assembly element*, a *system element* (3.5.8), a *network element* (3.5.12), or a *breakdown element*.

Note 3 to entry: If the whole is a material object, then each *part* is also a *material object*. However, a *part* can be different material at different times.

Note 4 to entry: A *part* can be identified solely by the place where it is. A *part* is not necessarily a serial numbered *material product* (3.3.4).

Note 5 to entry: If a *part* is a material object which can be replaced, then the identity of the *part* is derived from its relationship with the whole that it is part of.

Note 6 to entry: A *part* can be a *shape feature* (3.4.2).

Note 7 to entry: A *part* can be empty space. In a process plant, an access route can be an important and identified *part*.

3.4.2
shape feature
part (3.4.1) that is distinguished from a whole by its shape

Note 1 to entry: A *shape feature* is not usually a *component* (3.4.2) for an *assembly* (3.5.2). A *shape feature* is not usually separable from the whole.

Note 2 to entry: A *shape feature* can be formed by the addition or removal of material. A *shape feature* can be a hole.

Note 3 to entry: A *shape feature* can be classified according to its shape. Such classifications include thread, groove, slot, and stud.

Note 4 to entry: A *shape feature* can be classified according to its engineering purpose. Such classifications include lifting lug and drain hole.

Note 5 to entry: The boundary of a *shape feature* can be incompletely defined. Hence the boundary between a lifting lug and the *material object* (3.3.4) to which it is fixed can be vague. It can be somewhere in the region of the weld.

3.4.3
component
product (3.3.3) that was created with the intention that it be part of an *assembly* (3.5.2), *system* (3.5.6) or *network* (3.5.11)

EXAMPLE 1 Nut is a generic *kind* (3.2.2) of *component*.

EXAMPLE 2 Flange nut is a generic *kind* of *component*.

EXAMPLE 3 "Flange nut to specification N-DEF" is a specific *kind* of *component*.

Note 1 to entry: A *component* is usually a *material object* (3.3.2), but can be a non-material thing such as software.

Note 2 to entry: A *component* can be an *assembly*.

Note 3 to entry: A *component* can have different statuses during its life, such as:

— not assembled: available for use in an *assembly*;

— assembled and replaceable: can be removed from its *assembly* and replaced by a *component* with similar form, fit or function;

— assembled and not replaceable: cannot be removed from its *assembly*.

In a factory that makes circuit boards, a bare board is a *component*, which initially has the status of not assembled. Once it is part of a completed circuit board, it has the status of assembled and not replaceable. A completed circuit board is itself a *component*. In a distribution centre, a complete circuit board has the status of not assembled.

Note 4 to entry: In ISO/TS 10303-4000:2023 and in the Application Reference Model of ISO 10303-242:2022, the term "product" is replaced by "part". With this usage, it can be a *component* that is being referred to.

3.5 Terms related to things that are aggregations of parts

3.5.1
collection
aggregation
two or more *particular* (3.2.1) things together as a whole, where the relationships between the things are unimportant

EXAMPLE 1 The load of bricks delivered to site UGE-1 on 2020-03-17 is a *particular collection* of bricks. The load of bricks is also an *artefact* (3.3.1), *material object* (3.3.2) and *product* (3.3.3).

EXAMPLE 2 The paintings in the UK National Gallery are a *collection*. The paintings in the *collection* change from time to time.

Note 1 to entry: A *collection* is not a *set*. If the things in a *collection* are *material objects*, then the *collection* is itself also a *material object*.

Note 2 to entry: A *collection* can be arbitrary, non-contiguous or both.

Note 3 to entry: The *parts* (3.4.1) of a *collection* can change during the life of the *collection*.

3.5.2
assembly
two or more things, where each is a *material object* (3.3.2), assembled together into a contiguous whole

Note 1 to entry: A distinct *part* (3.4.1) within an *assembly* is an *assembly element* (3.4.3).

3.5.3
assembly element
material object (3.3.2) that is assembled with others to create an *assembly* (3.5.2)

EXAMPLE 1 The building with site identifier "B-101" is a *particular* (3.2.1) *assembly*. Some of its *assembly elements*, such as doors and windows, are *components* (3.4.3) which are brought to the site. Other *assembly elements*, such as the walls, are made in-place.

Each wall of building "B-101" is a *particular assembly*. A wall has bricks as *assembly elements*. The bricks are *components*.

EXAMPLE 2 The motor car with registration number "DV 58 HUK" is a *particular assembly*. All of its assembly elements are *components*, such as the body shell, engine, and transmission. The engine is usually regarded as replaceable, whilst the body shell is not.

EXAMPLE 3 The engine design "E-ABC" is or defines (according to ontological view) a *kind* (3.2.2) of *assembly*. The arrangement of the head nuts for the engine design "E-ABC" is shown in Figure 2.

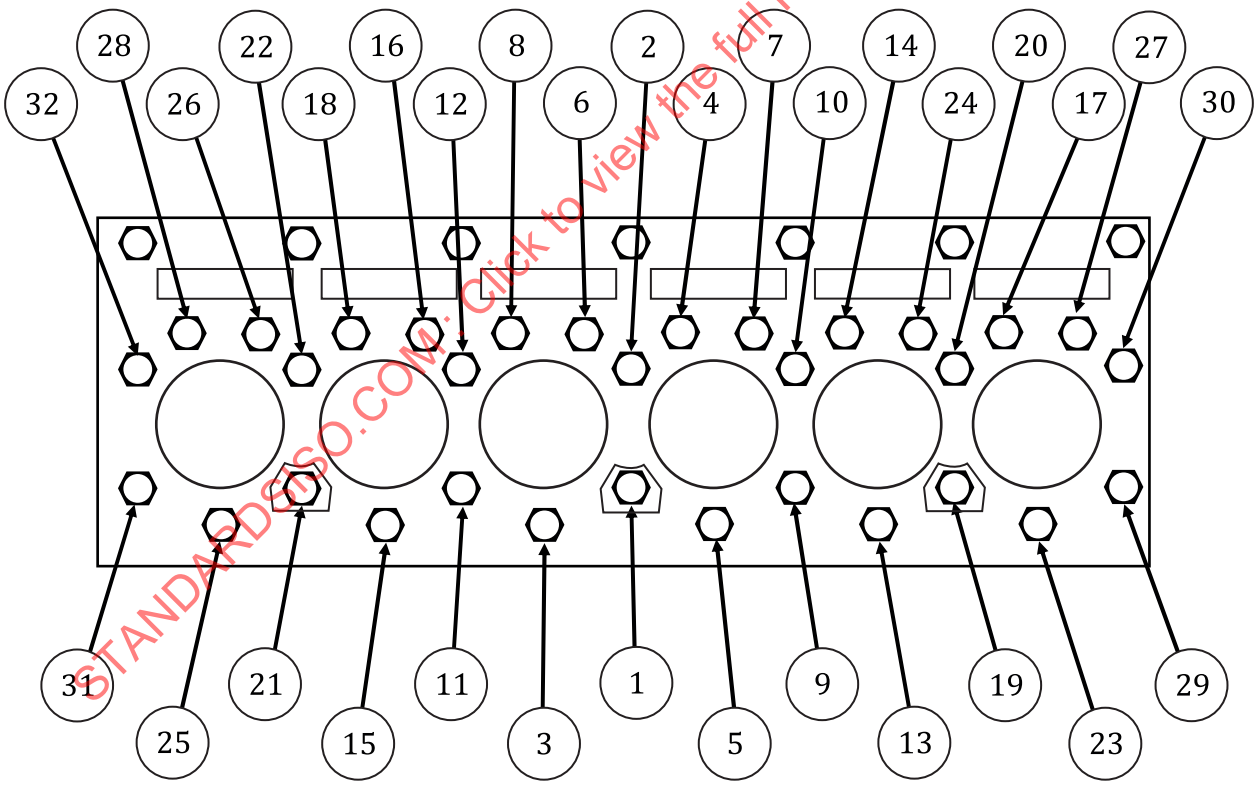

Figure 2 — Head nut arrangement for engine design "E-ABC"

EXAMPLE 4 The material of the cylinder head directly under head nut 27 of the engine with serial number "98/12345" is a *particular part*. This is not a *particular assembly element* but an arbitrary *particular part* (3.4.1). The material could change if that material were ground out and new material welded in.

EXAMPLE 5 The material of the cylinder head directly under head nut 27 of the *kind* of engine to design E-ABC is a *kind* of *part*. This is not a *kind* of *assembly element* but an arbitrary *kind* of *part*.

Note 1 to entry: An *assembly element* exists only as a *part* of an *assembly*. Its identity depends upon the *assembly* so that when an *assembly* ceases to exist, so necessarily do all of its *assembly elements*. A *component* that has been used as an *assembly element* can continue to exist and may be refurbished and re-used elsewhere.

Note 2 to entry: An *assembly element* can be made in-place, or can be a *component* which has been brought from elsewhere.

Note 3 to entry: An *assembly element* can be replaceable. In a design, some *assembly elements* can be flagged as replaceable parts.

Note 4 to entry: An *assembly element* can be joined by welding, and therefore cannot be replaced easily. An *assembly element* can be joined by nuts and bolts, and therefore can be replaced more easily.

Note 5 to entry: A *part* of an *assembly* can be an arbitrarily defined *part*, which is not an *assembly element*.

