



**International
Standard**

ISO 20140-5

**Automation systems and
integration — Evaluating energy
efficiency and other factors of
manufacturing systems that
influence the environment —**

**Part 5:
Environmental performance
evaluation data**

*Systèmes d'automatisation et intégration — Évaluation de
l'efficacité énergétique et autres facteurs de fabrication des
systèmes qui influencent l'environnement —*

*Partie 5: Données d'évaluation de la performance
environnementale*

**Second edition
2024-09**

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Foreword

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

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

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For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 5, *Interoperability, integration, and architectures for enterprise systems and automation applications*, in collaboration with the International Electrotechnical Commission (IEC), Technical Committee IEC/TC 65, *Industrial-process measurement, control and automation*.

This second edition cancels and replaces the first edition (ISO 20140-5:2017), which has been technically revised.

The main changes are as follows:

- a) renewal of [Clause 4](#) according to EPE data class definition;
- b) restructuring and updates of Clauses 5 to 8 into new [Clause 5](#) and [Clause 6](#) in terms of EPE data class definitions and their properties;
- c) replacement of Annexes with new [Annex A](#), [Annex B](#) and [Annex C](#).

A list of all parts in the ISO 20140 series can be found on the ISO website.

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

Introduction

The ISO 20140 series specifies a method for evaluating the energy efficiency and other factors of a manufacturing system that influence the environment, such as energy consumption, waste, and release.

The ISO 20140 series can be used for:

- benchmarking the environmental performance against a generic reference manufacturing system or comparing between different manufacturing systems;
- alternative studies for improving environmental performance;
- setting targets for improving environmental performance;
- visualizing the environmental performance of a manufacturing system under operation;
- managing carbon footprints of products (CFP) in a supply chain;
- evaluating the environmental performance of manufacturing systems.

Expected users of the ISO 20140 series are:

- a) managers who are responsible for the environmental conditions of a manufacturing system;
- b) engineers who design manufacturing processes for products;
- c) engineers who design a manufacturing system;
- d) engineers and supervisors who are responsible for manufacturing products.

This document classifies environmental performance evaluation (EPE) data. The classification intends to support the association of EPE data with context information and transferring them across various locations and disciplines in the manufacturing system.

This document provides EPE data classes which are used in the aggregation process specified in ISO 20140-3 to evaluate environmental performance of a manufacturing system. This document intends to allow mapping EPE data to various implementations based on different technologies by providing formal and technology-independent definitions of EPE data classes. The EPE data classes are intended to be stored in concept data dictionaries (e.g. IEC CDD).

This document is the second edition of ISO 20140-5, which replaces the first edition ISO 20140-5: 2017. The objective and the scope of both documents are the same. Both documents define the same set of EPE data classes. In order to improve the applicability of EPE data for evaluating various manufacturing processes, this document defines EPE data classes by a classification scheme differently from the first edition. The classification of the first edition is based on properties of manufacturing operations, i.e., source and time of EPE data generation. The classification of this document is based on a general concept of a manufacturing process, and detailed EPE data classes are defined systematically. The definitions of EPE data classes and types of properties are given respectively in [Clause 5](#) and [Clause 6](#) of this document. In order to retain the general use of the definitions, individual EPE data derived from EPE data classes and its properties are not described in this document. Detailed individual EPE data and properties specified in the first edition of ISO 20140-5 can be represented by using the class definitions given in this document.

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Automation systems and integration — Evaluating energy efficiency and other factors of manufacturing systems that influence the environment —

Part 5: Environmental performance evaluation data

1 Scope

This document defines a set of environmental performance evaluation (EPE) data classes, including their properties.

It is applicable to entire manufacturing facilities or to parts of a manufacturing facility.

This document applies to manufacturing systems including discrete, batch and continuous control, which are defined in IEC 62264-1.

The following are outside the scope of this document:

- syntax of EPE data and data models;
- protocols to exchange EPE data;
- functions that can be enabled by the use of EPE data;
- product life cycle assessment;
- EPE data that are specific to a particular industry sector, manufacturer or machinery;
- acquisition of EPE data.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10303 (all parts), *Industrial automation systems and integration — Product data representation and exchange*

ISO 11014, *Safety data sheet for chemical products — Content and order of sections*

ISO 13584-42, *Industrial automation systems and integration — Parts library — Part 42: Description methodology: Methodology for structuring parts families*

ISO 14224, *Petroleum, petrochemical and natural gas industries — Collection and exchange of reliability and maintenance data for equipment*

ISO/TS 15926-4, *Industrial automation systems and integration — Integration of life-cycle data for process plants including oil and gas production facilities — Part 4: Initial reference data*

ISO 20140-1, *Automation systems and integration — Evaluating energy efficiency and other factors of manufacturing systems that influence the environment — Part 1: Overview and general principles*

IEC TS 62720, *Identification of units of measurement for computer-based processing*

IEC 60721 (all parts), *Classification of environmental conditions*

IEC 61360-4, *IEC/SC 3D — Common Data Dictionary (CDD — V2.0015.0004)*

IEC 61987 (all parts), *Industrial-process measurement and control — Data structures and elements in process equipment catalogues*

IEC 62683-1, *Low-voltage switchgear and controlgear — Product data and properties for information exchange — Part 1: Catalogue data*

IEC/TR 63213, *Power measurement applications within electrical distribution networks and electrical installations*

3 Terms, definitions, abbreviated terms and conventions

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20140-1 and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1.1

assembly

number of parts, subassemblies or combinations thereof joined together

[SOURCE: IEC 60194:2021, 3.1.72, modified — removed Note 1 to entry.]

3.1.2

attribute

data element for the computer-sensible description of a class definition or a property

[SOURCE: IEC 61360-1:2017, 3.1.2, modified — “a property, a relation or a class” was replaced with “a class definition or a property”.]

3.1.3

classifying property

property applicable for a particular class, having a value list whose values define the subclasses of the class

[SOURCE: IEC 61360-1:2017, 3.1.7]

3.1.4

consumable

any part or material that is necessary for continued use or maintenance of the product

[SOURCE: IEC/IEEE 82079-1:2019, 3.7]

3.1.5

environmental performance evaluation data

EPE data

data that are used to evaluate the environmental performance

[SOURCE: ISO 20140-3:2019, 3.7]

3.1.6

environmental performance evaluation data class

EPE data class

description of a set of EPE data that share common characteristics

Note 1 to entry: Adapted from IEC 62832-2:2020.

3.1.7

environmental performance evaluation data class definition

EPE data class definition

grouping of references to property or to another EPE data class definition, that defines the shared structure of a group of EPE data classes

3.1.8

environmental performance evaluation data value

EPE data value

number, text, or artefact encoding that expresses a quantity or quality held by EPE data

3.1.9

material

substance or mixture within a product or a part of a product

[SOURCE: IEC 62474:2012, 3.15]

3.1.10

part

material or functional element that is or can be a constituent of different products

[SOURCE: ISO 13584-1:2001, 3.1.16, modified – The phrase “intended to constitute a component” is replaced by “is or can be a constituent”.]

3.1.11

product

intended or accomplished result of labour, or of a natural or artificial process

[SOURCE: IEC 81346-1:2022, 3.6]

3.1.12

property

defined parameter suitable for the description and differentiation of objects

Note 1 to entry: A property describes one characteristic of a given object.

Note 2 to entry: A property can have attributes such as code, version, and revision.

Note 3 to entry: The specification of a property can include predefined choices of values.

[SOURCE: IEC 61360-1:2017, 3.1.24]

3.1.13

subclass definition

environmental performance evaluation (EPE) data class definition that is included in another EPE data class definition

3.1.14

tool

device for imparting a desired shape, form, or finish to a material

Note 1 to entry: The desired shape can be achieved by different means, e.g. by material removal, forming, shaping.

[SOURCE: ISO 14955-3:2020, 3.5]

3.1.15**value type**

stereotype of properties that is used to define types of values that are allowed to express information

3.2 Abbreviated terms

CAS	Chemical Abstracts Service
CFP	Carbon Footprint of Products
ECD	Environmental Characteristics Data
EPE	Environmental Performance Evaluation
GHG	Greenhouse Gas
ID	Identifier
IO	Input and Output
LCA	Life Cycle Assessment
NC	Numerical Control
UML	Unified Modelling Language

3.3 Conventions for defining class definitions and properties

Words connected with underscore (e.g. EPE_data) are used for representing class definitions and properties in [Clause 4](#), [Clause 5](#) and [Clause 6](#).

[Table 1](#) is the template used in this document for specifying an EPE data class definition.

Table 1 — Template for specifying EPE data class definitions

Attributes of the class definition	Value of the attribute	
ID of the class definition	<ID of the class definition >	
Preferred name	<preferred name of the class definition >	
Description of the class definition	<description of class definition >	
Source of the description	<source of the description>	
Preferred name of parent class definition	Subclause number defining the parent class definition	
<preferred name of parent class definition>	< Subclause number where the parent class definition is defined.>	
Property included in the class definition	Cardinality	Subclause defining the property
<preferred name of property #1>		<subclause number defining the property #1>
....		...
<preferred name of property #N>		<subclause number defining the property #M>
Class definitions included in this class definition	Cardinality	Subclause defining the class definition

Table 1 (continued)

<preferred name of class definition #1>		<subclause number defining the class definition #1>
...		...
<preferred name of class definition #N>		<subclause number defining the class definition #N>

The shaded cells indicate the meaning of associated unshaded cell.

The text in the angle bracket (i.e. "<" and ">") in each unshaded cell describes what the cell is used for.

The "Attributes of the class definition" part of the template provides identifying information for this EPE data class definition formatted as fields (unshaded cells) with respective values. The fields are designated ID of the class definition, Preferred name, and Description of the class definition.

The "Preferred name of parent class definition" part of the template provides references to another EPE data class definition (parent class definition). The EPE data class definition being specified inherits the properties of the parent class definition, which is referenced by preferred name.

The "Property included in the class definition" part of the template provides a list of properties for inclusion into this EPE data class definition by indicating the preferred names and the number of possible occurrences (cardinality). The first row for the "Property included in the class definition" part of the template is used for the classifying property of the class definition, if applicable. The preferred names of classifying properties are represented in bold text.

The "Class definitions included in the class" part of the template provides a list of other EPE class definitions for inclusion into this EPE data class. The EPE data class definition being defined inherits the properties of the included EPE data class definition that is referenced by indicating the preferred name and number of possible occurrences (cardinality).

NOTE For ease of understanding, reference subclause numbers in this document are added to the tables.

The field "Cardinality" contains a range which defines the number of constituent elements, which are properties or EPE class definitions. The range is expressed using the following convention:

[a..b]

where:

- a is the minimum number of constituent elements;
- b is the maximum number of constituent elements.

EXAMPLE The number of constituent elements can be expressed as follows:

- [0..1] indicates the EPE class definition has none or one constituent element;
- [0..n] indicates the EPE class definition has none or as many as n constituent elements;
- [1..1] indicates the EPE class definition has one constituent element;
- [1..n] indicates the EPE class definition has one or as many as n constituent elements.

[Table 2](#) specifies the template used to list subclass definitions which are EPE class definitions derived from the class definition that is defined by the template of [Table 1](#). It also indicates the value of the classifying property which characterizes each subclass definition.

Table 2 — Template for listing subclass definitions

Classifying property	Preferred name of subclass definition that is derived from the class definition	Subclause number in this document specifying the subclass definition
<value of classifying property #1>	<preferred name of subclass definition #1 that is derived from the class definition to be defined>	<subclause # for subclass definition #1>
....		
<value of classifying property #N>	<preferred name of subclass definition #N that is derived from the class definition to be defined>	<subclause # for subclass definition #N>

[Table 3](#) specifies the template to be used for defining a specific property.

Table 3 — Template for defining properties

Attribute of the property	Value of the attribute
ID of the property	<ID of the property >
Preferred name	<preferred name of the property >
Description of the property	<description of the property >
Source of the description	<source of the description>
Value type	< type of the property value which is defined in 3.4 >
Code of quantity	< Identifier of quantity defined by IEC TS 62720. This attribute applies properties whose value type is MeasureType.>
Coding system	<This attribute is used to specify the coding system(s) in case of properties whose value type is CodeType.>

The template provides the definition of a specific property of EPE data (identity and meaning) and the attributes for defining it. In some cases, additional rows are added.

Each shaded cell indicates the name of an attribute; the value is shown in the unshaded cell.

A specific property is defined by providing data in the relevant unshaded cells (i.e. the table is filled). An “N/A” in an unshaded cell indicates that the field is not applicable to the definition of the specific property.

The attribute of Code of quantity is used for specifying the quantity of the value specified by the property in the case where its value type is MeasureType.

NOTE Since multiple units of measure can be used for a property, identifiers of quantities defined by IEC TS 62720 is used for specifying the code of quantity, instead of unit of measures. Specifying the unit of measure for properties is out of the scope of this document. In an implementation of exchanging properties, a unit of measure corresponding to the code of quantity is specified separately.

The attribute of Coding system can be used in the following three different ways for properties whose value type is CodeType.

- In the case where a specific existing coding system is used, a reference to the coding system (e.g. designation of standard, URL, name of coding systems) is specified.
- In the case where only the coding system is defined by this document, the Table number of the Table defining it is indicated. In this case, the coding system is defined by using the template specified by [Table 4](#).
- In the case where multiple coding systems can be used, “SELECTABLE” is indicated. In this case, applicable coding systems are listed by using the template specified by [Table 5](#).

[Table 4](#) is the template for specifying the coding system by listing the possible values for properties defined with [Table 3](#), whose value type is CodeType or IndicatorType.

Table 4 — Template for listing possible values of a property

Possible value for the property	Description
<possible value #1 of the property to be defined>	<description of the possible value #1>
...	...
<possible value #N of the property to be defined>	<description of the possible value #N>

[Table 5](#) specifies the template for listing the applicable coding systems for properties defined with [Table 3](#) whose value type is CodeType.

Table 5 — Template for listing applicable coding systems

Designation of coding system	Name of coding system
<designation of coding system #1>	<name of coding system #1>
...	...
<designation of coding system #N>	<name of coding system #N>

3.4 Value types

[Table 6](#) lists value types used by definitions in this document. The pascal case (e.g. PascalCase) is used for reserved terms.

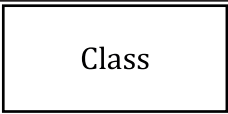
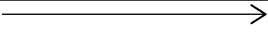
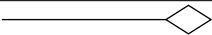
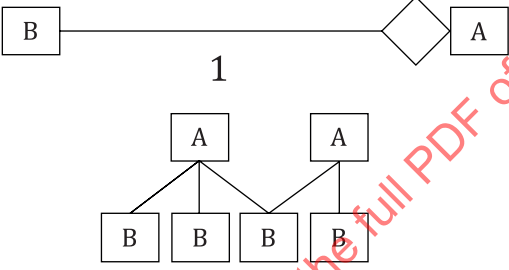
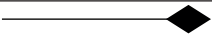
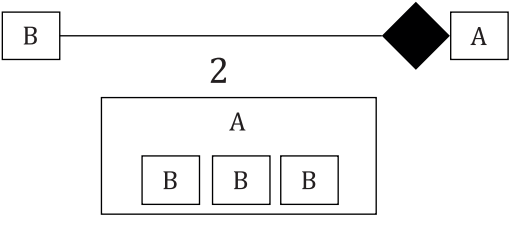
Table 6 — Definitions of value types

Value type designation	Value type description
AmountType	A number of monetary units specified in a currency where the unit of currency is explicit or implied.
BinaryObjectType	A data type representing graphic, picture, sound, video, or other forms of data that can be represented as a finite length sequence of binary octets.
CodeType	A character string that is used to represent an entry from a fixed set of enumerations.
DateTimeType	A particular point in time together with the relevant supplementary information to identify the time zone information. This is a specific instance on time using the ISO 8601 CE (Common Era) calendar extended format and abbreviated versions.
IdentifierType	A character string to identify and distinguish uniquely, one instance of an object in an identification scheme from all other objects in the same scheme.
IndicatorType	A list of two mutually exclusive Boolean values that express the only possible states of a Property. EXAMPLE 1 “True” or “False”.
MeasureType	A numeric value determined by measuring an object along with the specified unit of measure.
NumericType	A number that is assigned or is determined by calculation, counting, or sequencing. It does not require a unit of quantity or unit of measure.
QuantityType	A counted number of non-monetary units, possibly including fractions.
TextType	A character string generally in the form of words of a language. EXAMPLE 2 A finite set of characters.