3.5.4
component in an assembly
occurrence
assembly element (3.5.3) that is a *component* (3.4.3)

EXAMPLE 1 Head nut is a generic *kind* (3.3.2) of *component in an assembly*.

EXAMPLE 2 The "head nut labelled 27 within engine design E-ABC" is a specific *kind* of *component in an assembly*.

EXAMPLE 3 The "head nut labelled 27 of the engine with serial number 98/12345" is a *particular* (3.3.1) *component in an assembly*. During the life of the engine with serial number "98/12345", different *particular components* can be installed as this *particular component in an assembly*.

Note 1 to entry: An *assembly element*, such as a wall of a building, can be built in-place and is not a *component*. An *assembly element*, such as a window frame, can exist before being *part* (3.4.1) of an *assembly* (3.5.2), and is a *component*.

Note 2 to entry: During the life of a *particular assembly*, a *particular component in an assembly* can be replaced.

Note 3 to entry: ISO/TS 10303-1026:2023 defines an approach to the design for manufacture, the actual manufacture and maintenance of parts, that are assemblies. The following are defined:

— promissory usage: the relationship between an assembly and a component, regardless of the number of intermediate levels between them, which supports the representation of a bill of material;

— next assembly usage: the relationship between a component and its immediate parent assembly in a product structure.

These structures are used during design relating kinds of product ("parts" in ISO 10303 terminology) and during operation and maintenance relating particular products ("individual parts" in ISO 10303 terminology). At the design stage, the relationships are between "parts" or "occurrences of parts". An "occurrence of a part" is a "part" or "configured part" that is in an identified role. An "occurrence of a part" can have specific properties or need specific maintenance.

Note 4 to entry: The term replaceable part is a near synonym. However, a *component in an assembly* need not be practically replaceable.

3.5.5
sub-assembly
assembly element (3.5.3) that is an *assembly* (3.5.2)

EXAMPLE The building with site identifier "B-101" is a *particular* (3.2.1) *assembly*. Each wall of building "B-101" is a *particular sub-assembly*. A wall has bricks as *assembly elements* (3.5.3). The bricks are *components* (3.4.3).

Note 1 to entry: Usually a *sub-assembly* is a *component*. It is possible that some *sub-assemblies* can only exist when *part* (3.4.1) of a whole, and therefore are not *components* even though they are assembled from *components*.

Note 2 to entry: During the life of a *particular assembly*, a *particular sub-assembly* can be replaced.

3.5.6
system
two or more things with interactions between them, giving the whole a *behaviour* (3.8.1)

Note 1 to entry: A interacting part of a *system* is a *system element* (3.5.8).

Note 2 to entry: A *system* has a *breakdown* (3.7.1) into its *system elements*. A *system* can have other *breakdowns* into *parts* (3.4.1) that are not *system elements*.

Note 3 to entry: A *system* can have *parts* which are not *system elements*. A *part* of a *system* can be all that is within a particular area or compartment. This *part* can be without a *function* (3.8.3) as a whole, and can be neither a *sub-system* (3.5.10) nor a *component* (3.4.3).

3.5.7
engineered system
system (3.5.6) that is an *artefact* (3.3.1) created for a purpose

Note 1 to entry: An *engineered system* is intended to have *capabilities* (3.8.2).

Note 2 to entry: An *engineered system* can have *system elements* (3.5.8) in the natural world that are not *artefacts*.

3.5.8
system element
thing that is one of the interacting parts that together form a *system* (3.5.6)

Note 1 to entry: A *system element* of a *engineered system* (3.5.7) has a *function* (3.8.3).

Note 2 to entry: A *system element* can be a *sub-system* (3.5.10), a *component* (3.4.3) or both. A circuit board can be a *sub-system*, but if it is replaced as a whole when anything goes wrong it is also a *component*.

3.5.9
component in a system
system element (3.5.8) that is a *component* (3.4.3)

EXAMPLE The relationship between a *component* and a *system* (3.5.6) can be complicated. Consider a circuit board that has some *parts* (3.4.1) that interact with "system A" and some parts that interact with "system B". The circuit board is a *component*, but not a *system element* (3.5.8) of either "system A" or "system B".

The circuit board is a *component in an assembly* within the *assembly* (3.5.2) that is the rack of circuit boards. The circuit board can be a *component in a system* of the *system* has both "system A" and "system B" as *sub-systems* (3.5.10).

Note 1 to entry: During the life of a *particular* (3.2.1) *system*, a *particular component in a system* can be replaced.

Note 2 to entry: A *component in a system* is a functionally defined role within a *particular system* that exists for the life of the *system*. A *component* is usually a *product* (3.3.3) which may be able fill that role. Because of the different identity criteria and lifecycles of these things, *component of a system* is not a specialisation of *component*.

3.5.10
sub-system
system element (3.5.8) that is a *system* (3.5.6)

3.5.11
network
two or more things with discrete connections between them

EXAMPLE The South Eastern Railway is a transport *network*. The railway stations are *network elements* (3.5.12) and the connections between them are train operations. There can be a flow of passengers between railway stations.

Note 1 to entry: A connected *part* (3.4.1) of a *network* is a *network element*.

Note 2 to entry: Things are connected if something can pass between them. If mechanical force can pass, then things are physically connected. Things are also connected in energy or information can pass between them. Hence a satellite can be a *part* of a *network* that is a communications system.

Note 3 to entry: A line of posts preventing the access of vehicles is an *assembly* (3.5.2), but not a *network* because the *parts* are not connected.

Note 4 to entry: A *network* has a *breakdown* (3.7.1) into its *network elements* and into the connectors between elements if these are regarded as objects. A *network* can have other *breakdowns* into *parts* that are not *network elements* or connectors.

3.5.12
network element
one of the connected things that together form a *network* (3.5.11)

3.6 Terms related to activity and participation

3.6.1
activity
something that happens or is being done

EXAMPLE 1 The pumping of batch B-101 from tank A to tank B on 2019-10-09 is a *particular* (3.2.1) *activity*.

EXAMPLE 2 Pumping is a generic *kind* (3.2.2) of *activity*.

EXAMPLE 3 "Pumping from tank A to tank B" is a specific *kind* of *activity*.

Note 1 to entry: An *activity* causes a change in the world.

Note 2 to entry: Different industry sectors define *kinds* of *activity* and *roles* (3.6.3) useful to their businesses.

Note 3 to entry: The beginning and end of an *activity* can be an arbitrary administrative decision. At an instant in time, one *activity* can end and another, which consists of the same people and material, can begin.

Note 4 to entry: An *activity* can be intended to take place in the future. The term "planned" can be used as a synonym for "intended", and can imply not only an intention, but the existence of a *plan* (3.13.2).

Note 5 to entry: The FRISCO (Framework of Information System Concepts) report [33] defines *kinds* of *activity* and *kinds* of *role*.

3.6.2
participant
thing that contributes to the performance of an *activity* (3.6.1) or that is affected by an *activity*

EXAMPLE 1 Pump P-101 is a *particular* (3.2.1) *participant* in the *activity* of pumping batch B-101 from tank A to tank B on 2019-10-09. The fluid that is pumped is also a *particular participant*.

EXAMPLE 2 John Doe is a *particular participant* in project Refurb-101 during 2018. He is the *particular participant* with the *role* (3.6.3) of project manager.

EXAMPLE 3 The ship Arctic Queen is a *particular participant* in the operation of platform UGE-1 during May 2019. It is the *particular participant* with the *role* of support vessel.

3.6.3
role
kind of participant
kind (3.2.2) of *participant*3.6.2)

EXAMPLE 1 Performer of pumping is a generic *role*.

EXAMPLE 2 "Performer of pumping from tank A to B" is a specific *role*.

EXAMPLE 3 Project manager is a generic *role*.

EXAMPLE 4 Support vessel is a generic *role*.

3.7 Terms related to breakdown

3.7.1
breakdown
tree structure of whole-part relationships such that at each level of the tree structure the vertices of the tree are disjoint

EXAMPLE ISO 14224:2016 defines *kinds* (3.2.2) of *breakdown* for maintenance. A *kind* of *breakdown* for a pump taken from ISO 14224:2016, 8.1 is shown in Figure 3.

Note 1 to entry: This *breakdown* has top level parts: power transmission, pump unit, control and monitoring, lubrication system, and miscellaneous. The inclusion of miscellaneous makes this a *complete breakdown*.

Note 2 to entry: There can be different *breakdowns* of the same thing for different purposes, such as procurement, construction, and maintenance.

Note 3 to entry: A *breakdown* can be a *complete breakdown* (3.7.2) or a *partial breakdown* (3.7.3).

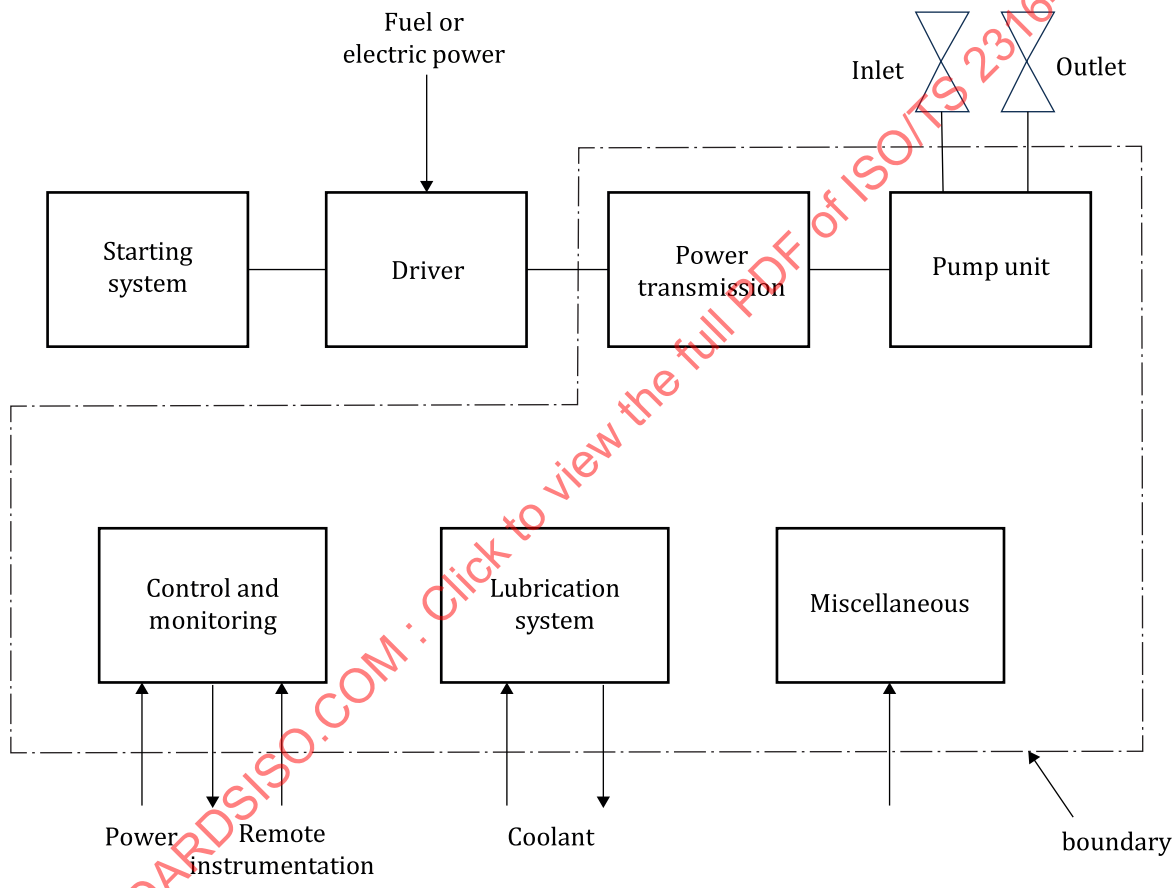

Figure 3 — Kind of breakdown for a pump

3.7.2
complete breakdown
breakdown (3.7.1) where the sum of the *parts* (3.4.1) at a level equals the whole

3.7.3
partial breakdown
breakdown (3.7.1) where the sum of the *parts* (3.4.1) at a level does not equal the whole

Note 1 to entry: If a *breakdown* omits *parts* that are not relevant to its purpose, then it is a *partial breakdown*. Such a *breakdown* is often turned into a *complete breakdown* by a *part* called “other” or “miscellaneous”.

3.7.4
breakdown element
part (3.4.1) that is a vertex within a *breakdown* (3.7.1) tree structure

3.7.5
functional breakdown
breakdown (3.7.1) such that each *breakdown element* (3.7.4) performs a function (3.8.3)

EXAMPLE The *breakdown* of a pump shown in Figure 3 is a *functional breakdown* because each *part* (3.4.1) has a *function*.

A zonal breakdown of a pump that has a *part* "things mounted above the pump unit" is probably not a *functional breakdown*. A *part* of the control and monitoring system and a *part* of the lubrication system may be above the pump unit. Therefore, there is no *function* that is performed by the things above the pump unit as an aggregation.

Note 1 to entry: A zonal breakdown has the equipment items within a particular zone as a *part*. Each equipment item has a *function*, but there may be no *function* that is performed by the aggregation of the equipment items within a zone.

3.7.6
assembly breakdown
physical breakdown
breakdown (3.7.1) of an *assembly* (3.5.2) into *parts* (3.4.1), each of which is an *assembly element* (3.5.3)

3.7.7
system breakdown
breakdown (3.7.1) of a system (3.5.6) into *parts* (3.4.1), each of which is a system element (3.5.8)

3.7.8
activity breakdown
breakdown (3.7.1) of an *activity* (3.6.1) into *parts* (3.4.1), each of which is an *activity*

EXAMPLE In chemical engineering, a Process Flow Diagram, which represents an overall *kind* (3.2.2) of *activity*, shows a *breakdown* into elementary *kinds* of *activity* or unit operations, such as heat transfer.

Note 1 to entry: In engineering there are many hybrid diagrams, in which some symbols represent *kinds* of *activity* and other symbols represent equipment items and their functions.

3.8 Terms related to behaviour, capability and function

3.8.1
behaviour
way a thing acts, transforms or reacts to inputs in a given condition or environment

EXAMPLE Stable hovering whilst lifting a load of 1 tonne is a behaviour, which is possessed by helicopter H-1234.

Note 1 to entry: A thing can have many *behaviours*. The *behaviours* of a *material object* (3.3.2) can include stress-strain behaviours at different temperatures and load rates, creep behaviour, thermal expansion behaviour, and magnetic behaviour.

3.8.2
capability
what something is capable of doing or being

EXAMPLE 1 The pump with serial number 98-12345 is a *product* (3.3.3). It has the *capability* of pumping a sand-sea water mixture continuously at a rate of 0,1 m^3 sec^{-1} with a head of 20 m. It has other capabilities at different heads, and other capabilities for short periods.

When installed within *system* (3.5.6) S-101 as pump P-101-A, the pump with serial number 98/12345 has the *capability* of pumping a sand-sea water mixture from tank A to tank B continuously at reduced power with a rate of 0,05 m^3 sec^{-1}, or at full power for short periods. The installed pump cannot be operated continuously at full power because the driver overheats.

EXAMPLE 2 It is a *capability*, within its operational envelope, of an assault craft to rescue refugees.

EXAMPLE 3 Delivering fire pumps is a *capability* which is possessed by helicopter H-1234.

Note 1 to entry: A *capability* is a potential of something. It is what a thing might do or be. This potential may never be fulfilled.

Note 2 to entry: Kinds of thing that can have *capabilities* include equipment item, *system*, *person* (3.10.2), and *organization* (3.10.1).

Note 3 to entry: A number of *capabilities* can be referred to as an "operational envelope".

Note 4 to entry: In some circumstances a *capability* can be referred to as a "capacity".

Note 5 to entry: The *capabilities* of a thing can change during its life.

Note 6 to entry: A *product* (3.3.3) has *capabilities* when manufactured, which are independent of its subsequent use. A *product* that is *part* (3.4.1) of a *system* has *capabilities*, which may be limited by its use as a *system element* (3.5.8) within a *system*.

Note 7 to entry: A *capability* of a thing can be determined by testing the thing itself or by testing one or more similar things. A *capability* of a thing can also be determined by analysis.

Note 8 to entry: A *capability* of a thing can be deemed by a regulatory body.

Note 9 to entry: A *function* (3.8.3) is an intended use and is intended to be within a *capability*. Hence a particular pump has *capabilities* when it is manufactured, but *functions* only when it is *part* of a *system*.

3.8.3
function
design function
what a thing is intended to do

EXAMPLE 1 When installed within *system* (3.5.6) S-101 as pump P-101-A, the pump with serial number 98-12345 has the function of ensuring that tank A does not overflow, by pumping its contents into tank B at a rate of 0,05 m^3 sec^{-1} for periods during the day as required. This is within *capability* (3.8.2) of the installed pump, which can pump at this rate continuously.

EXAMPLE 2 In the design of a process plant, *functions* and the flows between them can be represented by symbols on a Process Flow Diagram (PFD) as shown in Figure 4.

EXAMPLE 3 Delivering fire pumps for the New Forest fire brigade is a *function* which is possessed by helicopter H-1234.

Note 1 to entry: Identifiers associated with *functions* may also be identifiers, or tags, of equipment items that perform the *functions*.

Note 2 to entry: A thing can actually be doing what it is intended to do.

Note 3 to entry: The term *function* has different meanings in mathematics and in control system design. The qualified term "design function" can be used to make it clear that neither the mathematical nor control system design meaning is intended.

Note 4 to entry: Things that can have *functions* include equipment item, *system*, *person* (3.10.2), and *organization* (3.10.1).

Note 5 to entry: The *functions* of a thing can change during its life.

Note 6 to entry: The term *function* is used with the same meaning in the compound terms *functional breakdown* (3.7.5) and *functional requirement* (3.12.2).

Note 7 to entry: In an engineering design, it is usually intended that a *function* of an equipment item is within a *capability* that it has.