3.5 UML notation

[Table 7](#) defines the UML notations used in this document.

Table 7 — UML notation used

Symbol	Definition
	Represents a UML class of objects, each with the same types of attributes. Each object is uniquely identifiable or enumerable. No operations or methods are listed for the classes.
 Association Name	An association between elements of a class and elements of another or the same class. Each association is identified. Can have the expected number or range of members of the subclass, when '*' indicates an indeterminate number. EXAMPLE 1 0..* means that zero or more members of the subclass can exist. The semantics of the association are defined in the object relationship table of each object participating in the relationship.
	Generalization (arrow points to the super class) shows that an element of the class is a specialized type of the super class.
	Aggregation shows an element of the class (whole element) is made up of elements of other classes (part elements). EXAMPLE 2  Key 1 Is an aggregation of The aggregation notation identifies that the lifetime of the part element is independent of the whole element. The part element is able to be a part of multiple parent elements. When a whole element is deleted, the part elements are not deleted. The parts' physical relationship is independent of its lifetime relationship. A part can be represented directly in the whole or referenced from the whole.
	A composition relationship represents a whole-part relationship and is a type of aggregation. A composition relationship specifies that the lifetime of the part classifier is dependent on the lifetime of the whole classifier. Composition shows a strong form of aggregation, which requires a) a part instance is included in only one composition at a time and b) the composition object has sole responsibility for disposition of its parts. EXAMPLE 3  Key 2 Is a composite of The composition notation identifies that the lifetime of the part elements is dependent on the whole element. When a whole element is deleted, the part elements are deleted. The parts' physical relationship is independent of its lifetime relationship as a part represented directly in the whole or referenced from the whole.

4 Outline of EPE data

4.1 Overview

[Clause 4](#) outlines the information necessary to specify class definitions for EPE data.

As an introduction to the set of EPE data class definitions which represent structures of EPE data, a simplified overview of class hierarchy and composition relationship of EPE data is shown in [Figure 1](#). Only the major elements are shown in [Figure 1](#). Precise definitions of the EPE data classes are described in [Clause 5](#).

NOTE 1 The relationships between EPE data, EPE data class and EPE data class definition are explained in [4.2](#).

NOTE 2 As a background of EPE data, [Annex A](#) explains a relationship to the other related international standards.

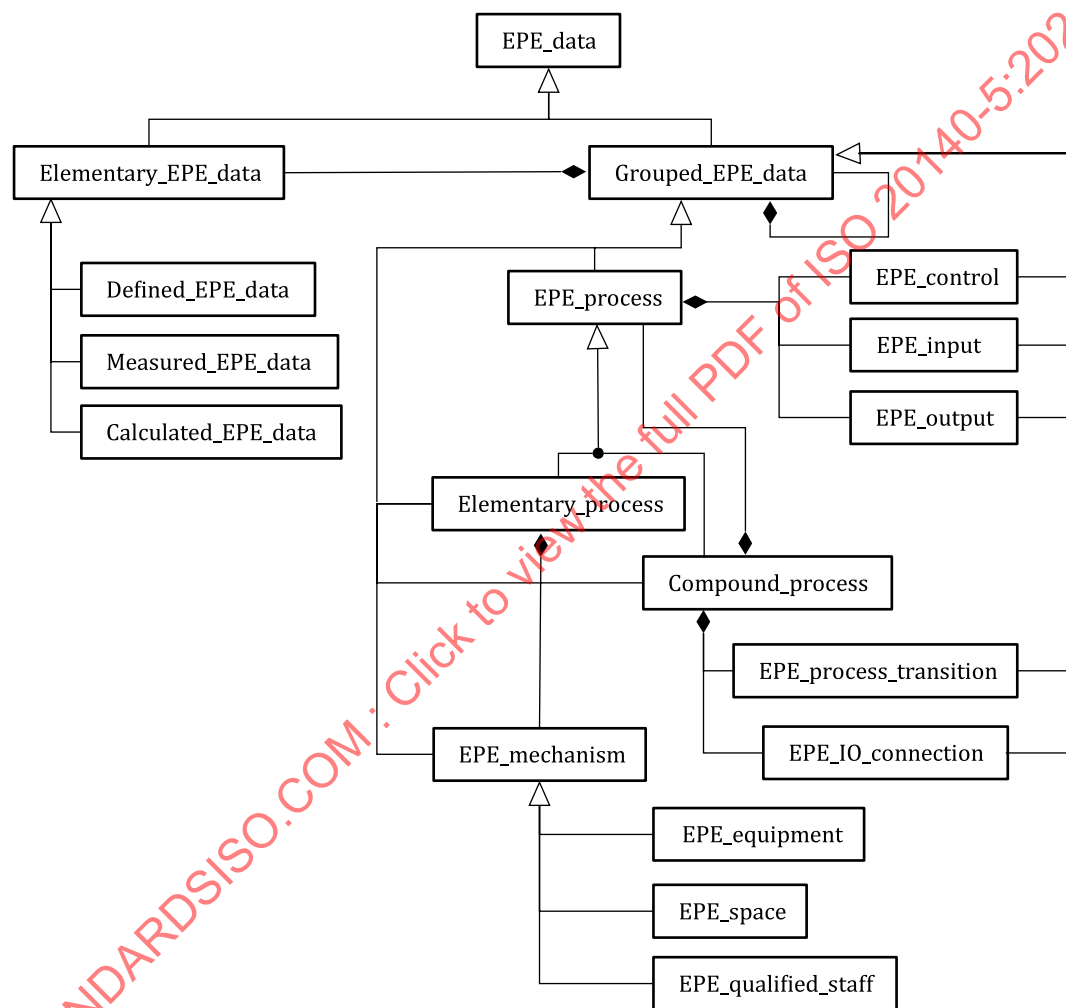


Figure 1 — Overview of classes of EPE data

4.2 EPE data, EPE data class and EPE data class definition

4.2.1 EPE_data

4.2.1.1 Overview

As depicted in [Figure 2](#), EPE_data (see [5.2](#)) can be either Elementary_EPE_data (see [5.3](#)) or Grouped_EPE_data (see [5.4](#)).

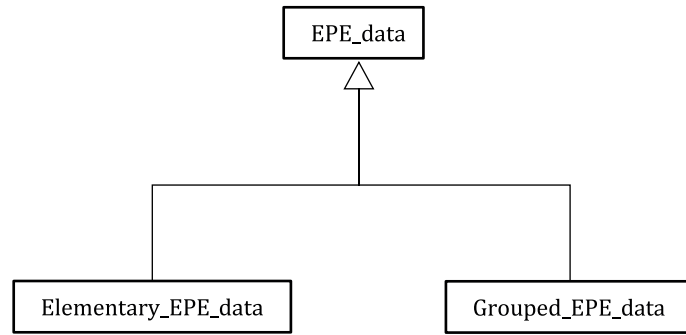


Figure 2 — Overview of classes of EPE_data

4.2.1.2 Elementary_EPE_data

An Elementary_EPE_data has two parts. One part is the EPE_data_value (see 5.3), and the other part is the EPE data description, which explains what the EPE_data_value means.

EXAMPLES Quantity of a particular lot of material, measured power consumption of an instance of a particular type of equipment at a given time, and dimensions of a particular type of equipment in its specification.

An EPE data description has one or more data elements, each of which is a pair of a property and a value corresponding to the property.

The property of a data element specifies what type of characteristic is represented by the data element.

A value of a data element defines a particular characteristic of the EPE data in terms of the type of characteristic given by the property.

Figure 3 shows the structure of Elementary_EPE_data.

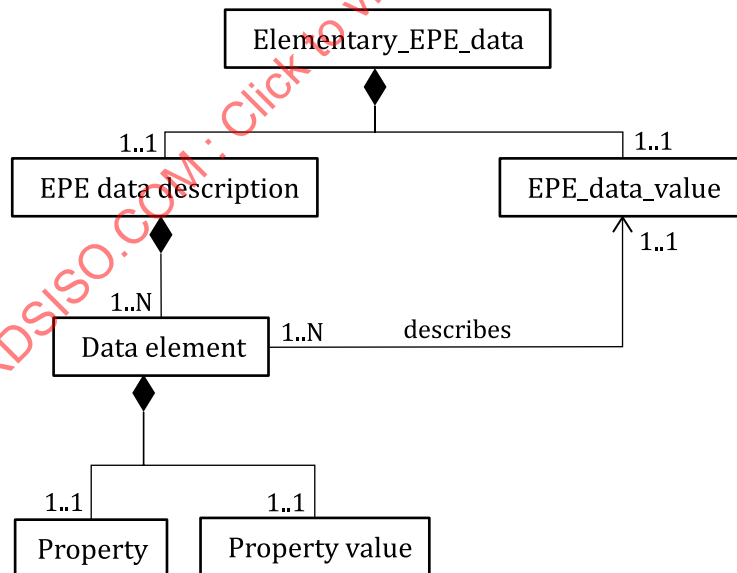


Figure 3 — Elementary_EPE_data

A property consists of multiple pairs, each of which is made of an attribute and the corresponding attribute value.

4.2.1.3 Grouped_EPE_data

A Grouped_EPE_data includes multiple Elementary_EPE_data and represents a tangible or intangible object.

EXAMPLE 1 A process (e.g. particular painting process in a given production line on a given day) and a piece of equipment (e.g. particular pieces of equipment identified by a serial-number in a given production line).

Each Elementary_EPE_data that contributes to the composition of a Grouped_EPE_data represents one characteristic of the object.

EXAMPLE 2 Time duration of a process, and power consumption of a piece of equipment.

Grouped_EPE_data can include other Grouped_EPE_data.

Figure 4 shows the structure of Grouped_EPE_data.

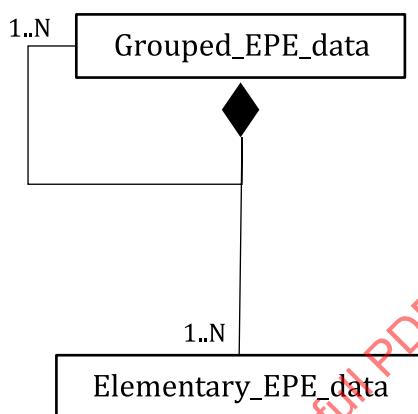


Figure 4 — Grouped_EPE_data

4.2.2 EPE data class

EPE data class is the description of a set of EPE data that share common characteristics.

For Elementary_EPE_data, common characteristics shared by EPE data in an EPE data class are a set of data elements.

EXAMPLE 1 The percentage of a composition of a given material (e.g. percentage of naphtha of a type of crude oil), measured power consumption of an individual of a given type of equipment (e.g. electric power consumption of a press machine), and dimensions of a given type of equipment (e.g. dimensions of conveyer).

For Grouped_EPE_data, common characteristics shared by EPE data in an EPE data class are a set of Elementary_EPE_data.

EXAMPLE 2 A type of process (e.g. painting process), and a type of equipment.

An EPE data class can be defined based on an EPE data class definition by inheriting all properties of the EPE data class definition and assigning values to some properties.

Figure 5 shows the relationship between EPE data class and EPE data.

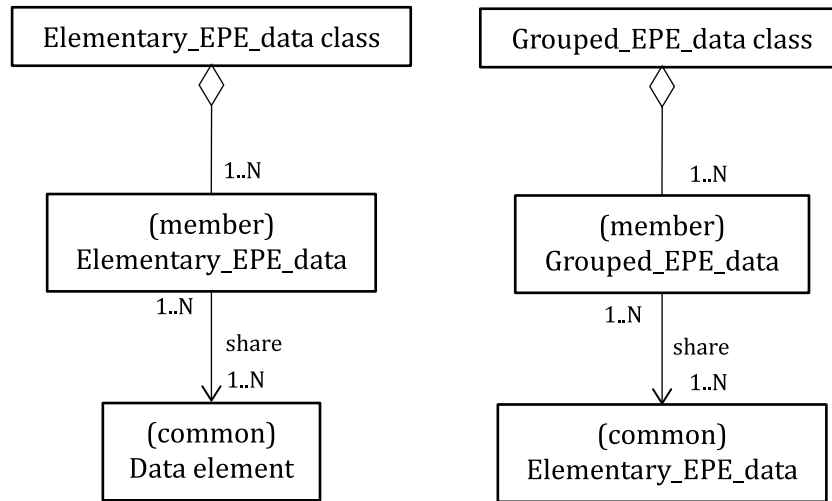


Figure 5 — Relationship between EPE data class and EPE data

Values of properties and EPE_data_values of EPE data classes can be left undefined.

Each EPE data can be deemed as an implementation of an EPE data class that represents a group of EPE data that shares common characteristics.

4.2.3 Descriptions of EPE data class definition

EPE data class definition is a collection of references to properties, that defines the structure of a group of EPE data classes that share the same structure.

EPE data class definition is used as a template for defining EPE data classes, but it includes neither value of a property nor EPE data value. An EPE data class definition defines only the common structure of EPE data classes by using references to properties and references to other EPE data class definitions.

A structure of EPE data class definition together with definitions of related properties provides the semantics of EPE data independent from real implementations of the manufacturing system.

Figure 6 shows the structure of EPE data class definition and its relationship with EPE data class and EPE data.

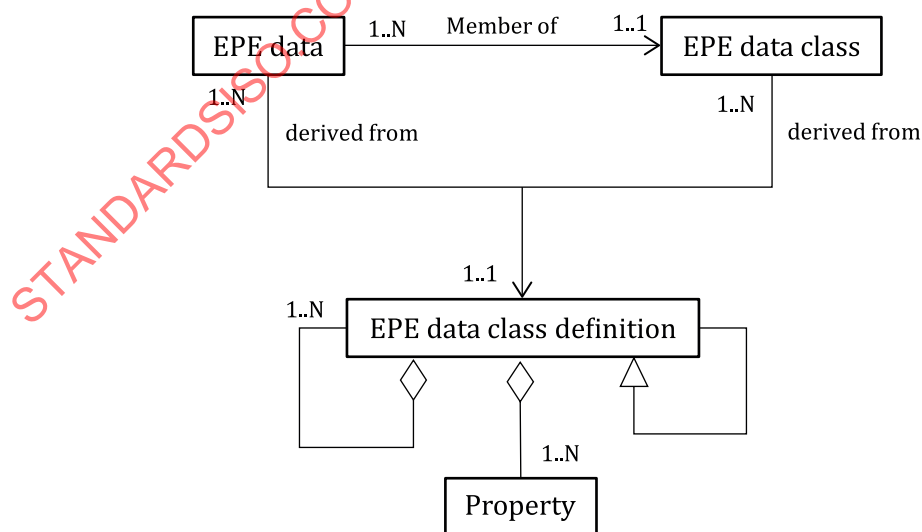


Figure 6 — Structure of EPE data class definition

NOTE This document defines a common set of EPE data class definitions so that EPE data classes can be defined and necessary EPE data can be used.

4.2.4 Hierarchy of EPE data class definitions

EPE data class definitions have two types of hierarchies. One is the inheritance hierarchy where the “is a” relationship associates two EPE data class definitions. The other is the structural hierarchy where the “has” relationship associates two EPE data class definitions (see [Figure 6](#)).

In an “is a” relationship, all properties of the parent EPE data class definition are inherited by the child EPE data class definition. As a result, properties of an EPE data class derived from the parent EPE data class definition are inherited to every child EPE data class derived from the child EPE data class definition.