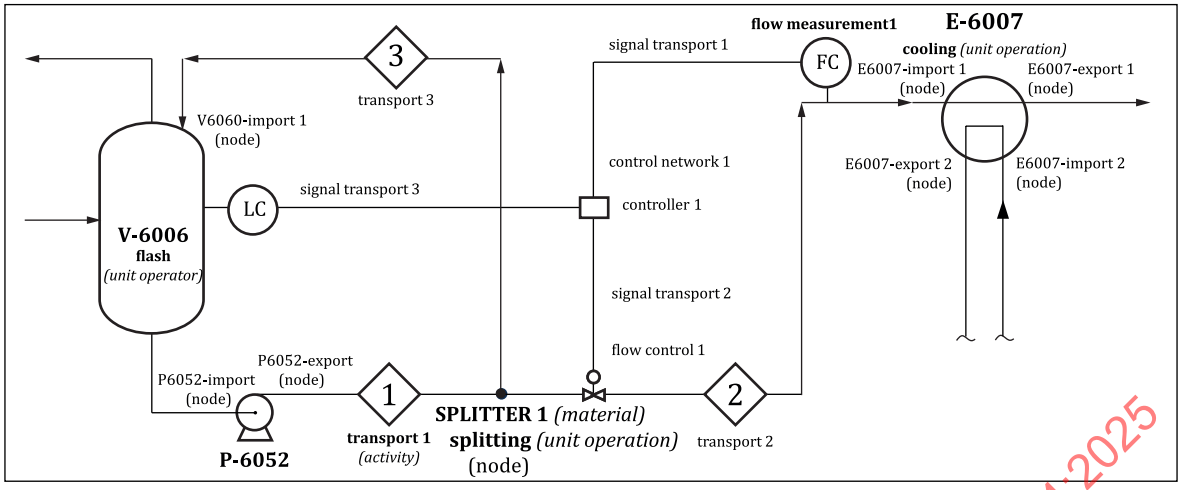

Figure 4 — Process flow diagram

3.9 Terms related to state

3.9.1
particular state
state
temporal part
particular (3.2.1) thing for a period of time

EXAMPLE 1 Electric switch S-101 from 2019-05-02T20:44:00Z until 2019-05-02T21:39:00Z is a *particular state*. In this *particular state* the electric switch is open to prevent an electric current.

EXAMPLE 2 Marie Curie from 26th July 1895 until 19th April 1906 is a *particular state*. This *particular state* begins with the marriage of Marie to Pierre Curie. In this *particular state*, Marie is married.

Marie Curie has the *particular state* that is married from 26th July 1895 until 19th April 1906. This *particular state* begins with the marriage of Marie to Pierre Curie.

Note 1 to entry: A *particular state* is usually defined for a period of time during which something is true.

3.9.2
kind of state
status
kind (3.2.2) of *particular state* (3.9.1)

EXAMPLE 1 Open to prevent an electric current is a *kind* of *state*. This *kind* of *state* is valid for electric switches and is of *kind* electric switch position.

EXAMPLE 2 Married is a *kind* of *state*. This *kind* of *state* is valid for *persons* (3.10.2) and is of *kind* marital status.

Note 1 to entry: Different *particular states* can be of the same *kind*.

Note 2 to entry: A *particular* thing can have *states* of different *kinds* during its life. If a *kind* cannot change, then it is not a *kind* of *state*, but a *kind* of the *particular* thing.

Note 3 to entry: Some *kind* of *states* are restricted to *kinds* of thing. Only a *person* can have the *kind* of *state* married. Only an electric switch can have the *kind* of *state* open to prevent an electric current.

Note 4 to entry: A *kind* of *state* can have a *kind*. Often there are only a finite number of *kinds* of *state* of the same *kind*. Hence the *kinds* of *state* open to prevent an electric current and closed to permit an electric current are both of *kind* electric switch position. There are no other *kinds* of *state* of this *kind*.

Note 5 to entry: The *kinds* of *state* of the same *kind* are often unordered.

Note 6 to entry: The term “status” is often used where the *kind* of *state* is one of a finite set, such as “open” or “closed”.

3.9.3
maintenance condition
particular state (3.9.1) that requires a maintenance *activity* (3.6.1) to be performed

EXAMPLE Engine E-101 having run for more than 10 000 hours since last service is a *maintenance condition* of engine E-101. This *maintenance condition* requires the *activity* "service engine_E-101".

3.10 Terms related to person, organization, position and role in organization

3.10.1
organization
one or more people or organizations with a common purpose

EXAMPLE 1 The task force sent to salvage the sunk ship Arctic Queen is an *organization*.

EXAMPLE 2 The sales department of Fred Bloggs and Co. Limited is an *organization*. In March 2018 the entire staff of the sales department resigned, and no new staff were recruited until May 2018.

EXAMPLE 3 Fred Bloggs and Co. Limited is an *organization*. This *organization* owns the assets of Fred Bloggs and Co. Limited.

EXAMPLE 4 ISO TC 184/SC 4 is an *organization*.

Note 1 to entry: An *organization* is a *system* (3.5.6).

Note 2 to entry: A *material object* (3.3.2) can be owned or controlled by an *organization*. A *material object* is not *part* (3.4.1) of an *organization*.

Note 3 to entry: An *organization* can have a continuous existence even if it consists of no people for periods of time. A corporation sole is a *kind* (3.2.2) of *organization* that consists of one *person* (3.10.2) or none for periods of time.

Note 4 to entry: The beginning and end of an *organization* is an arbitrary administrative decision. At an instant in time, one *organisation* can end and another, which consists of the same people, can begin.

3.10.2
person
human being

EXAMPLE Marie Curie, born on the 7th November 1867 and died on the 4th July 1934 is a *person*.

Note 1 to entry: The beginning and end of *person* is not arbitrary and are physical events associated with conception or birth and with death. The exact instant at which a *person* begins or ends can depend upon law and philosophy, but nonetheless a *person* cannot be arbitrarily declared to have ended at a point in time, and the cells that make up his or her body be declared to be a new *person*.

3.10.3
particular state of a person
state of a person
person (3.10.2) for a period of time

3.10.4
kind of state of person
person status
status of a person (3.10.2) for a period of time

EXAMPLE The following are examples of *kind of state of person*:

— adult;

— married;

— citizen (generic);

— citizen of France (more specific);

— chartered engineer (generic);

— chartered electrical engineer (more specific);

— member of the Institution of Electrical Engineers (more specific again);

— qualified slinger-signaller.

3.10.5
particular state of an organization
state of an organization
organization (3.10.1) for a period of time

3.10.6
kind of state of an organization
organization status
status of an organization (3.10.1) for a period of time

EXAMPLE 1 The following are examples of *kind of state of organization*:

— company (generic);

— limited company in England and Wales (more specific);

— inactive (a company not trading);

— dissolved (a company that no longer exists);

— supplier (generic);

— approved supplier to UGE Inc. (more specific).

EXAMPLE 2 The *organization* Bloggs and Partners became a limited company in England and Wales on the 1st January 1989, and changed its name to "Fred Bloggs and Company Limited".

EXAMPLE 3 The *organization* Fred Bloggs and Company Limited became inactive on the 5th April 2019, but was not dissolved.

EXAMPLE 4 The *organization* Fred Bloggs and Company Limited became an approved supplied to UGE Inc. on the 31st March 2005.

3.10.7
position in organization
position within an organization (3.10.1) held by a person (3.10.2) or sequence of *persons* or by an *organization* or sequence of *organizations*

EXAMPLE The chief engineer of Fred Bloggs and Co is a *position in organization*. From the 1st January 1990 until the 30th September 2010, the position is held by John Doe. From the 1st November 2010, the position is held by Rachel Roe. During the month of October 2010, nobody holds the position.

Note 1 to entry: At different times during the life of an *organization*, a *position in organization* can be different *persons*.

Note 2 to entry: A *position in organization* is a *system element*.

3.10.8
role in organization
kind of position in organization
kind (3.2.2) of *position in organization* (3.10.7)

EXAMPLE The following are examples of *role in organization*:

— chief engineer;

— managing director.

Note 1 to entry: The alternative term is identical to the natural language definition.

Note 2 to entry: A *role in organization* is a *kind* of *system element* (3.5.8).

3.11 Terms related to process and service

3.11.1
process
activity (3.6.1) that consists of interrelated of *part* (3.4.1) *activities* intended to achieve a goal

EXAMPLE 1 Bessemer process is a *kind* (3.2.2) of *process* for making steel.

EXAMPLE 2 The steel production in Youngstown on 5th January 1941 was a *particular* (3.2.1) *process* of *kind* Bessemer process.

3.11.2
service
activity (3.6.1) that is performed for the benefit of one person (3.10.2) or several, or one organization (3.10.1) or several

EXAMPLE 1 "Return current account balance to mobile phone upon request" is a *kind* (3.2.2) of *service*.

EXAMPLE 2 The return of "$210,47" at 2019-05-02T09:05:00 to Fred Bloggs's mobile phone is a *particular* (3.2.1) *service* of *kind* "return current account balance to mobile phone upon request".

3.12 Terms related to requirement, design and specification

3.12.1
requirement
thing that is needed or wanted

EXAMPLE It is a *requirement* that the intended pump P-101 shall have a mass of no more than 5 kg.

Note 1 to entry: A requirement specification is information that specifies a *requirement*. A requirement specification document is a document that contains a requirement specification.

Note 2 to entry: A *requirement* can have one or more *specifications* (3.12.3) against which a *product design*, *product* or *activity* proposed to satisfy the *requirement* can be tested.

3.12.2
functional requirement
function (3.8.3) that is needed or wanted

EXAMPLE 1 Pumping a sand-sea water mixture continuously at a rate of 0,05 m^3 sec^{-1} with a head of 20 m is a *functional requirement*. Pumping for 10,000 hours without maintenance and with a mean time between failures of 50,000 hours is also a *requirement* (3.12.1).

Whether this second *requirement* is regarded also a *functional requirement*, or as separate maintainability and reliability requirement depends upon the business practice.

EXAMPLE 2 Pumping that is performed with a pump that can be serviced from a depot in the European Union is not a *functional requirement*.

3.12.3
specification
one or more criteria against which a thing can be tested

Note 1 to entry: A *specification* can be one or more of the following:

— requirement specification: criteria for a *product design* (3.12.4), *product* (3.3.3), *plan* (3.12.2) or *activity* (3.6.1) satisfying or potentially satisfying a *requirement* (3.12.1);

— design specification: criteria for a *product* that are within a *product design*;

— product specification: criteria that a producer or supplier asserts that a *product* satisfies;

— material specification: criteria for the production process, testing, properties and documentation for a *material product* (3.3.4).

3.12.4
product design
detailed specification (3.12.3) of a possible *product* (3.3.3) or series of *products*

Note 1 to entry: A *product design* is one or more *specifications* against which a *product* purported to be in accordance with a *product design* can be tested.

Note 2 to entry: The existence of a *product design* implies an intention to manufacture one or more *products* to the design. However, the intention can be conditional. Alternative *product designs* can be created. The decision on which *product design* to manufacture, if any, can be made subsequently.

Note 3 to entry: An as built or as realized *product design* can be created after a *product* has been built or manufactured. This is the *product design* that would have been the *specification* for the *product*, if what has been built or realized had been the original intention.

3.13 Terms related to method and plan

3.13.1
method
way to perform a kind of *activity* (3.6.1)

EXAMPLE Agile software development is a method for software development.

The development during 2018 of UGE Banking Inc.'s mobile phone account balance service was carried out following a plan based upon the agile software development method.

3.13.2
plan
detailed specification (3.12.3) of a possible *activity* (3.6.1) or series of *activities*

EXAMPLE Fred Bloggs and Co. is awarded the contract to refurbish refinery UGE-1. The *plan* defined by Fred Bloggs and Co. is submitted to UGE Inc. for approval.

Note 1 to entry: The existence of a *plan* implies an intention to perform an *activity*. However, the intention can be conditional. Alternative *plans* can be created. The decision on which *plan* to perform, if any, can be made subsequently.

Note 2 to entry: An *activity* can be intended without there being a *plan*.

Note 3 to entry: A *plan* can be for a possible *activity* that is hoped never to be carried out, such as an emergency evacuation. Only when required by an emergency, is the *plan* is intended to be carried out

Note 4 to entry: Timings can, but need not, be specified for a *plan*. If specified a timing can be:

— a range, such as "within September 2020";

— relative, such as "within one month of the start".

Note 5 to entry: A *method* (3.13.1) can, but need not, be specified by a *plan*.

Note 6 to entry: A *plan* can be for a possible *activity* that is intended to be carried out once, or for a possible *activity* that is intended to be carried out many times, such as a maintenance program.

3.14 Terms related to physical quantity and physical property

3.14.1
physical quantity
something observable about phenomenon, body, or substance that has a magnitude that can be expressed as a number and a reference

EXAMPLE 1 The diameter of *particular* (3.2.1) shaft S-101.

EXAMPLE 2 The wavelength of the sodium D radiation.

EXAMPLE 3 The kinetic energy of *particular* particle P-101 at time T.

EXAMPLE 4 The heat of vaporization of *particular* water sample SE-101.

EXAMPLE 5 The electric charge of the proton.

EXAMPLE 6 The electric resistance of *particular* resistor R-101.

EXAMPLE 7 The amount of substance concentration of ethanol in *particular* wine sample SV-101.

EXAMPLE 8 The number concentration of erythrocytes in *particular* blood sample IB-101.

EXAMPLE 9 The Rockwell C hardness of *particular* steel sample SA-101.

EXAMPLE 10 The specific *kind* (3.2.2) of *assembly* (3.5.2) that is an equipment item to *product design* (3.12.4) E-ABC has the specific *kind* of *assembly element* (3.5.3) that is shaft S-101 as a *part* (3.4.1). The diameter of shaft S-101 in the *product design* is a *physical quantity*, which has a deemed true *physical quantity value* (3.14.3) of 100 mm.

EXAMPLE 11 The *particular assembly* that is the delivered equipment item E-101 has the *particular assembly element* that is shaft S-101 as a *part*. The diameter of shaft S-101 in delivered equipment item E-101 is a *physical quantity*, which has measured *physical quantity values* between 99,98 and 100,02 mm. The shaft in the delivered equipment item is not perfectly cylindrical, so the *physical quantity value* is different for different diameters and different locations along the shaft.

Note 1 to entry: Examples 1 to 9 are adapted from the table of examples in VIM [34] 1.1 NOTE 1.

Note 2 to entry: The term *physical quantity* defined here is identical in meaning to the term "quantity" defined in the VIM (International Vocabulary for Metrology). The prefix "physical" has been added to make it clear that the term does not encompass money and other non-physical quantities.

Note 3 to entry: The VIM [34] definition of "quantity" includes the term "property". The VIM definition has been adapted because "property" is assigned a different meaning in this document.

Note 4 to entry: A reference can be a measurement unit, a measurement procedure, a reference material, or a combination of such. [Source VIM [34] 1.1 NOTE 2]

Note 5 to entry: A *physical quantity* can be associated with a particular phenomenon, body or substance, or with a kind of phenomenon, body or substance.

Note 6 to entry: A *physical quantity* can be a scalar. A *physical quantity* can be a vector or tensor, where each scalar component is a *physical quantity*. [Adapted from VIM [34] 1.1 NOTE 5]

3.14.2
kind of physical quantity

physical quantities (3.14.1) that have something in common and are mutually comparable

EXAMPLE 1 Kinetic energy is a specific *kind of physical quantity*. The kinetic energy of *particular* (3.2.1) particle P-101 at time T is a *physical quantity* of this *kind* (3.2.2).

EXAMPLE 2 Length is a generic *kind of physical quantity*. The diameter of *particular* shaft S-101 and the wavelength of the sodium D radiation are *physical quantities* of this *kind*.

EXAMPLE 3 Diameter is a specific *kind of physical quantity*. The diameter of *particular* shaft S-101 is a *physical quantity* of this *kind*.

EXAMPLE 4 Energy is a generic *kind of physical quantity*. The kinetic energy of *particular* particle P-101 at time T and the heat of vaporization of *particular* water sample SE-101 are *physical quantities* of this *kind*.

EXAMPLE 5 Heat is a specific *kind of physical quantity*. The heat of vaporization of *particular* water sample SE-101 is a *physical quantity* of this *kind*.

EXAMPLE 6 Electric charge is a generic *kind of physical quantity*. The electric charge of the proton is a *physical quantity* of this *kind*.

EXAMPLE 7 Electric resistance is a generic *kind of physical quantity. The* electric resistance of *particular* resistor I-101 is a *physical quantity* of this *kind*.

EXAMPLE 8 Amount of substance concentration of an entity is a *kind of physical quantity*. The amount-of-substance concentration of ethanol in *particular* wine sample SV-101 is a *physical quantity* of this *kind*.

EXAMPLE 9 Number concentration of an entity is a *kind of physical quantity*. The number concentration of erythrocytes in *particular* blood sample IB-101 is a *physical quantity* of this *kind*.

EXAMPLE 10 Rockwell C hardness is a *kind of physical quantity*. The Rockwell C hardness of *particular* steel sample SA-101 is a *physical quantity* of this *kind*.

Note 1 to entry: Examples 1 to 10 are adapted from the table of examples in VIM [34] 1.1 NOTE 1, in accordance with VIM 1.2 NOTE 3.

Note 2 to entry: The definition of the term *kind of physical quantity* is adapted from the definition of the term "kind of quantity" in the VIM 1.2. The VIM term has been adapted to be consistent with the term *physical quantity*.

3.14.3
physical quantity value
magnitude of a *physical quantity* (3.14.1) that can be expressed as a number and a reference

EXAMPLE 1 Magnitude of the length of *particular* (3.2.1) rod R-101 presented as 5,34 m or 534 cm

EXAMPLE 2 Magnitude of the mass of *particular* body B-101 presented as 0,152 kg or 152 g

EXAMPLE 3 Magnitude of the curvature of *particular* arc A-101 presented as 112 m^{-1}

EXAMPLE 4 Magnitude of the temperature of *particular* sample S-101 presented as -5 °C

EXAMPLE 5 Magnitude of the electric impedance of *particular* circuit element CE-101 at a frequency of 50 Hz, where j is the imaginary unit, presented as (7 + 3j) Ω

EXAMPLE 6 Magnitude of the refractive index of *particular* glass sample SG-101 presented as 1,32

EXAMPLE 7 Magnitude of the Rockwell C hardness of *particular* steel sample SA-101 presented as 43,5 HRC

EXAMPLE 8 Magnitude of the mass fraction of cadmium in *particular* copper sample SC-101 presented as 3 µg kg^{-1} or $3 \cdot 10^{-9}$

EXAMPLE 9 Magnitude of the molality of Pb^{2+} in *particular* water sample SE-101 presented as 1,76 µmol kg^{-1}

EXAMPLE 10 Magnitude of the arbitrary amount of substance concentration of lutropin in *particular* sample of human blood plasma SB-101 (WHO International Standard 80/552 used as a calibrator) presented as 5,0 IU/l, where "IU" stands for "WHO International Unit".