In a “has” relationship, all properties of all given constituent EPE data class definitions are included in the EPE data class definition to be defined. It is allowed to specify multiple constituent EPE data class definitions in an EPE data class definition. As a result, an EPE data class derived from the EPE data class definition includes EPE data class derived from the constituent EPE data class definition included in the EPE data class definition. Furthermore, an EPE data that is derived from the EPE data class includes the constituent EPE data.

EXAMPLE EPE process has EPE input. An energy consuming process is a type of EPE process which has an EPE input. Therefore, the energy consuming process also has an EPE input, although EPE input is actually the energy input.

4.3 EPE_process

4.3.1 Overview

An EPE_process (see [5.4.2](#)), which is a type of Grouped_EPE_data, represents a manufacturing process.

An EPE_process can be a manufacturing process to be evaluated by EPE specified by ISO 20140-2 or a constituent activity which is a result of the decomposition sub-process specified by ISO 20140-3.

An EPE_process includes one or more EPE_inputs (see [5.4.3](#)), one or more EPE_outputs (see [5.4.4](#)) and an EPE_control (see [5.4.6](#)).

Each EPE_input or EPE_output is directly associated with a particular environmental influence.

There are two types of EPE_process. One type is the Elementary_process (see [5.4.2.2](#)) and the other is the Compound_process (see [5.4.2.9](#)).

[Figure 7](#) shows the structure of EPE_process.

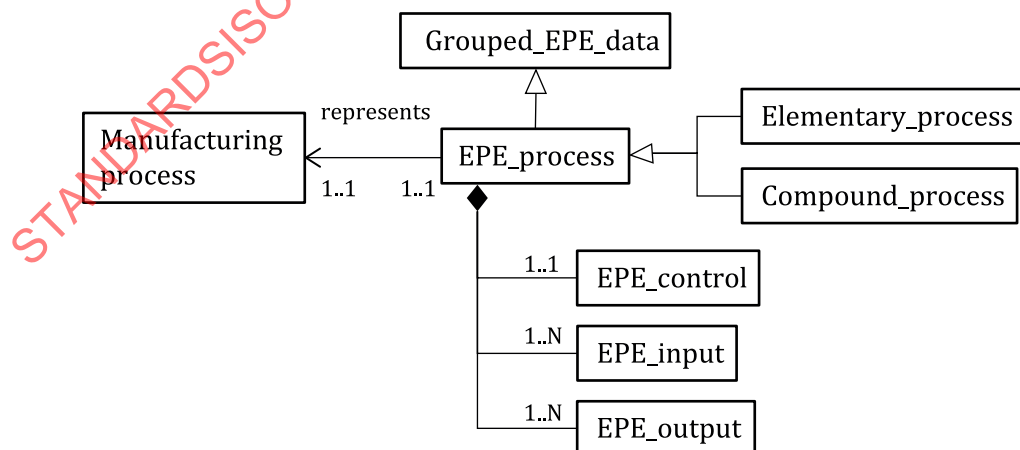


Figure 7 — Structure of EPE_process

4.3.2 Elementary_process

An `Elementary_process` is an `EPE_process` that has no `EPE_process` within. It has one or more `EPE_mechanism` (see 5.4.5).

Figure 8 shows the structure of `Elementary_process`.

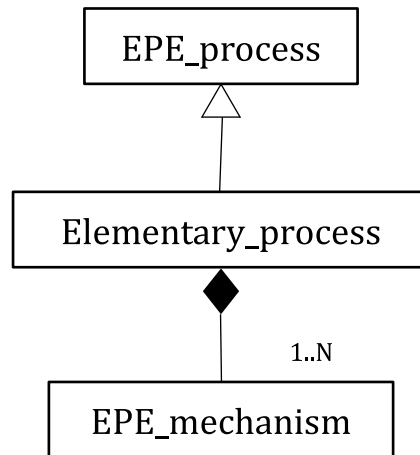


Figure 8 — Structure of `Elementary_process`

4.3.3 Compound_process

A `Compound_process` is an `EPE_process` that includes two or more `EPE_process` classes. `EPE_process` classes in a `Compound_process` can be associated by `EPE_process_transition` classes (see 5.4.7). A `Compound_process` can have `EPE_IO_connection` classes (see 5.3.5) which associate `EPE_input` classes and `EPE_output` classes of the `Compound_process` and of its constituent `EPE_process` classes.

A `Compound_process` has a structural hierarchy. Each `EPE_process` of a `Compound_process` is an `Elementary_process` or a `Compound_process`, i.e. a `Compound_process` can be broken down into multiple `Elementary_process` classes.

NOTE This break down process corresponds to the decomposition sub-process specified in ISO 20140-3.

All `EPE_mechanism` classes used by the `Compound_process` are included in the `Elementary_process` classes of the `Compound_process`, and a `Compound_process` does not directly have any `EPE_mechanism`.

Figure 9 shows the structure of a `Compound_process`.

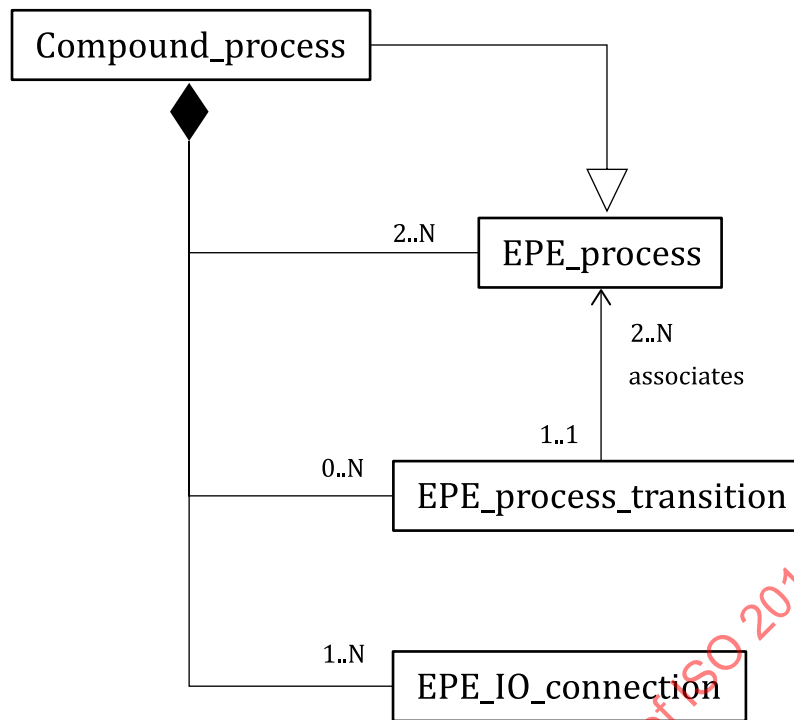


Figure 9 — Structure of Compound_process

[Figure 10](#) shows an example of a Compound_process. It depicts a Compound_process consisting of three Elementary_process classes and one Compound_process.

The Compound_process X starts with Elementary_process A. After completion of the Elementary_process A, Elementary_process B and Elementary_process C are triggered and executed in parallel. After both Elementary_process B and Elementary_process C completed, the Compound_process Y is triggered and executed. After the Compound_process Y is completed, the Compound_process X ends.

Input 1 and Input 2 of the Compound_process X are connected internally to an input of Elementary_process A and an input of Elementary_process C respectively.

The output of Elementary_process A is connected to an input of Elementary_process B, the output of Elementary_process B is connected to an input of Compound_process Y. The output of Compound_process Y is connected to the output of Compound_process X internally.

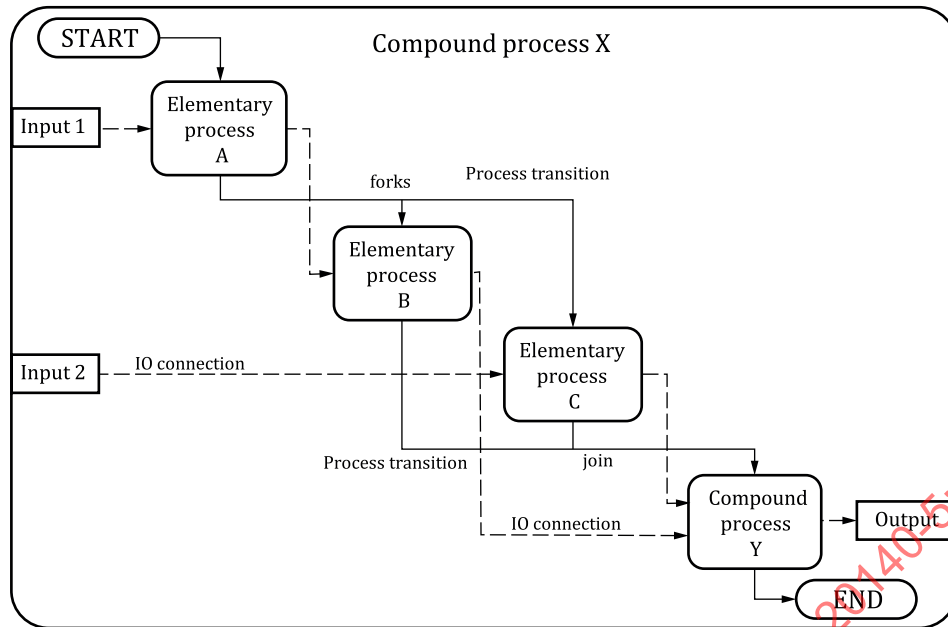


Figure 10 — Example of Compound_process

4.3.4 EPE_process_transition

An EPE_process_transition is a Grouped_EPE_data that associates one or more leading processes to one or more following processes in terms of sequence of execution.

An EPE_process_transition having only one leading process and multiple following processes is called “fork”, and An EPE_process_transition having only one following process and multiple leading processes is called “join”.

EPE_process_transition classes allow a Compound_process to represent its activities executed in parallel and its activities executed in serial.

Figure 11 shows the structure of an EPE_process_transition.

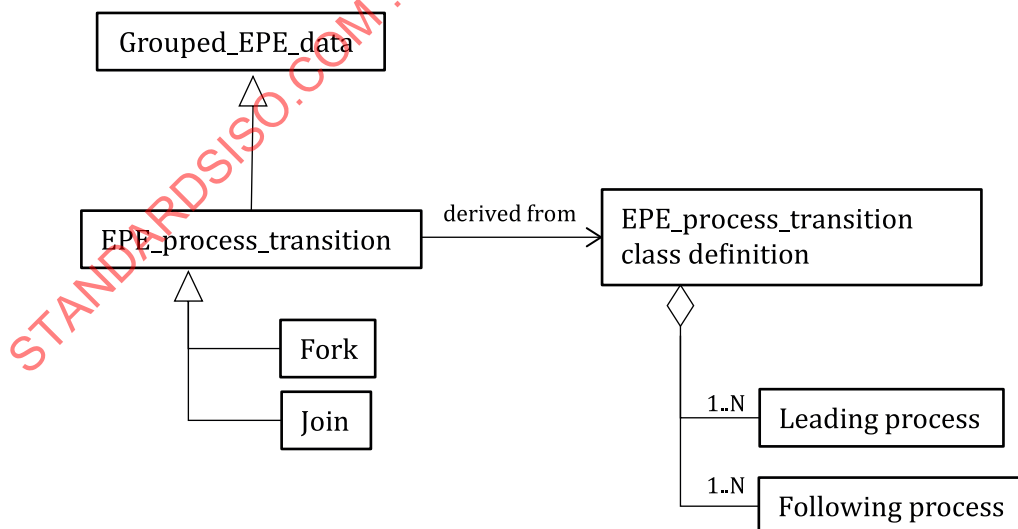


Figure 11 — Structure of EPE_process_transition

4.3.5 EPE_IO_connection

An EPE_IO_connection is a Grouped_EPE_data that associates

- an EPE_input of a Compound_process and an EPE_input of its constituent EPE_process,
- an EPE_output of a constituent EPE_process and an EPE_input of another constituent EPE_process, or
- an EPE_output of a constituent EPE_process and an EPE_output of the Compound_process.

A Compound_process can have EPE_input classes and EPE_output classes. The EPE_input classes are usually associated with EPE_input classes of its constituent EPE_process classes. Some of the EPE_input classes of constituent EPE_process classes are associated with EPE_output classes of other constituent EPE_process classes and do not appear as EPE_input classes of the Compound_process. Similarly, although the EPE_output classes are usually associated with EPE_output classes of its constituent EPE_process classes, some of the EPE_output classes of constituent EPE_process classes can be associated with EPE_input classes of other constituent EPE_process classes and do not appear as EPE_output classes of the Compound_process.

Figure 12 shows the structure of EPE_IO_connection.

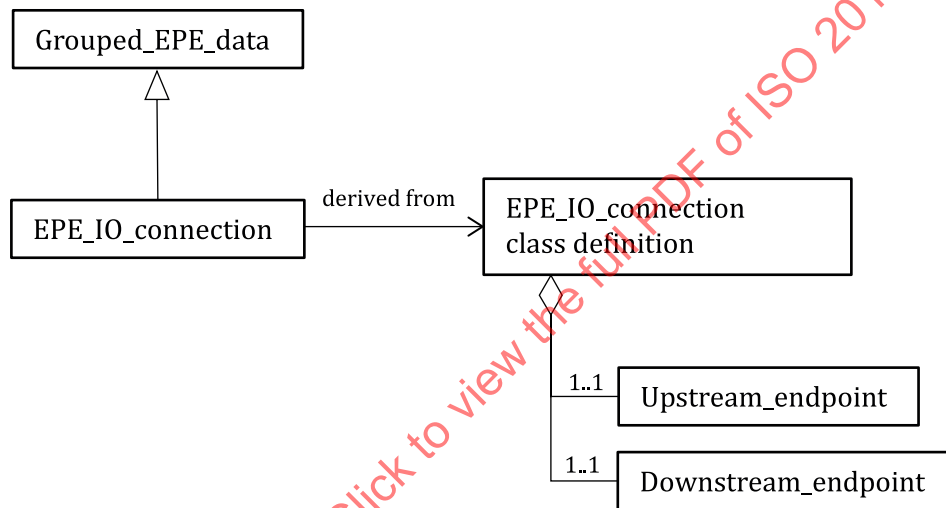


Figure 12 — Structure of EPE_IO_connection

4.3.6 Flow_control_process

A Flow_control_process (see 5.4.2.8) is an Elementary_process and has one or more EPE_input classes and one or more EPE_output classes, dedicated for branching and merging of flows between EPE_output classes and EPE_input classes of different EPE_process classes. It is also possible to buffer the flow.

In the case of branching, it has only one EPE_input and multiple EPE_output classes. It can store the input temporally with upper limit.

4.4 EPE_input

An EPE_input is a Grouped_EPE_data that represents a particular type of input to EPE_process classes together with its Upstream_data (see 5.4.3.9), which represents accumulated environmental influence caused before the input reaches the EPE_process.

NOTE The Upstream_data of EPE_input is used to evaluate environmental influence caused by EPE process that has the EPE_input and consumes it.

EXAMPLE 1 Energy, material, part, assembly, and consumable.

EXAMPLE 2 Information about quantity of GHG emission caused by producing input parts and information about energy used for transporting input material from the place it is produced.

The quantity of EPE_input is represented by an Elementary_EPE_data, although the way to indicate it depends on the type of EPE_input. Therefore, a corresponding type of Elementary_EPE_data is used depending on the type of EPE_input.

EXAMPLE 3 Number of pieces of a part, mass of material, volume of material in gas phase, quantity of energy in electricity.

Some types of EPE_input can be considered as environmental influence about a particular type of environmental aspect caused by the process.

EXAMPLE 4 Consuming energy, consuming material of limited earth resource.

The Upstream_data is a Grouped_EPE_data that represents accumulated environmental influence caused before the input is coming to the process or before the output is going out from the process.

Upstream_data can include information about consumed energy, consumed materials, emitted GHGs and emitted harmful substances.

Figure 13 shows the structure of EPE_input.

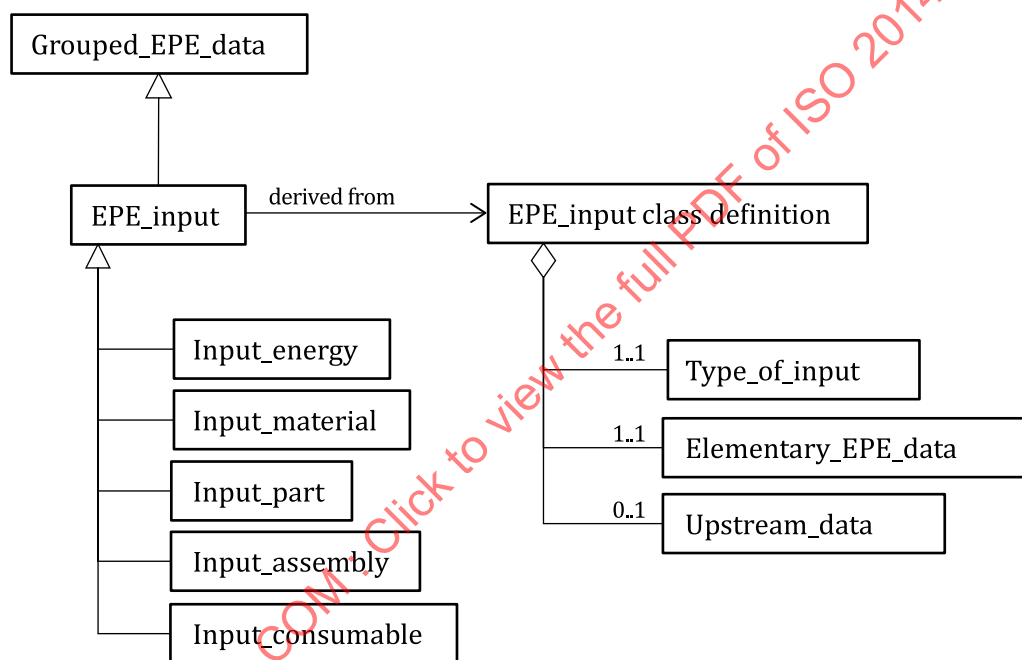


Figure 13 — Structure of EPE_input

Energy used by the manufacturing system can be obtained from various sources. For example, the electric energy can be generated by hydroelectric or fossil-fuel power plants or by renewable sources of energy such as wind and solar energy. The environmental impact of generating, transmitting, storing, and distributing energy depends on the energy resource and the technology used to convert and supply the energy to the manufacturing system.

4.5 EPE_output

An EPE_output is a Grouped_EPE_data that represents a particular type of output from EPE_process classes together with its Upstream_data, which represents accumulated environmental influence caused before the output is passed to the following EPE_process.

NOTE The Upstream_data of EPE_output is used by the EPE_process in the downstream.

EXAMPLE 1 Final product, by-product, energy, GHG, and harmful substance.

Some types of EPE_output can be considered as environmental influence about a particular type of environmental aspect caused by the EPE_process.

EXAMPLE 2 Emitting GHG, emitting harmful substance.

The quantity of EPE_output is represented by an Elementary_EPE_data, although the way to indicate it depends on the type of EPE_output. Therefore, a corresponding type of Elementary_EPE_data is used depending on the type of EPE_output.

Figure 14 shows the structure of EPE_output.

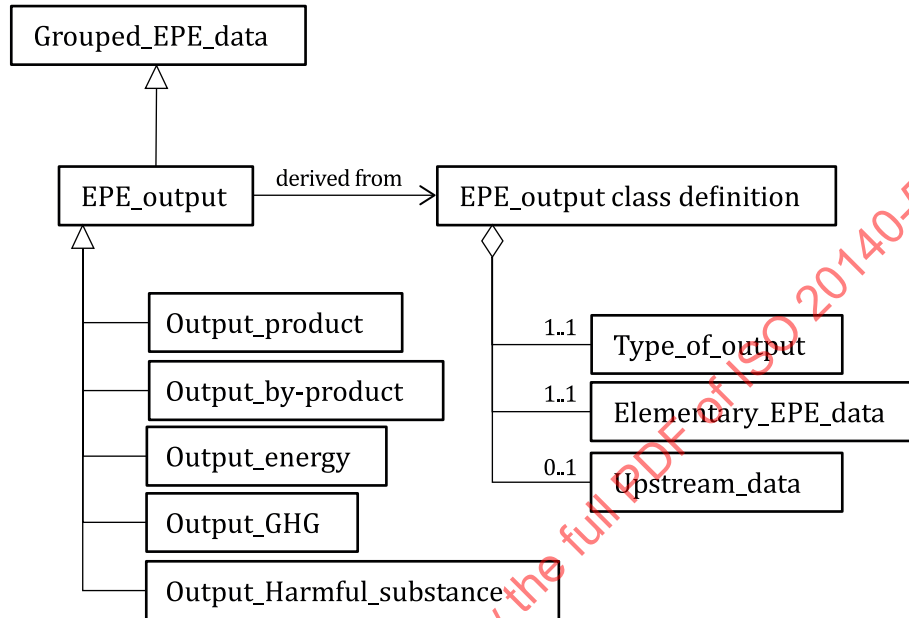


Figure 14 — Structure of EPE_output

4.6 EPE_mechanism

4.6.1 General

An EPE_mechanism is a Grouped_EPE_data that represents the means used to perform a function of Elementary_process classes.

EXAMPLE 1 Equipment, person, and space.

An EPE_mechanism can include multiple Elementary_EPE_data which represent characteristics of the EPE_mechanism and are used to calculate the quantity of EPE_input classes or the quantity of EPE_output classes, or both, of the EPE_process.

EXAMPLE 2 Rated power consumption of a type of equipment can be used for calculating input energy of an EPE_process.

EXAMPLE 3 Volume of space that requires air conditioning can be used for calculating input energy of an EPE_process.

EXAMPLE 4 The area of workspace that requires lighting can be used for calculating input energy of an EPE_process.

An EPE_mechanism can have structural hierarchy by having other EPE_mechanism classes as its constituents.

NOTE This feature can be used to represent complicated structured equipment.

Figure 15 shows the structure of an EPE_mechanism.

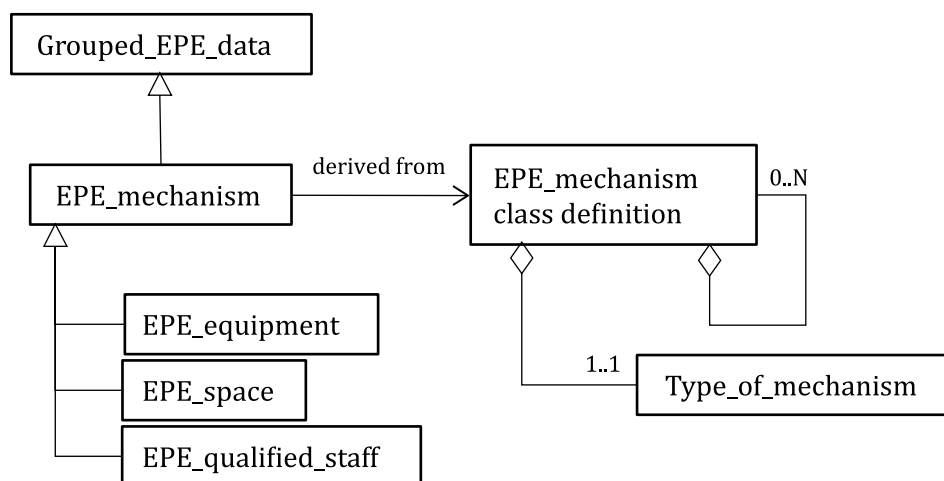


Figure 15 — Structure of EPE_mechanism

4.6.2 EPE_equipment

EPE_equipment (see 5.4.5.2) is a type of EPE_mechanism that represents a piece of equipment used in the Elementary_process.

An EPE_equipment as an EPE data represents a particular piece of individual equipment that exists in real world or is virtually planned, for a particular application. It has one or more Elementary_EPE_data based on the corresponding EPE_equipment class definition defined by 5.4.5.2. EPE_data_value of each Elementary_EPE_data represents the characteristics of the equipment in terms of the Elementary_EPE_data.

EXAMPLE 1 An NC machine installed in a particular production line in the real world.

EXAMPLE 2 A planned production line designed including some NC machines for a particular factory site.

An EPE_equipment as an EPE data class represents a type of designed equipment. It has one or more Elementary_EPE_data based on the corresponding EPE_equipment class definition defined by 5.4.5.2. The EPE_data_value of each Elementary_EPE_data can be left undefined. If it is defined, the EPE_data_value of each Elementary_EPE_data represents the characteristics of the equipment type in terms of the Elementary_EPE_data.

EXAMPLE 3 A type of NC machine designed by a particular vendor.

An EPE_equipment as an EPE data class definition represents a generic common structure of similar types of EPE_equipment classes. It has reference to one or more Elementary_EPE_data, but it has no EPE_data_value.

EXAMPLE 4 A generic type of NC machine.

An EPE_equipment class definition represents a structure of EPE_equipment classes that share a common structure. An EPE_equipment class represents a type of designed equipment. The structure of an EPE_equipment class is derived from the corresponding EPE_equipment class definition. An EPE_equipment as an EPE data is a member of an EPE_equipment class and interpreted as an implementation of the EPE_equipment class.

Each EPE_equipment as an EPE data, or EPE_equipment class has some Elementary_EPE_data, which can be used for calculating an EPE_input or an EPE_output, which is considered as environmental influence, of the corresponding Elementary_process.

EXAMPLE 5 Rated power consumption, designed quantity of GHG emitted, and energy consumed for producing the equipment.

Each EPE_data_value of Elementary_EPE_data of an EPE_equipment as an EPE data can be derived from the EPE_equipment class or defined dedicated to the particular individual of EPE_equipment.

These EPE_data_value of an Elementary_EPE_data for EPE_equipment as an EPE data can differ depending on the mode of operation of the equipment. An EPE_equipment, as either an EPE data or an EPE data class, can include multiple operation modes.

Each operation mode is specified by Possible_EPE_operation_mode (see 5.4.5.5).

EXAMPLE 6 Energy consuming rate, material consuming rate, GHG emission rate.

Figure 16 shows the relationship between EPE_equipment as an EPE data, EPE_equipment class and EPE_equipment class definition.

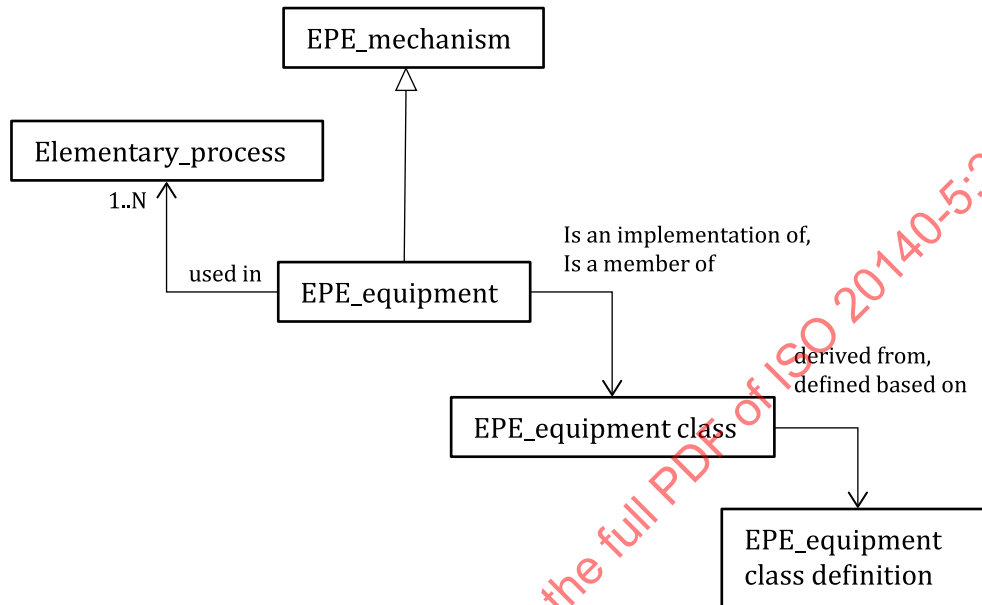


Figure 16 — Relationships between EPE_equipment, EPE_equipment class and EPE_equipment class definition

4.6.3 EPE_space

EPE_space (see 5.4.5.3) is a type of EPE_mechanism that represents physical space used for a process. It includes one or more environmental condition data, which indicate conditions surrounding an EPE_space. Each environmental condition data represents one of environmental conditions defined by the IEC 60721 series.

Environmental condition data includes states in the surrounding environment parameters that might not be controllable (e.g. weather) by the manufacturing system.

The differences in environmental condition data can affect the environmental performance of manufacturing processes.

NOTE 1 Environmental condition data such as the average ambient temperature are relevant when assessing the environmental benefits of using various sources of energy such as heat pumps or electrical heating and cooling.

NOTE 2 Real time measurement of environmental condition data can be critical when the manufacturing process includes thermal or chemical processes.

EXAMPLE 1 The air quality of the environment surrounding the manufacturing system (e.g. air-conditioned manufacturing facility) as well as weather parameters are ECD needed for the EPE of a manufacturing system. Weather can be considered as an environmental condition data, unless the manufacturing system boundaries are factored into a controlled environment, such as an air-conditioned manufacturing facility.

EXAMPLE 2 Demand response data exchanged with the smart grid are also a type of environmental condition data.

4.7 EPE_control

EPE_control is a Grouped_EPE_data that represents control, which is defined as “conditions required to produce correct output”, of a manufacturing process.

EPE_control provides conditions for the EPE_process to execute its process.

An EPE_control has multiple Elementary_EPE_data that specify the conditions. The Elementary_EPE_data include starting time, ending time, and time period required.

Figure 17 shows the structure of EPE_control.

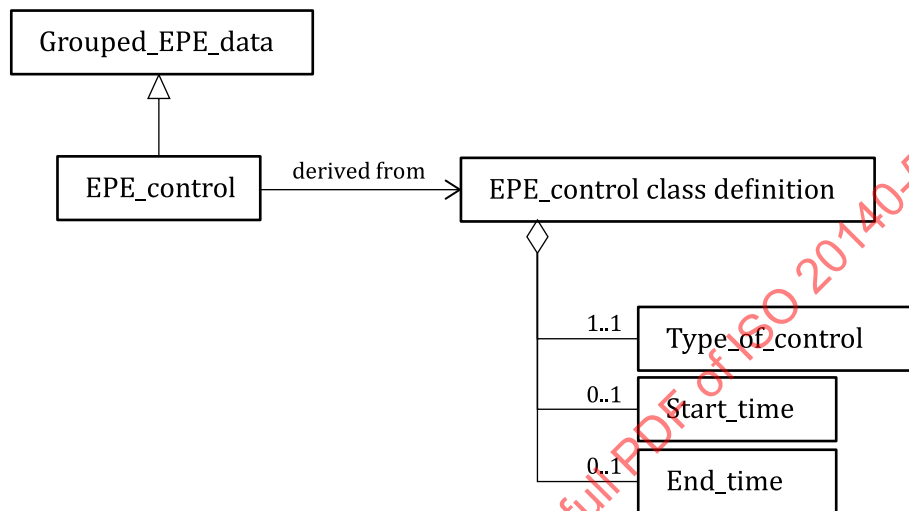


Figure 17 — Structure of EPE_control

5 EPE data class definitions

5.1 Overview

Clause 5 defines class definitions for EPE data.

NOTE To avoid complexity, “class definition” is omitted from the name of each class definition (e.g. EPE_data class definition → EPE_data) in 5.2 to 5.4.

5.2 Class definition of EPE_data

Table 8 shows the overview of EPE_data as a class definition.