EXAMPLE 11 Magnitude of the force acting on *particular* particle P-101 at time T (presented as Cartesian components (F_x; F_y; F_z)) presented as (-31,5; 43,2; 17,0) N

EXAMPLE 12 The specific *kind* (3.2.2) of *assembly* (3.5.2) that is an equipment item to *product design* (3.12.4) E-ABC has the specific *kind* of *assembly element* (3.5.3) that is shaft S-101 as a *part* (3.4.1). The diameter of shaft S-101 in the *product design* is a *physical quantity*, which has a deemed true *physical quantity value* of 100 mm.

EXAMPLE 13 The *particular assembly* that is the delivered equipment item E-101 has the *particular assembly element* that is shaft S-101 as a *part*. The diameter of shaft S-101 in delivered equipment item E-101 is a *physical quantity*, which has measured *physical quantity values* between 99,98 and 100,02 mm. The shaft in the delivered equipment item is not perfectly cylindrical, so the physical quantity value is different for different diameter orientations and different locations along the shaft.

Note 1 to entry: Examples 1 to 11 are adapted from VIM [34] 1.19.

Note 2 to entry: The term *physical quantity value* defined here is identical in meaning to the term "quantity value" defined in the VIM (International Vocabulary for Metrology). The prefix "physical" has been added to make it clear that the term does not encompass money and other non-physical quantities.

Note 3 to entry: The VIM [34] clause 1.19 definition of "quantity value" has been adapted because it leads to confusion between a *physical quantity value* and a *presentation of a physical quantity value*.

Note 4 to entry: A particular number and reference are a *presentation of a physical quantity value* (3.14.4).

Note 5 to entry: According to the type of reference, a *physical quantity value* is either:

— a product of a number and a measurement unit (see examples 1, 2, 3, 4, 5, 8 and 9); the measurement unit "one" is generally not indicated for quantities of dimension one (see examples 6 and 8); or

— a number and a reference to a measurement procedure (see example 7); or

— a number and reference material (see example 10). [source VIM [34] 1.19 NOTE 1]

Note 6 to entry: The number can be complex (see example 5). [source VIM <ref5>> 1.19 NOTE 2]

Note 7 to entry: A *physical quantity value* can be presented in more than one way (see examples 1, 2 and 8). [source VIM [34] 1.19 NOTE 3]

Note 8 to entry: In the case of vector or tensor quantities, each component has a physical quantity value (see example 11). [source VIM [34] 1.19 NOTE 4]

Note 9 to entry: Using the terminology of the VIM,[34] a *physical quantity value* can be "attributed" to a *physical quantity*. The attribution can be the result of a measurement.

Note 10 to entry: Using the terminology of the VIM, a *physical quantity* can have a "true" *physical quantity value*.

Note 11 to entry: During *design*, a *physical quantity* can have a deemed *physical quantity value*, or a deemed set of *physical quantity values* that specifies the tolerance.

3.14.4
presentation of a physical quantity value
number and a reference that present a *physical quantity value* (3.14.3)

EXAMPLE 5,34 with metre as the reference and 534 with centimetre as the reference are two different presentations of the same *physical quantity value*.

3.14.5
physical property
relationship between a phenomenon, body, or substance and a *physical quantity* (3.14.1)

EXAMPLE 1 Shaft diameter is a *kind* (3.2.2) of *physical property*. Each *physical property* of this *kind* is a relationship between a shaft and a *physical quantity* of *kind* length.

EXAMPLE 2 The specific *kind* of *assembly* (3.5.2) that is an equipment item to *product design* (3.12.4) E-ABC has the specific *kind* of *assembly element* (3.5.3) that is shaft S-101 as a *part* (3.4.1). The relationship between shaft S-101 in the *product design* and the *physical quantity* of *kind* length that is the diameter of shaft S-101 is a *physical property* of *kind* shaft diameter. The *physical quantity* has a deemed *physical quantity value* (3.14.3) that is 100 mm.

This example is illustrated informally by Figure 5.

EXAMPLE 3 The *particular* (3.2.1) *assembly* that is the delivered equipment item E-101 has the *particular assembly element* that is shaft S-101 as a *part*. The relationship between shaft S-101 in delivered equipment item E-101 and the *physical quantity* of *kind* length that is the diameter of shaft S-101 is a *physical property* of *kind* shaft diameter. The *physical quantity* has measured *physical quantity values* of between 99,98 and 100,02 mm. The shaft in the delivered equipment item is not perfectly cylindrical, so the *physical quantity value* is different for different diameter orientations and different locations along the shaft.

This example is illustrated informally by Figure 5.

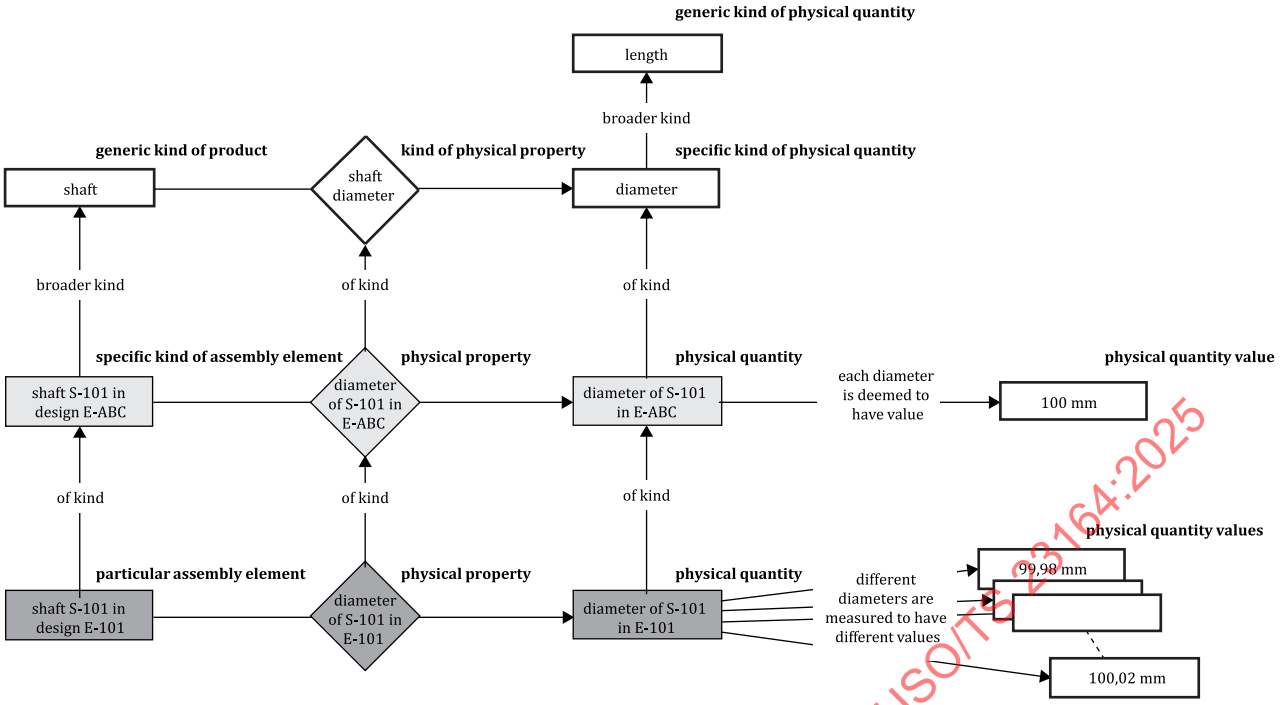

Figure 5 — Example of physical quantity and physical property

Figure 5 shows examples of *physical quantity*, *physical property* and *physical quantity value* and shows their relationships informally. The figure is not intended as a formal ontological analysis, which is out of scope of this document.

3.15 Abbreviated terms

BFO Basic Formal Ontology

CDD Common Data Dictionary

VIM International Vocabulary for Metrology

Annex A
(informative)

Development methodology

A.1 Content of this document

The core terms will be generic, clearly defined and equally valid for all industrial data.

These terms will be a vocabulary for industrial data that can be understood by engineers, whether or not they are involved in ontology or data model development, and business decision makers.

EXAMPLE 1 The terms product, component, breakdown, state, activity, task, and method are contained in this document. These terms can be specialised by experts for particular engineering domains.

EXAMPLE 2 The terms pump, pipe, valve, and vessel are all specialisations of component, which are relevant to fluid handling. The terms functional location and process unit are specialisations of system element, which are relevant to the process industry.

NOTE 1 Many classes in the IEC Common Data Dictionary are specialisations of "component", which are relevant to electro-technical equipment.

NOTE 2 Many industrial ontologies and data models have been developed outside ISO TC 184/SC 4. This document can help define relationships with other ontologies and data models.

A.2 Use of this document

The future use of the terms in this document in an international standard, depends upon the level of standardisation, as follows:

a) This document is published as a TS or IS.