Table 8 — Overview of EPE_data

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	EPE_data	
Description of the class definition	the top-level class definition of the semantic structure of EPE data defined by this document	
Preferred name of parent class definition	Subclause number defining the parent class definition	
<None>	<N/A>	
Property included in the class definition	Cardinality	Subclause defining the property
Structure_of_EPE_data	1..1	6.2.42
ID_of_EPE_data_class	1..1	6.2.14

Table 8 (continued)

Location_EPE_data_value_generated	1..1	6.2.19
Functional_Hierarchy_Level	1..1	6.2.13
Timing_EPE_data_value_generated	1..1	6.2.44
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

[Table 9](#) lists subclass definitions in this document that are derived from EPE_data.

Table 9 — Subclass definition of EPE_data

Structure_of_EPE_data	Preferred name of subclass definition	Subclause defining the class definition
Elementary	Elementary_EPE_data	5.3
Grouped	Grouped_EPE_data	5.4

5.3 Class definition of Elementary_EPE_data

5.3.1 General

[Table 10](#) shows the overview of Elementary_EPE_data.

Table 10 — Overview of Elementary_EPE_data

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Elementary_EPE_data	
Description of the class definition	EPE_data that contains only one EPE_data_value	
Preferred name of parent class definition	Subclause number defining the parent class definition	
EPE_data	5.2	
Property included in the class definition	Cardinality	Subclause defining the property
Way_for_generating	0..1	6.2.68
EPE_data_granularity	0..1	6.2.9
EPE_data_resolution	0..1	6.2.10
Quantity_identifier	0..1	6.2.36
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
EPE_data_value	1..1	5.3.1

EPE_data_value is not actually an EPE data class definition but a part of elementary EPE data. EPE_data_value does not have a pair of EPE data description and EPE data value as its elements. EPE_data_value is included in [Table 10](#) for clarifying the location of the value of elementary EPE data. Ultimately, it clarifies where the values of grouped EPE data, which has multiple elementary EPE data, are located.

[Table 11](#) lists subclass definitions in this document that are derived from Elementary_EPE_data.

Table 11 — Subclass definition of Elementary_EPE_data

Way_for_generating	Preferred name of subclass definition	Subclause defining the class definition
Defined	Defined_EPE_data	5.3.2
Measured	Measured_EPE_data	5.3.3
Calculated	Calculated_EPE_data	5.3.4

5.3.2 Class definition of Defined_EPE_data

[Table 12](#) shows the overview of Defined_EPE_data.

Table 12 — Overview of Defined_EPE_data

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Defined_EPE_data	
Description of the class definition	Elementary_EPE_data whose EPE_data_value is defined	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_EPE_data	5.3	
Property included in the class definition	Cardinality	Subclause defining the property
Organization_defining_EPE_data_value	1..1	6.2.31
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

NOTE Defined_EPE_data can be defined in literature, standards, product specifications and product labels.

5.3.3 Class definition of Measured_EPE_data

[Table 13](#) shows the overview of Measured_EPE_data.

Table 13 — Overview of Measured_EPE_data

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Measured_EPE_data	
Description of the class definition	Elementary_EPE_data whose EPE_data_value is obtained by measuring	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_EPE_data	5.3	
Property included in the class definition	Cardinality	Subclause defining the property
Way_of_measurement	0..1	6.2.69
Measuring_equipment_used	0..1	6.2.21
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.3.4 Class definition of Calculated_EPE_data

[Table 14](#) shows the overview of Calculated_EPE_data.

Table 14 — Overview of Calculated_EPE_data

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Calculated_EPE_data	
Description of the class definition	Elementary_EPE_data whose EPE_data_value is obtained by calculation	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_EPE_data	5.3	

Table 14 (continued)

Property included in the class definition	Cardinality	Subclause defining the property
Formula_for_calculation	0..1	6.2.12
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.3.5 Class definition of EPE_IO_connection

[Table 15](#) shows the overview of EPE_IO_connection.

Table 15 — Overview of EPE_IO_connection

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	EPE_IO_connection	
Description of the class definition	Elementary_EPE_data that associate an EPE_input or an EPE_output of an EPE_process with an EPE_inut or an EPE_output of another EPE_process	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_EPE_data	5.3	
Property included in the class definition	Cardinality	Subclause defining the property
Upstream_endpoint	1..1	6.2.67
Downstream_endpoint	1..1	6.2.6
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.3.6 Class definition of Environmental_condition_data

[Table 16](#) shows the overview of Environmental_condition_data.

Table 16 — Overview of Environmental_condition_data

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Environmental_condition_data	
Description of the class definition	Elementary_EPE_data that indicates a condition surrounding an EPE_space	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_EPE_data	5.3	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_environmental_condition	1..1	6.2.49
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4 Class definition of Grouped_EPE_data

5.4.1 General

[Table 17](#) shows the overview of Grouped_EPE_data.

Table 17 — Overview of Grouped_EPE_data

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Grouped_EPE_data	
Description of the class definition	EPE_data that contains multiple EPE data value	
Preferred name of parent class definition	Subclause number defining the parent class definition	
EPE_data	5.2	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_grouped_EPE_data	1..1	6.2.52
Number_of_properties	1..1	6.2.28
Number_of_class_definitions	1..1	6.2.25
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

NOTE The class definitions included in Grouped_EPE_data depend on the type of grouped EPE data. They are defined in the subclass derived from Grouped_EPE_data.

[Table 18](#) lists subclass definitions in this document that are derived from Grouped_EPE_data.

Table 18 — Subclass definition of Grouped_EPE_data

Type_of_grouped_EPE_data	Preferred name of subclass definition	Subclause defining the class definition
process	EPE_process	5.4.2
input	EPE_input	5.4.3
output	EPE_output	5.4.4
mechanism	EPE_mechanism	5.4.5
control	EPE_control	5.4.6
process_transition	EPE_process_transition	5.4.7

5.4.2 Class definition of EPE_process

5.4.2.1 General

[Table 19](#) shows the overview of EPE_process.

Table 19 — Overview of EPE_process

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	EPE_process	
Description of the class definition	Grouped_EPE_data that represents a manufacturing process to be evaluated or its constituent processes	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Grouped_EPE_data	5.4	
Property included in the class definition	Cardinality	Subclause defining the property
Structure_of_process	1..1	6.2.43
EPE_process_identifier	1..1	6.2.11

Table 19 (continued)

Class definitions included in this class definition	Cardinality	Subclause defining the class definition
EPE_control	1..1	5.4.6
EPE_input	1..n	5.4.3
EPE_output	1..n	5.4.4

[Table 20](#) lists subclass definitions in this document that are derived from EPE_process.

Table 20 — Subclass definition of EPE_process

Structure_of_process	Preferred name of subclass definitions	Subclause defining the class definition
Elementary	Elementary_process	5.4.2.2
Compound	Compound_process	5.4.2.9

5.4.2.2 Class definition of Elementary_process

[Table 21](#) shows the overview of Elementary_process.

Table 21 — Overview of Elementary_process

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Elementary_process	
Description of the class definition	EPE_process that includes no EPE_process_transition	
Preferred name of parent class definition	Subclause number defining the parent class definition	
EPE_process	5.4.2	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_process	1..1	6.2.61
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
EPE_mechanism	1..n	5.4.5

[Table 22](#) lists subclass definitions in this document that are derived from Elementary_process.

Table 22 — Subclass definition of Elementary_process

Type_of_process	Preferred name of subclass definition	Subclause defining the class definition
Energy_consuming	Energy_consuming_process	5.4.2.3
Material_consuming	Material_consuming_process	5.4.2.4
Consumable_consuming	Consumable_consuming_process	5.4.2.5
GHG_emitting	GHG_emitting_process	5.4.2.6
Harmful_substances_emitting	Harmful_substances_emitting_process	5.4.2.7
Flow_control	Flow_control_process	5.4.2.8

5.4.2.3 Class definition of Energy_consuming_process

[Table 23](#) shows the overview of Energy_consuming_process.

Table 23 — Overview of Energy_consuming_process

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Energy_consuming_process	
Description of the class definition	Elementary_process that consumes a specific type of energy	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_process	5.4.2.2	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_energy	1..1	6.2.48
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
Input_energy	1..1	5.4.3.2
Output energy	0..n	5.4.4.3

EXAMPLE Examples for Energy_consuming_process are: electricity consuming process, fuel energy consuming process, and heat energy consuming process.

5.4.2.4 Class definition of Material_consuming_process

[Table 24](#) shows the overview of Material_consuming_process.

Table 24 — Overview of Material_consuming_process

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Material_consuming_process	
Description of the class definition	Elementary_process that consumes a specific type of materials	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_process	5.4.2.2	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_material	1..1	6.2.56
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
Input_matrial	1..1	5.4.3.3

5.4.2.5 Class definition of Consumable_consuming_process

[Table 25](#) shows the overview of Consumable_consuming_process.

Table 25 — Overview of Consumable_consuming_process

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Consumable_consuming_process	
Description of the class definition	Elementary_process that consumes a specific type of consumable	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_process	5.4.2.2	
Property included in the class definition	Cardinality	Subclause defining the property

Table 25 (continued)

Type_of_consumable	1..1	6.2.46
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
Input_consumable	1..1	5.4.3.8

5.4.2.6 Class definition of GHG_emitting_process

[Table 26](#) shows the overview of GHG_emitting_process.

Table 26 — Overview of GHG_emitting_process

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	GHG_emitting_process	
Description of the class definition	Elementary_process that emits a specific type of GHG	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_process	5.4.2.2	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_GHG	1..1	6.2.55
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
Output_GHG	1..1	5.4.4.4

5.4.2.7 Class definition of Harmful_substances_emitting_process

[Table 27](#) shows the overview of Harmful_substances_emitting_process.

Table 27 — Overview of Harmful_substances_emitting_process

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Harmful_substances_emitting_process	
Description of the class definition	Elementary_process that emits a specific type of Harmful_substances	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_process	5.4.2.2	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_Harmful_substance	1..1	6.2.54
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
Output_Harmful_substance	1..1	5.4.4.5

5.4.2.8 Class definition of Flow_control_process

[Table 28](#) shows the overview of Flow_control_process.

Table 28 — Overview of Flow_control_process

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Flow_control_process	
Description of the class definition	Elementary_process that performs branching, merging and buffering the flows between EPE outputs and EPE inputs of different EPE processes	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_process	5.4.2.2	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_flow_control	1..1	6.2.51
Capacity_of_buffering	0..1	6.2.2
Number_of_branches	0..1	6.2.24
Distribution_ratio	0..n	6.2.5
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
EPE_input	1..n	5.4.3
EPE_output	1..n	5.4.4

NOTE The cardinalities of EPE_input and EPE_output depend on the Type_of_flow_control.

5.4.2.9 Class definition of Compound_process

[Table 29](#) shows the overview of Compound_process.

Table 29 — Overview of Compound_process

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Compound_process	
Description of the class definition	EPE_process that includes at least one EPE_process_transition	
Preferred name of parent class definition	Subclause number defining the parent class definition	
EPE_process	5.4.2	
Property included in the class definition	Cardinality	Subclause defining the property
Number_of_EPE_processes	1..1	6.2.29
Number_of_EPE_process_transitions	1..1	6.2.26
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
EPE_process	2..n	5.4.2
EPE_process_transition	0..n	5.4.7
EPE_IO_connection	1..n	5.3.5

5.4.3 Class definition of EPE_input

5.4.3.1 General

[Table 30](#) shows the overview of EPE_input.

Table 30 — Overview of EPE_input

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	EPE_input	
Description of the class definition	Grouped_EPE_data that represents a particular type of input to a manufacturing process	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Grouped_EPE_data	5.4	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_input	1..1	6.2.53
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
Upstream_data	0..1	5.4.3.9
Elementary_EPE_data	1..1	5.3

NOTE Each of the different types of input is represented by an independent EPE_input.

[Table 31](#) lists subclass definitions in this document that are derived from EPE_input.

Table 31 — Subclass definition of EPE_input

Type_of_input	Preferred name of subclass definition	Subclause defining the class definition
energy	Input_energy	5.4.3.2
material	Input_material	5.4.3.3
part	Input_part	5.4.3.4
assembly	Input_assembly	5.4.3.7
consumable	Input_consumable	5.4.3.8

5.4.3.2 Class definition of Input_energy

[Table 32](#) shows the overview of Input_energy.

Table 32 — Overview of Input_energy

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Input_energy	
Description of the class definition	EPE_input that represents quantity of a specific type of energy input to a manufacturing process	
Preferred name of parent class definition	Subclause number defining the parent class definition	
EPE_input	5.4.3	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_energy	1..1	6.2.48
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.3.3 Class definition of Input_material

[Table 33](#) shows the overview of Input_material.

Table 33 — Overview of Input_material

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Input_material	
Description of the class definition	EPE_input representing quantity of a specific type of material that is used by the manufacturing process, and that becomes a part of product	
Preferred name of parent class definition	Subclause number defining the parent class definition	
EPE_input	5.4.3	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_material	1..1	6.2.56
Phase_of_material	1..1	6.2.35
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.3.4 Class definition of Input_part

[Table 34](#) shows the overview of Input_part.

Table 34 — Overview of Input_part

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Input_part	
Description of the class definition	EPE_input representing number of a specific type of part that is used by a manufacturing process, and that becomes a part of the product	
Preferred name of parent class definition	Subclause number defining the parent class definition	
EPE_input	5.4.3	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_part	1..1	6.2.59
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

[Table 35](#) lists subclass definitions in this document that are derived from Input_part.

Table 35 — Subclass definition of Input_part

Type_of_part	Preferred name of subclass definition	Subclause defining the class definition
Mechanical	Mechanical_part	5.4.3.5
Electric or Electronic	Electric_or_electronic_component	5.4.3.6

5.4.3.5 Class definition of Mechanical_part

[Table 36](#) shows the overview of Mechanical_part.

Table 36 — Overview of Mechanical_part

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Mechanical_part	
Description of the class definition	Input_part representing number of a specific type of mechanical parts	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Input_part	5.4.3.4	
Property included in the class definition	Cardinality	Subclause defining the property
Dimension	1..n	6.2.4
Type_of_material	1..1	6.2.56
Mass_of_part	1..1	6.2.20
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.3.6 Class definition of Electric_or_electronic_component

[Table 37](#) shows the overview of Electric_or_electronic_component.

Table 37 — Overview of Electric_or_electronic_component

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Electric_or_electronic_component	
Description of the class definition	Input_part representing number of a specific type of electric or electronic component	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Input_part	5.4.3.4	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_electric_or_electronic_component	1..1	6.2.47
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.3.7 Class definition of Input_assembly

[Table 38](#) shows the overview of Input_assembly.

Table 38 — Overview of Input_assembly

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Input_assembly	
Description of the class definition	EPE_input representing number of a specific type of assembly that is used by a manufacturing process, and that becomes a part of the product	
Preferred name of parent class definition	Subclause number defining the parent class definition	
EPE_input	5.4.3	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_assembly	1..1	6.2.45
Dimension	1..n	6.2.4

Table 38 (continued)

Identifier_of_part	1..n	6.2.16
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.3.8 Class definition of Input_consumable

[Table 39](#) shows the overview of Input_consumable.

Table 39 — Overview of Input_consumable

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Input_consumable	
Description of the class definition	EPE_input representing quantity of specific type of consumable that is used and consumed by a manufacturing process	
Preferred name of parent class definition	Subclause number defining the parent class definition	
EPE_input	5.4.3	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_consumable	1..1	6.2.46
Recommended_replacement_cycle	1..1	6.2.37
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.3.9 Class definition of Upstream_data

[Table 40](#) shows the overview of Upstream_data.

Table 40 — Overview of Upstream_data

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Upstream_data	
Description of the class definition	Grouped_EPE_data representing accumulated environmental influence caused before the input is coming into the process or before output is going out from the process	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Grouped_EPE_data	5.4	
Property included in the class definition	Cardinality	Subclause defining the property
type_of_upstream_data	1..1	6.2.66
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
Upstream_energy_consumed	0..n	5.4.3.10
Upstream_material_consumed	0..n	5.4.3.11
Upstream_GHG_emitted	0..n	5.4.3.12
Upstream_Harmful_substance_emitted	0..n	5.4.3.13

5.4.3.10 Class definition of Upstream_energy_consumed

[Table 41](#) shows the overview of Upstream_energy_consumed.

Table 41 — Overview of Upstream_energy_consumed

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Upstream_energy_consumed	
Description of the class definition	Elementary_EPE_data representing the quantity of a specific type of energy that has been consumed before the input is coming into the process or before the output is going out from the process	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_EPE_data	5.3	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_energy	1..1	6.2.48
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.3.11 Class definition of Up_steam_material_consumed

[Table 42](#) shows the overview of Upsteam_material_consumed.

Table 42 — Overview of Upsteam_material_consumed

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Upsteam_material_consumed	
Description of the class definition	Elementary_EPE_data representing the quantity of a specific type of material that has been consumed before the input is coming into the process or before the output is going out from the process	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_EPE_data	5.3	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_material	1..1	6.2.56
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.3.12 Class definition of Upstream_GHG_emitted

[Table 43](#) shows the overview of Upstream_GHG_emitted.

Table 43 — Overview of Upstream_GHG_emitted

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Upstream_GHG_emitted	
Description of the class definition	Elementary_EPE_data representing the quantity of a specific type of GHG that has been emitted before the input is coming into the process or before the output is going out from the process	
Preferred name of parent class definition	Subclause number defining the parent class definition	

Table 43 (continued)

Elementary_EPE_data	5.3	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_GHG	1..1	6.2.55
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.3.13 Class definition of Upstream_Harmful_substance_emitted

[Table 44](#) shows the overview of Upstream_Harmful_substance_emitted.

Table 44 — Overview of Upstream_Harmful_substance_emitted

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Upstream_Harmful_substance_emitted	
Description of the class definition	Elementary_EPE_data representing the quantity of a specific type of Harmful substance that has been emitted before the input is coming into the process or before the output is going out from the process	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_EPE_data	5.3	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_Harmful_substance	1..1	6.2.54
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.4 Class definition of EPE_output

5.4.4.1 General

[Table 45](#) shows the overview of EPE_output.

Table 45 — Overview of EPE_output

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	EPE_output	
Description of the class definition	Grouped_EPE_data that represent quantity of a particular type of output from a manufacturing process	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Grouped_EPE_data	5.4	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_output	1..1	6.2.58
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
Upstream_data	0..1	5.4.3.9
Elementary_EPE_data	1..1	5.3

NOTE Each of the different types of output is represented by an independent EPE_output.

[Table 46](#) lists subclass definitions in this document that are derived from EPE_output.

Table 46 — Subclass definition of EPE_output

Type_of_output	Preferred name of subclass definition	Subclause defining the class definition
product	Output_product	5.4.4.2
energy	Output_energy	5.4.4.3
GHG	Output_GHG	5.4.4.4
Harmful_substance	Output_Harmful_substance	5.4.4.5

5.4.4.2 Class definition of Output_product

[Table 47](#) shows the overview of Output_product.

Table 47 — Overview of Output_product

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Output_product	
Description of the class definition	EPE_output representing quantity of a specific product that is produced by a manufacturing process	
Preferred name of parent class definition	Subclause number defining the parent class definition	
EPE_output	5.4.4	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_product	1..1	6.2.62
Economic_value_of_a_product	0..1	6.2.7
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.4.3 Class definition of Output_energy

[Table 48](#) shows the overview of Output_energy.

Table 48 — Overview of Output_energy

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Output_energy	
Description of the class definition	EPE_output representing quantity of a specific type of energy that is produced by a manufacturing process	
Preferred name of parent class definition	Subclause number defining the parent class definition	
EPE_output	5.4.4	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_energy	1..1	6.2.48
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.4.4 Class definition of Output_GHG

[Table 49](#) shows the overview of Output_GHG.

Table 49 — Overview of Output_GHG

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Output_GHG	
Description of the class definition	EPE_output representing quantity of a specific type of GHG that is produced by a manufacturing process	
Preferred name of parent class definition	Subclause number defining the parent class definition	
EPE_output	5.4.4	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_GHG	1..1	6.2.55
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.4.5 Class definition of Output_Harmful_substance

[Table 50](#) shows the overview of Output_Harmful_substance.

Table 50 — Overview of Output_Harmful_substance

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Output_Harmful_substance	
Description of the class definition	EPE_output representing quantity of a specific type of harmful substance that is produced by a manufacturing process	
Preferred name of parent class definition	Subclause number defining the parent class definition	
EPE_output	5.4.4	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_Harmful_substance	1..1	6.2.54
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.5 Class definition of EPE_mechanism

5.4.5.1 General

[Table 51](#) shows the overview of EPE_mechanism.

Table 51 — Overview of EPE_mechanism

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	EPE_mechanism	
Description of the class definition	Grouped_EPE_data that represents the means used to perform a function of a process	
Preferred name of parent class definition	Subclause number defining the parent class definition	

Table 51 (continued)

Grouped_EPE_data	5.4	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_mechanism	1..1	6.2.57
Mechanism_Identifier	1..1	6.2.22
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
EPE_mechanism	0..n	5.4.5

[Table 52](#) lists subclass definitions in this document that are derived from EPE_mechanism.

Table 52 — Subclass definition of EPE_mechanism

Type_of_mechanism	Preferred name of subclass definition	Subclause defining the class definition
Equipment	EPE_equipment	5.4.5.2
Space	EPE_space	5.4.5.3
Person	EPE_qualified_staff	5.4.5.4

5.4.5.2 Class definition of EPE_equipment

[Table 53](#) shows the overview of EPE_equipment.

Table 53 — Overview of EPE_equipment

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	EPE_equipment	
Description of the class definition	EPE_mechanism that represents a piece of equipment	
Preferred name of parent class definition	Subclause number defining the parent class definition	
EPE_mechanism	5.4.5	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_equipment	1..1	6.2.50
Number_of_operation_modes	1..1	6.2.27
Operation_mode_used	0..1	6.2.30
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
Possible_EPE_operation_mode	1..n	5.4.5.5

5.4.5.3 Class definition of EPE_space

[Table 54](#) shows the overview of EPE_space.

Table 54 — Overview of EPE_space

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	EPE_space	
Description of the class definition	EPE_mechanism that represents a specific type of physical space used for a process	
Preferred name of parent class definition	Subclause number defining the parent class definition	
EPE_mechanism	5.4.5	

Table 54 (continued)

Property included in the class definition	Cardinality	Subclause defining the property
Type_of_space	1..1	6.2.63
Dimension	1..n	6.2.4
Regulatory_requirement	0..n	6.2.40
Indoor_or_outdoor	1..1	6.2.17
Lighting_condition	1..1	6.2.18
Air_conditioning	1..1	6.2.1
Power_for_lighting	1..1	6.2.33
Power_for_air_conditioning	1..1	6.2.34
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
Environmental_condition_data	1..n	5.3.6

5.4.5.4 Class definition of EPE_qualified_staff

[Table 55](#) shows the overview of EPE_qualified_staff.

Table 55 — Overview of EPE_qualified_staff

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	EPE_qualified_staff	
Description of the class definition	EPE_mechanism that represents a specific type of staffs and roles of the type used for a process	
Preferred name of parent class definition	Subclause number defining the parent class definition	
EPE_mechanism	5.4.5	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_person	1..1	6.2.60
Personnel_role	1..n	6.2.32
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.5.5 Class definition of Possible_EPE_operation_mode

[Table 56](#) shows the overview of Possible_EPE_operation_mode.

Table 56 — Overview of Possible_EPE_operation_mode

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Possible_EPE_operation_mode	
Description of the class definition	Grouped_EPE_data that indicates environmental aspects of an EPE_equipment in a mode of operation	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Grouped_EPE_data	5.4	
Property included in the class definition	Cardinality	Subclause defining the property
Mechanism_Identifier	1..1	6.2.22
Identifier_of_operation_mode	1..1	6.2.15

Table 56 (continued)

Name_of_operation_mode	1..1	6.2.23
Description_of_operation_mode	1..1	6.2.3
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
Energy_consuming_rate	1..n	5.4.5.6
Consumable_rate	1..n	5.4.5.7
Material_consuming_rate	1..n	5.4.5.8
GHG_emission_rate	1..n	5.4.5.9
Harmful_substance_emission_rate	1..n	5.4.5.10

EXAMPLE Stop, start_up, idling, pre_processing, operation, post_operation, shut_down, malfunction, maintenance.

5.4.5.6 Class definition of Energy_consuming_rate

[Table 57](#) shows the overview of Energy_consuming_rate.

Table 57 — Overview of Energy_consuming_rate

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Energy_consuming_rate	
Description of the class definition	Elementary_EPE_data that indicates quantity of a specific type of energy consumed by an equipment during a unit of its activity	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_EPE_data	5.3	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_energy	1..1	6.2.48
Type_of_unit_activity	1..1	6.2.65
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.5.7 Class definition of Consumable_rate

[Table 58](#) shows the overview of Consumable_rate.

Table 58 — Overview of Consumable_rate

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Consumable_rate	
Description of the class definition	Elementary_EPE_data that indicates number or quantity of a specific type of consumable spent by an equipment during a unit of its activity	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_EPE_data	5.3	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_consumable	1..1	6.2.46
Type_of_unit_activity	1..1	6.2.65
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.5.8 Class definition of Material_consuming_rate

[Table 59](#) shows the overview of Material_consuming_rate.

Table 59 — Overview of Material_consuming_rate

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Material_consuming_rate	
Description of the class definition	Elementary_EPE_data that indicates quantity of a specific type of material consumed by an equipment during a unit of its activity	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_EPE_data	5.3	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_material	1..1	6.2.56
Type_of_unit_activity	1..1	6.2.65
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.5.9 Class definition of GHG_emission_rate

[Table 60](#) shows the overview of GHG_emission_rate.

Table 60 — Overview of GHG_emission_rate

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	GHG_emission_rate	
Description of the class definition	Elementary_EPE_data that indicates quantity of a specific type of GHG emitted by an equipment during a unit of its activity	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_EPE_data	5.3	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_GHG	1..1	6.2.55
Type_of_unit_activity	1..1	6.2.65
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.5.10 Class definition of Harmful_substance_emission_rate

[Table 61](#) shows the overview of Harmful_substance_emission_rate.

Table 61 — Overview of Harmful_substance_emission_rate

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	Harmful_substance_emission_rate	
Description of the class definition	Elementary_EPE_data that indicates quantity of a specific type of harmful substance by an equipment during a unit of its activity	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_EPE_data	5.3	
Property included in the class definition	Cardinality	Subclause defining the property

Table 61 (continued)

Type_of_Harmful_substance	1..1	6.2.54
Type_of_unit_activity	1..1	6.2.65
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.6 Class definition of EPE_control

[Table 62](#) shows the overview of EPE_control.

Table 62 — Overview of EPE_control

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	EPE_control	
Description of the class definition	Grouped_EPE_data that represents a control of a manufacturing process	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Grouped_EPE_data	5.4	
Property included in the class definition	Cardinality	Subclause defining the property
Start_time	1..1	6.2.41
End_time	1..1	6.2.8
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

5.4.7 Class definition of EPE_process_transition

[Table 63](#) shows the overview of EPE_output.

Table 63 — Overview of EPE_process_transition

Attributes of the class definition	Value of the attribute	
ID of the class definition		
Preferred name	EPE_process_transition	
Description of the class definition	Elementary_EPE_data that associates one or more leading_processes to one or more following_processes in terms of sequence of execution	
Preferred name of parent class definition	Subclause number defining the parent class definition	
Elementary_EPE_data	5.3	
Property included in the class definition	Cardinality	Subclause defining the property
Type_of_transition	1..1	6.2.64
Reference_to_leading_processes	1..n	6.2.39
Reference_to_following_processes	1..n	6.2.38
Class definitions included in this class definition	Cardinality	Subclause defining the class definition
<None>		<N/A>

6 Properties of EPE data class definitions

6.1 General

[Clause 6](#) defines properties used for specifying EPE data class definition in [Clause 5](#).

6.2 Definitions of property

6.2.1 Air_conditioning

[Table 64](#) defines Air_conditioning as a property.

Table 64 — Overview of Air_conditioning

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Air_conditioning
Description of the property	indication about whether air conditioning is applied to a given EPE_space or not
Value type	IndicatorType

6.2.2 Capacity_of_buffering

[Table 65](#) defines Capacity_of_buffering as a property.

Table 65 — Overview of Capacity_of_buffering

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Capacity_of_buffering
Description of the property	maximum quantity that a Flow_control_process can buffer
Value type	QuantityType

6.2.3 Description_of_operation_mode

[Table 66](#) defines Description_of_operation_mode as a property.

Table 66 — Overview of Description_of_operation_mode

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Description_of_operation_mode
Description of the property	description of an operation mode of an EPE_equipment
Value type	TextType

6.2.4 Dimension

[Table 67](#) defines Dimension as a property.

Table 67 — Overview of Dimension

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Dimension
Description of the property	numerical value of the linear dimension (diameter, length, etc.) in the chosen units of measurement
Source of the description	ISO 13059:2011, 3.1
Value type	MeasureType
Code of quantity	0112/2///62720# UAD072 (length)

6.2.5 Distribution_ratio

[Table 68](#) defines Distribution_ratio as a property.

Table 68 — Overview of Distribution_ratio

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Distribution_ratio
Description of the property	ratio of quantity of an EPE_output against the quantity of the EPE_input of a Flow_control_process
Value type	NumericType

6.2.6 Downstream_endpoint

[Table 69](#) defines Downstream_endpoint as a property.

Table 69 — Overview of Downstream_endpoint

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Downstream_endpoint
Description of the property	reference to an EPE_input of EPE_process or an EPE_output of Compound_process that is connected to the endpoint at the downstream side of an EPE_IO_connection
Value type	IdentifierType

6.2.7 Economic_value_of_a_product

[Table 70](#) defines Economic_value_of_product as a property.

Table 70 — Overview of Economic_value_of_a_product

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Economic_value_of_a_product
Description of the property	amount of economic value of a product
Value type	AmountType

6.2.8 End_time

[Table 71](#) defines End_time as a property.

Table 71 — Overview of End_time

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	End_time
Description of the property	time the EPE_process to be ended
Value type	DateTimeType

6.2.9 EPE_data_granularity

[Table 72](#) defines EPE_data_granularity as a property.

Table 72 — Overview of EPE_data_granularity

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	EPE_data_granularity
Description of the property	Indicator that indicates level of detail in an Elementary_EPE_data
Value type	TextType

6.2.10 EPE_data_resolution

[Table 73](#) defines EPE_data_resolution as a property.

Table 73 — Overview of EPE_data_resolution

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	EPE_data_resolution
Description of the property	Indicator that indicates least value of the measured quantity that can be distinguished
Value type	QuantityType

6.2.11 EPE_process_identifier

[Table 74](#) defines EPE_process_identifier as a property.

Table 74 — Overview of EPE_process_identifier

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	EPE_process_identifier
Description of the property	reference to an EPE_process
Value type	IdentifierType

6.2.12 Formula_for_calculation

[Table 75](#) defines Formula_for_calculation as a property.

Table 75 — Overview of Formula_for_calculation

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Formula_for_calculation
Description of the property	Text that specifies a mathematical rule for obtaining a Calculated_EPE_data
Value type	TextType

6.2.13 Functional_Hierarchy_Level

[Table 76](#) defines Functional_Hierarchy_Level as a property.

Table 76 — Overview of Functional_Hierarchy_Level

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Functional_Hierarchy_Level
Description of the property	Functional hierarchy level defined by IEC 62264-1 in which the EPE data is generated
Value type	CodeType

[Table 77](#) lists possible values for Functional_Hierarchy_Level with descriptions.