   A TS or IS can be referenced normatively. Hence core terms can be referenced in a Clause 3 and used in normative text.

b) A mapping between this document and a standard ontology or data model is published as a TS or IS.

   NOTE 1 Mappings to ontologies such as ISO/IEC 21838-2 (BFO) and ISO 15926-2:2003, and data models such as ISO/TS 10303-4000 and IEC 61360-2:2012/ISO 13584-42:2010 are possible.

   The mapping defines an object within an ontology or data model that corresponds to a core term. This will enable computer interpretable normative statements, such as member of, specialization of, instance of, to be made involving an object corresponding to a core term.

   NOTE 2 Going from a vocabulary to the mappings in level 3 is not trivial. Activities such as work on the SC4 reference architecture may contribute to this. The of formality also determines the role of this document in the development of a reference data library as follows:

   — Without a mapping to an ontology or data model, core terms are used within text definitions. The most generic objects within the different reference data library domains shown in Figure 1 can be defined using a consistent vocabulary. Because this vocabulary is precise and understandable to ontology and data model developers, the use of the reference data libraries in conjunction with an ontology or data model can be defined. However, this requires people to read the text definitions.

   — If the core terms are mapped to corresponding objects in an ontology or data model, then there is no need for further reading and understanding of text definitions. In this case, a reference data library that consists of specialisations of objects corresponding to core terms can be used directly.

A.3 Quality requirements for this document

This document has the following quality requirements:

— understandability: This document will be derived from previous work on ISO TC 184/SC 4 standards. However, the terminology should be understandable by engineers and business decision makers, who have had no contact with this work.

  This quality requirement has an impact on the explanatory text and examples that are produced alongside the formal definitions.

— comprehensiveness: Only very rarely should a domain expert need to define a term that is not a specialisation of an industrial data core term.

  Exceptions should prompt a thorough review, and can lead to an extension of this document.

— precision: For a term defined by a domain expert, the parent generic item in this document should be clear. The selection of this item should not require advice from ontology or data modelling experts.

  NOTE Different "top-level" ontologies can interpret terms in the core in different ways. However, the different approaches taken by top-level ontologies are not necessarily of interest to domain experts or business decision makers.

A.4 Relationships with a "top-level" ontology

This document does not define a top-level ontology.

A top-level ontology covers:

— how are actual and possible things distinguished;

— how is change over time represented;

— how are levels of reality or granularity distinguished;

— how are quantities and qualities represented;

— how are processes and events represented.

In order to be useful for engineering, a top-level ontology needs to include things to which the terms defined in this document apply.

A.5 Documentation style

The documentation of the this document has the following style:

— Terms in italics are core terms.

— Terms in quotes are discussed but are not defined by this document. Quotes are also used for the identifiers of things in examples.

— The terms "set" and "member" are not used, because they have precise mathematical meanings which are outside the scope of this document.

— The term "object" is only used within the compound term material object. If the nature of a thing is undefined or not of interest, then it is referred to as a "thing". The use of the term "thing" does not imply that a thing is inanimate.

A.6 Modality

A particular thing can have a modality, such as:

— actual;

— possible;

— intended;

— predicted;

— most likely;

— worst case;

— best case.

Modalities are handled in different ways by different ontological approaches. The definitions of modalities and the ways in which they are handled are outside the scope of this document. They may be contained in a domain terminology.

The definition of a particular thing in this document refers to it as if it actually exists in the real world.

NOTE The term planned is sometimes used as a synonym for intended. When applied to an activity, it usually implies not only an intention, but the existence of a plan.

EXAMPLE 1 Process plant UGE-1 has not yet been built, but is intended to be built. It is referred to as an intended process plant. When built, process plant UGE-1 will have system S-101 as a part. S-101 is referred to as an intended system.

EXAMPLE 2 The activity "commission system S-101 of UGE-1" has not yet happened, but is intended to happen. It is referred to as an intended activity.

A.7 Information and documents

Statements about a thing can be recorded as information content contained within an information carrier. Information content can be a definition or description of a thing. Information content can be intended for a person, and can be expressed using natural language and pictures. Information content can be intended for a computer, and expressed using a computer processable language.

An information carrier can be a computer file held on a server, or an ink and paper physical document.

Terms associated within information content and information carrier are not defined within this document.

A.8 Versions, variants and revisions

Particular things in the real world change through their life. These are changes of state.

There are also changes to specifications, requirements, designs and plans which result from designing and planning activities. These activities create complicated graphs of versions, variants, and revisions.

The terms version, variant, and revision are not defined in this document.

Annex B
(informative)

Guidance on groups of terms

B.1 Guidance on particular and kind

B.1.1 Difference between particular and kind

Different data modelling and ontological approaches begin in different ways. Some begin with statements about particular things, and others begin with kinds of thing. Depending upon the approach an unqualified term can refer to a particular thing, to a kind of thing, or to either.

Consider the term component. Unqualified, the term can refer to:

— a generic kind of component, such as a pump, motor or valve;

— a specific kind of component, such as a "Fred Bloggs and Co. model A-101" pump;

— a particular component, such as the pump with serial number "15/12345", manufactured by Fred Bloggs and Co. on 13th September 2015.

Where it is necessary to make it clear that a term refers to a kind of thing or to a particular thing, then the term can be prefixed by "kind of" or "particular".

Within this document, an unqualified term refers to a particular thing.

B.1.2 Guidance on kind

A kind of thing can be defined in many ways.

NOTE 1 IEC 81346 contains the following text about "type":

A type is a set of objects having the same set of characteristics. Depending on the number of common characteristics, and whether they are qualitative or quantitative, a type can be from very generic to very specific. For example:

— generic object types, for example the classes described in IEC 81346-2 [....].

— many kinds of products, for example motors, transformers, contactors, pneumatic cylinders are often designed as a range of sizes (e.g. frame sizes) with common characteristics. [....]

— each product variant in a product series with fixed values for voltage, power, etc. normally has an identifier [....] which identifies a type of presumably identical products.

[SOURCE IEC 81346-1:2022, 4.8]

Terms related to kind are as follows:

— specification: A particular thing can comply with one or more specifications.

  A specification can be defined by a customer as a requirement. A specification can be defined by a standard, and can be selected by a customer as a requirement. A specification can be defined by a supplier.

  A specification can require the following:

  — specified values or ranges for the properties of a particular thing;

  - the nature of the production process that created a particular thing, which can include specified value or ranges for its properties, and the inspection and testing regime.

- commercial offering: A commercial offering is an open offer to provide a product or service. The offer can state a price and perhaps conditions such as location.

  A particular thing can be supplied in response to an acceptance of a commercial offering. A supplier can assert that a commercial offering complies with one or more specifications.

  EXAMPLE The sign at a petrol/gas station stating the price of petrol/gas at the station is a commercial offering. The price of a product on the shelf of a supermarket is a commercial offering. The price of the same thing at different petrol/gas stations or supermarkets can be different, so they are different commercial offerings of the same product.

  NOTE 2 In some cases, the acceptance of a commercial offering can result in a contract to supply a product or service that meets some specification, at a price, and probably location. In other cases, a commercial offering is merely an item in a catalogue and further communication between customer and supplier maybe required to create a contract.

- product range: A product range is several similar kinds of product. Some statements are true for each kind of product in a range.

- product design (or product variant): A product design is a detailed definition of the form and properties of a particular product. A product design can include a detailed definition of the production process.

  A single product design can be used for different commercial offerings. The different commercial offerings can be differently priced, and the customer may not be told that they are identical.

  Different product designs can be used at different times for single commercial offering. A manufacturer can change its production process and produce a product that meets the same specifications in a different way. Occasionally this can lead to disputes between suppliers and customers.

  NOTE 3 “Product definition” and “product specification” may be near synonyms. Product design is used for a specification that is complete enough to pass on to manufacturing or construction.

- batch (or lot): A number of particular products that are produced together or from the same source materials.

  A batch as a whole is a particular thing. A batch can have particular products as parts.

- effectivity: An effectivity is the part of a production run associated with either a detailed specification for how the products should be produced, a detailed specification for the resulting products, or both.

  Effectivity can add detail in addition to the product design, such as which engineering change orders apply. It can specify which components from which suppliers to use in an assembly, and other constraints on how a product is to be made that are not within the product design.

  An effectivity as a whole can be regarded as a particular thing that has particular products as parts. Alternatively, an effectivity can be regarded as a more specialised product specification.

  In ISO/TS 10303-1057:2014 “Application module: Effectivity”, effectivity is defined as “the identification of a domain of applicability”. ISO/TS 10303-1057:2014 allows an effectivity to be defined in different ways, including:

  - dated effectivity: things made between a start and finish time;
  - time interval effectivity: things made within a set time duration after an event;
  - serial effectivity: things that have serial numbers within a range, possibly open ended;
  - lot effectivity: things that are within a lot or batch.

A kind can be a number of particular things where:

— each complies with the same specification;

— each is supplied in response to acceptance of the same commercial offering;

— each is supplied in response to acceptance of a commercial offering within the same product range;

— each was made according to the same product design;

— each was made as part the same batch.

NOTE 4 Particular material objects from the same batch need not have anything in common.

— each was made as part of the same effectivity.

NOTE 5 It is possible when considering batches and effectivities to think in terms of whole and part rather than kind. Nonetheless informally, a "1969 Ford Cortina" is often thought of as a kind of motor car.