Table 77 — Possible values for Functional_Hierarchy_Level

Possible value for the property	Description
Level 0	See IEC 62264-1:2013
Level 1	See IEC 62264-1:2013
Level 2	See IEC 62264-1:2013
Level 3	See IEC 62264-1:2013
Level 4	See IEC 62264-1:2013

6.2.14 ID_of_EPE_data_class

[Table 78](#) defines ID_of_EPE_data_class as a property.

Table 78 — Overview of ID_of_EPE_data_class

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	ID_of_EPE_data_class
Description of the property	reference to the EPE data class that an instance of EPE_data belongs to
Value type	IdentifierType

6.2.15 Identifier_of_operation_mode

[Table 79](#) defines Identifier_of_operation_mode as a property.

Table 79 — Overview of Identifier_of_operation_mode

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Identifier_of_operation_mode
Description of the property	reference to a Possible_EPE_operation_mode
Value type	IdentifierType

6.2.16 Identifier_of_part

[Table 80](#) defines Identifier_of_part as a property.

Table 80 — Overview of Identifier_of_part

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Identifier_of_part
Description of the property	reference to a part that is a member of an assembly
Value type	IdentifierType

6.2.17 Indoor_or_outdoor

[Table 81](#) defines Indoor_or_outdoor as a property.

Table 81 — Overview of Indoor_or_outdoor

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Indoor_or_outdoor
Description of the property	indication about whether an EPE_space is located at indoor or outdoor
Value type	IndicatorType

6.2.18 Lighting_condition

[Table 82](#) defines Lighting_condition as a property.

Table 82 — Overview of Lighting_condition

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Lighting_condition
Description of the property	description about the lighting condition of an EPE_space
Value type	TextType

6.2.19 Location_EPE_data_value_generated

[Table 83](#) defines Location_EPE_data_value_generated as a property.

Table 83 — Overview of Location_EPE_data_value_generated

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Location_EPE_data_value_generated
Description of the property	Category of the location in which the EPE data is generated
Value type	TextType

6.2.20 Mass_of_part

[Table 84](#) defines Mass_of_part as a property.

Table 84 — Overview of Mass_of_part

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Mass_of_part
Description of the property	mass of part
Value type	MeasureType
Code of quantity	0112/2///62720# UAD104 (mass)

6.2.21 Measuring_equipment_used

[Table 85](#) defines Measuring_equipment_used as a property.

Table 85 — Overview of Measuring_equipment_used

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Measuring_equipment_used
Description of the property	reference to equipment that was used to obtain the Measured_EPE_data
Value type	IdentifierType

6.2.22 Mechanism_identifier

[Table 86](#) defines Mechanism_identifier as a property.

Table 86 — Overview of Mechanism_identifier

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Mechanism_identifier
Description of the property	reference to an EPE_mechanism
Value type	IdentifierType

6.2.23 Name_of_operation_mode

[Table 87](#) defines Name_of_operation_mode as a property.

Table 87 — Overview of Name_of_operation_mode

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Name_of_operation_mode
Description of the property	Name of an operation mode of an EPE_equipment
Value type	TextType

6.2.24 Number_of_branches

[Table 88](#) defines Number_of_branches as a property.

Table 88 — Overview of Number_of_branches

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Number_of_branches
Description of the property	number of EPE_outputs of a Flow_control_process
Value type	NumericType

6.2.25 Number_of_class_definitions

[Table 89](#) defines Number_of_class_definitions as a property.

Table 89 — Overview of Number_of_class_definitions

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Number_of_class_definitions
Description of the property	Number of EPE_data that are contained in a grouped_EPE_data
Value type	NumericType

6.2.26 Number_of_EPE_process_transition

[Table 90](#) defines Number_of_EPE_process_transition as a property.

Table 90 — Overview of Number_of_EPE_process_transition

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Number_of_EPE_process_transition
Description of the property	Number of EPE_process_transitions that are contained in a compound_process
Value type	NumericType

6.2.27 Number_of_operation_modes

[Table 91](#) defines Number_of_operation_modes as a property.

Table 91 — Overview of Number_of_operation_modes

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Number_of_operation_modes
Description of the property	number of Possible_EPE_operation_modes that an EPE_equipment has
Value type	NumericType

6.2.28 Number_of_properties

[Table 92](#) defines Number_of_properties as a property.

Table 92 — Overview of Number_of_properties

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Number_of_properties
Description of the property	number of properties that a Grouped_EPE_data has
Value type	NumericType

6.2.29 Number_of_EPE_processes

[Table 93](#) defines Number_of_EPE_processes as a property.

Table 93 — Overview of Number_of_EPE_processes

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Number_of_EPE_processes
Description of the property	number of EPE_processes that are contained in a compound_process
Value type	NumericType

6.2.30 Operation_mode_used

[Table 94](#) defines Operation_mode_used as a property.

Table 94 — Overview of Operation_mode_used

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Operation_mode_used
Description of the property	reference to a Possible_EPE_operation_mode that is intended in the context of EPE_process
Value type	IdentifierType

6.2.31 Organization_defining_EPE_data_value

[Table 95](#) defines Organization_defining_EPE_data_value as a property.

Table 95 — Overview of Organization_defining_EPE_data_value

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Organization_defining_EPE_data_value
Description of the property	reference to an organized body of people with a particular purpose, that defined the value of an EPE_data
Value type	IdentifierType

EXAMPLE An example of IdentifierType for Organization_defining_EPE_data_value is ISO/IEC 6523-1.

6.2.32 Personnel_role

[Table 96](#) defines Personnel_role as a property.

Table 96 — Overview of Personnel_role

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Personnel_role
Description of the property	Description of a set of responsibilities assigned to an EPE_qualified_staff
Value type	TextType

6.2.33 Power_for_lighting

[Table 97](#) defines Power_for_lighting as a property.

Table 97 — Overview of Power_for_lighting

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Power_for_lighting
Description of the property	power required for lighting of EPE_space per unit of area
Value type	MeasureType
Code of quantity	0112/2///62720#UAD068 (irradiance)

6.2.34 Power_for_air_conditioning

[Table 98](#) defines Power_for_air_conditioning as a property.

Table 98 — Overview of Power_for_air_conditioning

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Power_for_air_conditioning
Description of the property	power required for air conditioning of EPE_space per unit of space
Value type	MeasureType
Code of quantity	0112/2///62720#UAD243 (volumic output power)

6.2.35 Phase_of_material

[Table 99](#) defines Phase_of_material as a property.

Table 99 — Overview of Phase_of_material

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Phase_of_material
Description of the property	Indication of a distinct and homogeneous form of material separated by its surface from other forms
Value type	TextType

6.2.36 Quantity_identifier

[Table 100](#) defines Quantity_identifier as a property.

Table 100 — Overview of Quantity_identifier

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Quantity_identifier
Description of the property	identifier of quantity of an EPE_data_value
Value type	CodeType
Coding system	IEC TS 62720

6.2.37 Recommended_replacement_cycle

[Table 101](#) defines Recommended_replacement_cycle as a property.

Table 101 — Overview of Recommended_replacement_cycle

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Recommended_replacement_cycle
Description of the property	description of recommendations for replacing a type of consumable
Value type	TextType

6.2.38 Reference_to_following_processes

[Table 102](#) defines Reference_to_following_processes as a property.

Table 102 — Overview of Reference_to_following_processes

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Reference_to_following_processes
Description of the property	EPE_process_identifier that is initiated by an EPE_process_transition NOTE In the case of terminating the series of process transitions in a Compound_process, the following process is the Compound_process.
Value type	IdentifierType

6.2.39 Reference_to_leading_processes

[Table 103](#) defines Reference_to_leading_processes as a property.

Table 103 — Overview of Reference_to_leading_processes

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Reference_to_leading_processes
Description of the property	reference to a process that initiates an EPE_process_transition NOTE In the case of initiating the series of process transitions in a Compound_process, the leading process is the Compound_process.
Value type	IdentifierType

6.2.40 Regulatory_requirement

[Table 104](#) defines Regulatory_requirement as a property.

Table 104 — Overview of Regulatory_requirement

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Regulatory_requirement
Description of the property	reference to a document providing binding legislative rules, that is adopted by an authority
Value type	IdentifierType

6.2.41 Start_time

[Table 105](#) defines Start_time as a property.

Table 105 — Overview of Start_time

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Start_time
Description of the property	time the EPE_process to be started
Value type	DateTimeType

6.2.42 Structure_of_EPE_data

[Table 106](#) defines Structure_of_EPE_data as a property.

Table 106 — Overview of Structure_of_EPE_data

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Structure_of_EPE_data
Description of the property	indication about whether an EPE_data has multiple EPE data values or not
Value type	CodeType

[Table 107](#) lists possible values for Structure_of_EPE_data with descriptions.

Table 107 — Possible values for Structure_of_EPE_data

Possible value for the property	Description
Elementary	Indicates the EPE_data has only one EPE data value
Grouped	Indicates the EPE_data multiple EPE data values

6.2.43 Structure_of_process

[Table 108](#) defines Structure_of_process as a property.

Table 108 — Overview of Structure_of_process

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Structure_of_process
Description of the property	Indication about whether an EPE_process contains other EPE_processes or not
Value type	CodeType

[Table 109](#) lists possible values for Structure_of_process with descriptions.

Table 109 — Possible values for Structure_of_process

Possible value for the property	Description
Elementary	Indicates the EPE_process contains no other EPE_process
Compound	Indicates the EPE_process contains at least one other EPE_process

6.2.44 Timing_EPE_data_value_generated

[Table 110](#) defines Timing_EPE_data_value_generated as a property.

Table 110 — Overview of Timing_EPE_data_value_generated

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Timing_EPE_data_value_generated
Description of the property	reference to the stage in the life cycle of the manufacturing system in which the EPE data is generated
Value type	CodeType

[Table 111](#) lists possible values for Timing_EPE_data_value_generated with descriptions.

NOTE These values are taken from ISO/IEC/IEEE TR 24748-1:2024, Figure 4.

Table 111 — Possible values for Timing_EPE_data_value_generated

Possible value for the property	Description
Concept	stage where Identifying stakeholders' needs, exploring concepts or Proposing viable solutions, or Identifying stakeholders' needs, exploring concepts and Proposing viable solutions, are happening
Development	stage where Refining system requirements, Create solution description, Build system or Verify and validate system, or Refining system requirements, Create solution description, Build system and Verify and validate system, are happening
Production	stage where produce systems, or Inspect and test, or both, are happening
Utilization	stage where system is operated to satisfy users' needs
Support	stage where providing sustained system capability is happening
Retirement	stage where system is Stored, archived or disposed

6.2.45 Type_of_assembly

[Table 112](#) defines Type_of_assembly as a property.

Table 112 — Overview of Type_of_assembly

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_assembly
Description of the property	indication of a group of similar assemblies sharing common characteristics
Value type	CodeType
Coding system	SELECTABLE

[Table 113](#) shows applicable coding systems for Type_of_assembly.

Table 113 — Applicable coding systems for Type_of_assembly

Designation of coding system	Name of coding system
ISO 10303 series	Industrial automation systems and integration — Product data representation and exchange
ISO/TS 15926-4	Industrial automation systems and integration — Integration of life-cycle data for process plants including oil and gas production facilities — Part 4: Initial reference data
ISO 13584-42	Industrial automation systems and integration — Parts library — Part 42: Description methodology: Methodology for structuring parts families
IEC 61360-4	IEC Common Data Dictionary — Electric/electronic components
IEC 61987 series	IEC Common Data Dictionary — Process automation
IEC 62683-1	IEC Common Data Dictionary — Low voltage switchgear
IEC TR 63213	IEC Common Data Dictionary — Measuring equipment for electrical quantities
ECLASS	https://eclass.eu/en/eclass-standard

6.2.46 Type_of_consumable

[Table 114](#) defines Type_of_consumable as a property.

Table 114 — Overview of Type_of_consumable

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_consumable
Description of the property	indication of a group of similar consumables sharing common characteristics
Value type	CodeType

[Table 115](#) lists possible values for Type_of_consumable with descriptions.

Table 115 — Possible values for Type_of_consumable

Possible value for the property	Description
material	further classification is provided by Type_of_material
part	further classification is provided by Type_of_part
assembly	further classification is provided by Type_of_assembly
tool	See 3.1.14 .

6.2.47 Type_of_electric_or_electronic_component

[Table 116](#) defines Type_of_electric_or_electronic_component as a property.

Table 116 — Overview of Type_of_electric_or_electronic_component

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_electric_or_electronic_component
Description of the property	indication of a type of electric_or_electronic_component
Value type	CodeType
Coding system	IEC 61360-4 CDD (Electric/electronic_component)

6.2.48 Type_of_energy

[Table 117](#) defines Type_of_energy as a property.

Table 117 — Overview of Type_of_energy

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_energy
Description of the property	indication of a form of energy
Value type	CodeType
Coding system	Standard International Energy Product Classification (SIEC) of International Recommendations for Energy Statistics (IRES) ^[30]

6.2.49 Type_of_environmental_condition

[Table 118](#) defines Type_of_environmental_condition as a property.

Table 118 — Overview of Type_of_environmental_condition

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_environmental_condition
Description of the property	indication of a type of surrounding condition
Value type	CodeType
Coding system	The IEC 60721 series (Classification of environmental conditions)

6.2.50 Type_of_equipment

[Table 119](#) defines Type_of_equipment as a property.

Table 119 — Overview of Type_of_equipment

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_equipment
Description of the property	indication of a group of similar equipment sharing common characteristics
Value type	CodeType
Coding system	SELECTABLE

[Table 120](#) shows applicable coding systems for Type_of_equipment.

Table 120 — Applicable coding systems for Type_of_equipment

Designation of coding system	Name of coding system
ISO 10303 series	Industrial automation systems and integration — Product data representation and exchange
ISO/TS 15926-4	Industrial automation systems and integration — Integration of life-cycle data for process plants including oil and gas production facilities — Part 4: Initial reference data
ISO 14224	Petroleum, petrochemical and natural gas industries — Collection and exchange of reliability and maintenance data for equipment
ISO 13584-42	Industrial automation systems and integration — Parts library — Part 42: Description methodology: Methodology for structuring parts families
IEC 61987 series	IEC Common Data Dictionary — Process automation
IEC 62683-1	IEC Common Data Dictionary — Low voltage switchgear
IEC TR 63213	IEC Common Data Dictionary — Measuring equipment for electrical quantities
ECLASS	https://eclass.eu/en/eclass-standard

6.2.51 Type_of_flow_control

[Table 121](#) defines Type_of_flow_control as a property.

Table 121 — Overview of Type_of_flow_control

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_flow_control
Description of the property	indication of a type of flow control that is performed by a Flow_control_process
Value type	CodeType

[Table 122](#) lists possible values for Type_of_flow_control with descriptions.

Table 122 — Possible values for Type_of_flow_control

Possible value for the property	Description
branching	The Flow_control_process has exactly one EPE_input and multiple EPE_outputs.
merging	The Flow_control_process has exactly one EPE_output and multiple EPE_inputs.
buffering	Buffering is the capability of locally storing material or immaterial assets, delaying further processing.

6.2.52 Type_of_grouped_EPE_data

[Table 123](#) defines Type_of_grouped_EPE_data as a property.

Table 123 — Overview of Type_of_grouped_EPE_data

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_grouped_EPE_data
Description of the property	indication of a type of grouped_EPE_data
Value type	CodeType

[Table 124](#) lists possible values for Type_of_grouped_EPE_data with descriptions.

Table 124 — Possible values for Type_of_grouped_EPE_data

Possible value for the property	Description
process	The grouped_EPE_data is an EPE_process.
input	The grouped_EPE_data is an EPE_input.
output	The grouped_EPE_data is an EPE_output.
mechanism	The grouped_EPE_data is an EPE_mechanism.
control	The grouped_EPE_data is an EPE_control.
process_transition	The grouped_EPE_data is an EPE_process_transition.