B.2 Guidance on artefact, product and material object

B.2.1 Difference between artefact, material object and product

There are three related terms:

— artefact: thing that is created by people;

— material object: thing that is matter;

— product: thing that is intended to be, or was, supplied, or thing that is the result of a process.

Very many things are all three.

NOTE A "materialized physical object" defined in ISO 15926-2:2003 is broadly similar to a material object, but also includes energy.

EXAMPLE 1 The pump with serial number X-05/1234 is an artefact, material object and product.

Some things are only one or two of the three.

EXAMPLE 2 The noise of vented steam from plant UGE-1 on 2020-03-17 is an artefact but not a material object or a product.

EXAMPLE 3 The electrical energy supplied to the power grid from plant UGE-1 on 2020-03-17 is an artefact and a product, but not a material object.

EXAMPLE 4 The footprints of Neil Armstrong on the moon are artefacts and material objects, but not products.

EXAMPLE 5 The sand dredged from the North Sea and delivered on shore by "Sea Dredge 01" is a material object and a product but not an artefact.

B.2.2 Guidance on material object and material specification

The term "material" is used loosely in natural language. The OED definition is "The matter from which a thing is or can be made.", but materials scientists think of a material as being the thing itself and not the matter from which it is made.

In natural language, a material specification such as AMS 4037 (also ISO AlCu4Mg) is often referred to as "the material". A material product is a batch of plate that is supplied to this specification.

The IEC 61360-4 (IEC CDD) defines “material” to be “product intended for further physical processing including chemical and nuclear processing during which their geometry or composition will change”.

NOTE 1 The oil industry calls such a product an intermediate product. However intermediate products can also be final products. For example, kerosene can be a final product or a component of heavier fuel oils.

IEC 61360-4 (IEC CDD) focus is on kinds of material product, and therefore the use of the term in the IEC 61360-4 (IEC CDD) corresponds most closely to material specification. However a material specification can apply to a finished material products and not solely to material products intended for further processing.

Consider the batch of aluminium plate supplied by Fred Bloggs Aluminum Inc. to UGE Aircraft on 2019-05-06. This is a material product.

This material product complies with the following material specifications:

— material form specification: plate with a thickness of 0.2 inches with a tolerance of 0.005 inches

— material alloy specification: ANSI UNS A92024 (usually known as “alloy 2024”), which is (percentage composition by weight):

  — Cu: 3,8 — 4,9

  — Mg: 1,2 — 1,8

  — Si: 0,50

  — Fe: 0,50

  — Mn: 0,30 — 0,9

  — Zn: 0,25

  — Ti: 0,15

  — Cr: 0,10

  — Others, each: 0,05

  — Others, total: 0,15

  — Balance: Aluminium

— material temper specification: T3, which is: solution heat-treated, cold worked, and naturally aged to a substantially stable condition

— material product specification: AMS 4037 (also ISO AlCu4Mg), which covers quality, variability, inspection, testing, necessary properties, and documentation

NOTE 2 Most specifications are the combination, or intersection, of multiple components such as those in the preceding list.

B.3 Guidance on part and component

The term part in this document refers to a thing being part of a whole. The term is not concerned with the nature of the thing, but only with its role in its relationship with the whole.

The term component in this document refers to a thing that was created with the intention of being part of a whole. The term is not concerned with the existence of a relationship with a whole, but only with the intention.

NOTE Everything is a part of many other things, except possibly the whole universe. Everything has many parts except possibly some fundamental particles.

A part can be an arbitrary division of the whole. A part can also be not arbitrary. A part that is not arbitrary can be an assembly element, a system element, a network element, or a breakdown element.

EXAMPLE The pump with serial number X-05/1234 is a component and a material product. During 2018, the pump is a part of the collection of pumps in store at Fred Bloggs and Co. awaiting shipment to customers. During 2019, the pump is a part, and system element, of the boiler feedwater system of plant UGE-1.

B.4 Guidance on things that are aggregations of parts

A thing that is two or more parts can be:

— collection: the relationships between the parts are unimportant;

— assembly: the parts are material objects that are arranged spatially with respect to each other;

— system: the parts interact and enable the operation of the whole;

— network: the parts are connected.

A thing can be all three of assembly, system and network.

EXAMPLE 1 The pump with serial number X-05/1234 is an assembly and system. It is not a network, because the connections between the parts are not discrete. It is also an artefact, material object and product.

Some things are only a collection, and not an assembly, system or network.

EXAMPLE 2 The load of bricks delivered to site UGE-1 on 2020-03-17 is a collection of bricks. The load of bricks is also an artefact, material object and product.

Some things are only one or two of the three.

EXAMPLE 3 The satellites and ground stations that are the "GPS system" are a system and a network. They are not an assembly.

EXAMPLE 4 Motor car is a generic kind of assembly and a generic kind of product. It has a near side front wheel as a generic kind of assembly element. Motor car wheel is a generic kind of component.

"1997 Opel Vectra" is a specific kind of assembly and a specific kind of product. It has an "Opel Vectra near side front wheel" as a specific kind of assembly element. An "Opel Vectra type A wheel" is a specific kind of component.

The motor car with vehicle registration "DV 58 HUK" is a particular assembly and a particular product. It has "DV 58 HUK near side front wheel" as a particular assembly element. The wheel with serial number "12345" is a particular component.

The relationships between these objects are shown in Figure B.1.

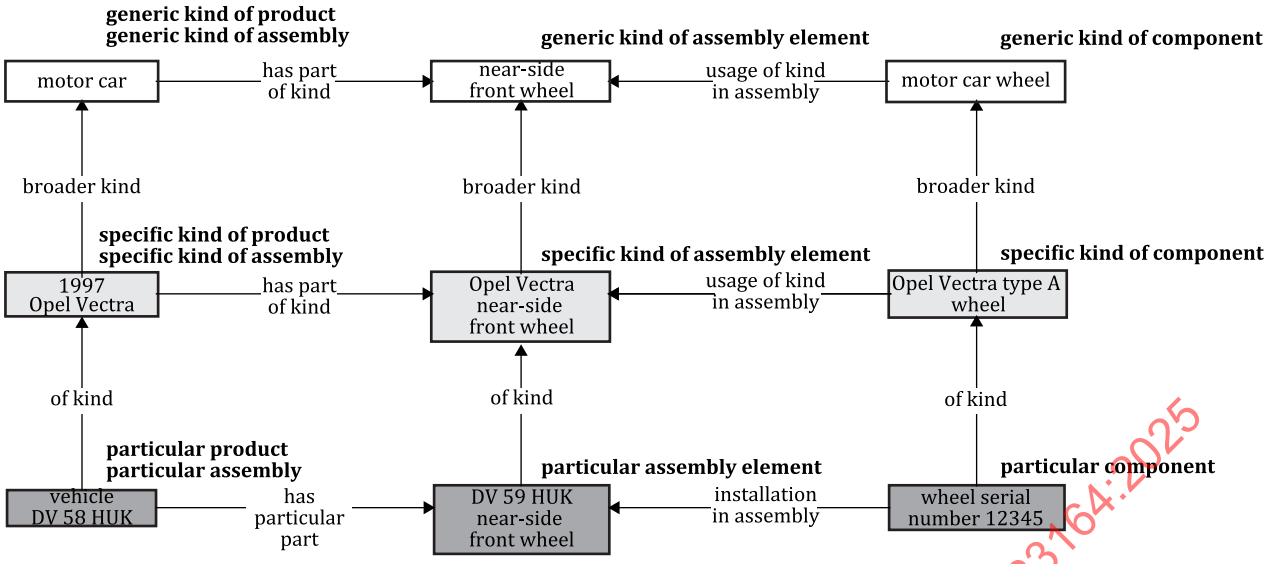

Figure B.1 — Example of assembly and component

B.5 Guidance on behaviour, capability and function

There are three related terms:

— behaviour: This is objective and is measurable or observable.

— capability: This derived from behaviour. It is the activities or uses for which a thing is suitable because of its behaviour. Whether or not a thing is suitable can depend upon engineering judgement and is therefore partially subjective. A code of practice can specify how a capability depends upon behaviour.

— function: This is a chosen use or role of a thing. A function follows from an intention.

NOTE In engineering, a function is chosen to be within a capability.

B.6 Guidance on physical quantity and physical property

This section is principally concerned with the following terms:

— physical quantity: something about a physical thing or kind of physical thing that has magnitude

EXAMPLE 1 The diameter of shaft S-101 is a physical quantity. The diameter of shaft S-101 at location P along the shaft at 10:15 on 2020-09-09 is also a physical quantity. This second physical quantity is more precisely defined.

— kind of physical quantity: mutually comparable physical quantities

NOTE 1 Kinds of physical quantity are defined in the ISO 80000 series of standards.

EXAMPLE 2 Length, mass, and temperature are kinds of physical quantity.

— physical quantity value: magnitude of a physical quantity that can be represented by a number and a reference

NOTE 2 In many cases, the reference is a unit of measure. In such cases, the number is the ratio of the physical quantity value that is represented to the physical quantity value that is the unit of measure. Units of measure are defined in the ISO 80000 series of standards.

EXAMPLE 3 The length magnitude that is represented by the number 10,0 with the reference metre is a physical quantity value. The same length magnitude can be represented by the number 10,000 with the reference millimetre.