6.2.53 Type_of_input

[Table 125](#) defines Type_of_input as a property.

Table 125 — Overview of Type_of_input

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_input
Description of the property	indication of a group of similar EPE_inputs sharing common characteristics
Value type	CodeType

[Table 126](#) lists possible values for Type_of_input with descriptions.

Table 126 — Possible values for Type_of_input

Possible value for the property	Description
energy	Further classification is provided by Type_of_energy.
material	Further classification is provided by Type_of_material.
part	Further classification is provided by Type_of_part.
assembly	Further classification is provided by Type_of_assembly.
consumable	Further classification is provided by Type_of_consumable.

6.2.54 Type_of_Harmful_substance

[Table 127](#) defines Type_of_Harmful_substance as a property.

Table 127 — Overview of Type_of_Harmful_substance

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_Harmful_substance
Description of the property	indication of a group of similar Harmful_substance sharing common characteristics
Value type	CodeType
Coding system	SELECTABLE

[Table 128](#) shows applicable coding systems for Type_of_Harmful_substance.

Table 128 — Applicable coding systems for Type_of_Harmful_substance

Designation of coding system	Name of coding system
ISO 11014	Safety data sheet for chemical products — Content and order of sections
CLP	Classification, Labelling and Packaging of substances and mixtures PART 3: HARMONISED CLASSIFICATION AND LABELLING TABLES ^[31]
ST/SG/AC.10/30/Rev.9 - GHS Rev.9	Globally Harmonized System of Classification and Labelling of Chemicals ^[32]

6.2.55 Type_of_GHG

[Table 129](#) defines Type_of_GHG as a property.

Table 129 — Overview of Type_of_GHG

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_GHG
Description of the property	indication of a group of similar GHG sharing common characteristics
Value type	CodeType
Coding system	Greenhouse Gas Protocol: We set the standards to measure and manage emissions. Available from https://ghgprotocol.org (2023-12-31).

6.2.56 Type_of_material

[Table 130](#) defines Type_of_material as a property.

Table 130 — Overview of Type_of_material

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_material
Description of the property	indication of a group of similar materials sharing common characteristics
Value type	CodeType
Coding system	SELECTABLE

[Table 131](#) shows applicable coding systems for Type_of_material.

Table 131 — Applicable coding systems for Type_of_material

Designation of coding system	Name of coding system
CAS REGISTRY	Chemical Abstracts Service REGISTRY number ^[40]
ISO/TS 4949	Steel names based on letter symbols
ISO 513	Classification and application of hard cutting materials for metal removal with defined cutting edges — Designation of the main groups and groups of application

6.2.57 Type_of_mechanism

[Table 132](#) defines Type_of_mechanism as a property.

Table 132 — Overview of Type_of_mechanism

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_mechanism
Description of the property	indication of a group of similar EPE_mechanisms sharing common characteristics
Value type	CodeType

[Table 133](#) lists possible values for Type_of_mechanism with descriptions.

Table 133 — Possible values for Type_of_mechanism

Possible value for the property	Description
equipment	The further classification is provided by Type_of_equipment
space	The further classification is provided by Type_of_space
person	The further classification is provided by Type_of_person

6.2.58 Type_of_output

[Table 134](#) defines Type_of_output as a property.

Table 134 — Overview of Type_of_output

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_output
Description of the property	indication of a group of similar EPE_outputs sharing common characteristics
Value type	CodeType

[Table 135](#) lists possible values for Type_of_output with descriptions.

Table 135 — Possible values for Type_of_output

Possible value for the property	Description
product	The further classification is provided by Type_of_product.
energy	The further classification is provided by Type_of_energy.
GHG	The further classification is provided by Type_of_GHG.
Harmful_substance	The further classification is provided by Type_of_Harmful_substance.

6.2.59 Type_of_part

[Table 136](#) defines Type_of_part as a property.

Table 136 — Overview of Type_of_part

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_part
Description of the property	indication of a group of similar parts sharing common characteristics
Value type	CodeType

[Table 137](#) lists possible values for Type_of_part with descriptions.

Table 137 — Possible values for Type_of_part

Possible value for the property	Description
Mechanical_part	Characteristics of a Mechanical_part are represented by some properties (e.g. Dimension, Type_of_material, and Mass_of_part).
Electric_or_electronic_component	The further classification is provided by IEC 61360-4.

6.2.60 Type_of_person

[Table 138](#) defines Type_of_person as a property.

Table 138 — Overview of Type_of_person

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_person
Description of the property	indication of a group of similar persons sharing common characteristics
Value type	TextType

6.2.61 Type_of_process

[Table 139](#) defines Type_of_process as a property.

Table 139 — Overview of Type_of_process

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_process
Description of the property	indication of a group of similar Elementary_processes sharing common characteristics
Value type	CodeType

[Table 140](#) lists possible values for Type_of_process with descriptions.

Table 140 — Possible values for Type_of_process

Possible value for the property	Description
Energy_consuming_process	Indicating that the process is an Energy_consuming_process
GHG_emitting_process	Indicating that the process is a GHG_emitting_process
Harmful_substances_emitting_process	Indicating that the process is a Harmful_substances_emitting_process
Flow_control_process	Indicating that the process is a Flow_control_process

6.2.62 Type_of_product

[Table 141](#) defines Type_of_product as a property.

Table 141 — Overview of Type_of_product

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_product
Description of the property	indication of a group of similar products sharing common characteristics
Value type	CodeType
Coding system	SELECTABLE

[Table 142](#) shows applicable coding systems for Type_of_product.

Table 142 — Applicable coding systems for Type_of_product

Designation of coding system	Name of coding system
CPC	UN's The Central Product Classification ^[33]
ETIM	The international classification standard for technical products ^[34]
SITC	Standard International Trade Classification ^[35]
ECLASS	ECLASS Standard ^[36]
GPC	Global Product Classification ^[37]
HS	The Harmonized Commodity Description and Coding System ^[38]

6.2.63 Type_of_space

[Table 143](#) defines Type_of_space as a property.

Table 143 — Overview of Type_of_space

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_space
Description of the property	indication of a group of similar EPE_spaces sharing common characteristics
Value type	TextType

6.2.64 Type_of_transition

[Table 144](#) defines Type_of_transition as a property.

Table 144 — Overview of Type_of_transition

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_transition
Description of the property	indication of a type of EPE_process_transition
Value type	CodeType

[Table 145](#) lists possible values for Type_of_transition with descriptions.

Table 145 — Possible values for Type_of_transition

Possible value for the property	Description
One_to_one	The EPE_transition is an one-to-one transition, which has only one leading EPE_process and only one following EPE_process.
fork	The EPE_transition is a fork transition, which has only one leading EPE_process and multiple EPE_processes.
join	The EPE_transition is a fjoin_transition, which has multiple leading EPE_processes and only one EPE_process.

6.2.65 Type_of_unit_activity

[Table 146](#) defines Type_of_unit_activity as a property.

Table 146 — Overview of Type_of_unit_activity

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_unit_activity
Description of the property	Indication about how a rate of Possible_EPE_operation_mode is specified
Value type	CodeType

[Table 147](#) lists possible values for Type_of_unit_activity with descriptions.

Table 147 — Possible values for Type_of_unit_activity

Possible value for the property	Description
Based_on_time	Specified time period of operation is used as the unit for calculating each rate of EPE operation mode.
Based_on_output	Specified quantity of EPE output is used as the unit for calculating each rate of EPE operation mode.
Based_on_input	Specified quantity of a given EPE_input is used as the unit for calculating each rate of EPE operation mode.

6.2.66 Type_of_upstream_data

[Table 148](#) defines Type_of_upstream_data as a property.

Table 148 — Overview of Type_of_upstream_data

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Type_of_upstream_data
Description of the property	indication of a type of Upstream_data
Value type	CodeType

[Table 149](#) lists possible values for Type_of_upstream_data with descriptions.

Table 149 — Possible values for Type_of_upstream_data

Possible value for the property	Description
energy_consumed	The Upstream_data is an Upstream_energy_consumed.
material_consumed	The Upstream_data is an Upstream_material_consumed.
GHG_emitted	The Upstream_data is an Upstream_GHG_emitted
Harmful_substance_emitted	The Upstream_data is an Upstream_Harmful_substance_emitted.

6.2.67 Upstream_endpoint

[Table 150](#) defines Upstream_endpoint as a property.

Table 150 — Overview of Upstream_endpoint

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Upstream_endpoint
Description of the property	reference to an EPE_input or an EPE_output that is connected the endpoint at the upstream side of an EPE_IO_connection
Value type	IdentifierType

6.2.68 Way_for_generating

[Table 151](#) defines Way_for_generating as a property.

Table 151 — Overview of Way_for_generating

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Way_for_generating
Description of the property	indication about how an EPE_data_value was generated
Value type	CodeType

[Table 152](#) lists possible values for Way_for_generating with descriptions.

Table 152 — Possible values for Way_for_generating

Possible value for the property	Description
Defined	The EPE_data_value was defined.
Measured	The EPE_data_value was measured.
Calculated	The EPE_data_value was Calculated.

6.2.69 Way_of_measurement

[Table 153](#) defines Way_of_measurement as a property.

Table 153 — Overview of Way_of_measurement

Attribute of the property	Value of the attribute
ID of the property	
Preferred name	Way_of_measurement
Description of the property	description about how an EPE_data_value was measured
Value type	TextType

Annex A (informative)

Relationship with the other related International Standards

A.1 General

This annex describes the relationship with other related International Standards.

The objective of this document is to define the EPE data classes, which can be used for EPE in various situations across the boundaries of individual enterprises. For this objective, the definitions are generic enough and conform to the established standards as much as possible.

The individual contents of EPE data are outside the scope of this document. However, many of those contents can be represented according to the related standards. When elaborating the EPE data for individual applications, the content must not be re-invented, but it should conform to the existing standards as much as possible.

A.2 Standards related to the definitions of EPE data classes

In EPE of manufacturing systems, kinds of data about manufacturing and environment are necessary in addition to EPE data. Cross-referencing is required between EPE data and other related data.

For this purpose, it is recommended to utilize the established data description methodologies in the field of manufacturing. IEC 61360-1 is the most widely accepted standardized methodology. By this approach, in principle, EPE data can be used, with simple mappings, in combination with other data about manufacturing and environment.

For semantic interoperability, the basic terms and their meanings in EPE data class definition can be elaborated to be integrated with other domains.

EPE data class definitions can be transformed to be integrated in IEC CDD or ECLASS by following the methodology of IEC 62656-1 and IEC TS 62656-2.

EPE data class definition can be used in deployment of Digital Factory framework (IEC 62832 series) supporting the DF dictionary, or AAS (IEC 63278-1) supporting submodels.

A.3 Standards related to environment

EPE of manufacturing systems based on EPE data is consistent with the LCA (Life Cycle Assessment) methodology specified by the ISO 14040 and ISO 14044.

EPE of manufacturing systems based on EPE data conforms to the LCA methodology. Therefore, most of the terms and meanings related with the environment in EPE data can be related with LCA terms and meanings by simple mappings. Some modifications and extensions can be necessary for adapting to the specific need for manufacturing.

Some of the related LCA standards are:

- ISO 14001: *Environmental management systems — Requirements with guidance for use*
- ISO 14031: *Environmental management — Environmental performance evaluation – Guidelines*
- ISO 14040: *Environmental management — Life cycle assessment — Principles and framework*

- ISO 14044: *Environmental management — Life cycle assessment — Requirements and guidelines*

A.4 Standards related to manufacturing systems

Environmental performance of manufacturing systems is evaluated under a certain context of manufacturing process executions. Such context can be expressed in manufacturing process information which is widely standardized for manufacturing system design, implementation and execution.

Representative standards for manufacturing processes are:

- IEC 62264-1: *Enterprise-control system integration — Models and terminology*
- IEC 62264-2: *Enterprise-control system integration — Objects and attributes for enterprise-control system integration*
- ISO 15531: *Industrial automation systems and integration — Industrial manufacturing management data*
- IEC 62264-4: *Enterprise-control system integration – Object model attributes for manufacturing operations management integration*
- ISO 18828: *Industrial automation systems and integration — Standardized procedures for production systems engineering*

Most of the manufacturing process information is described in the standards above, especially the IEC 62264 series. Some extensions can be necessary for accommodating specific requirements for EPE of manufacturing systems.

Annex B (informative)

Use case for EPE data

B.1 General

This [Annex B](#) provides one use case for EPE data.

B.2 Environmental performance evaluation (EPE) of a machining process from an energy usage perspective

B.2.1 Objective

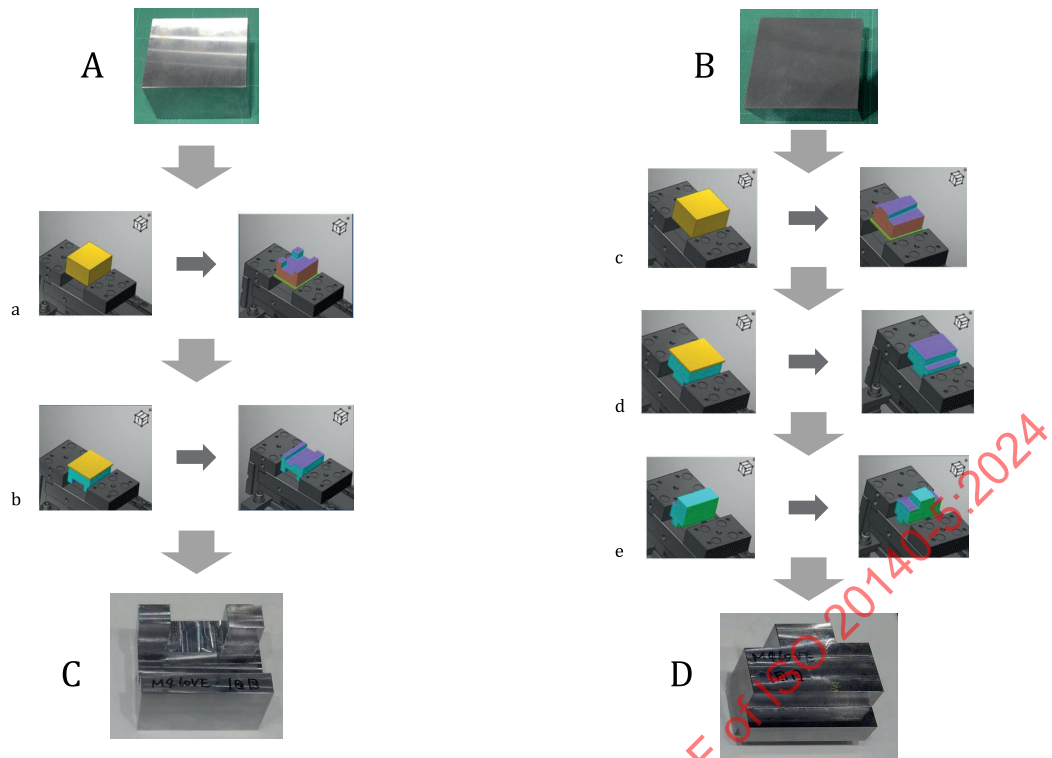
[Clause B.2](#) provides a use case of EPE data that represents a machining process for evaluating its environmental performance from an energy usage perspective.

B.2.2 Machining process under consideration

The machining process produces two different types of processed metal blocks from a type of raw metal block with consuming electricity. Its outputs are processed metal block 101 and processed metal block 102 and inputs are raw metal block 101, raw metal block 102 and electricity consumed, in this use case.

The machining process consists of five subprocesses as illustrated in [Figure B.1](#):

- a) Front face machining of raw metal block 101;
- b) Back face machining of raw metal block 101;
- c) Front face machining of raw metal block 102;
- d) Back face machining of raw metal block 102;
- e) Side face machining of raw metal block 102.

**Key**

- A raw metal block 101
- B raw metal block 102
- C processed metal block 101
- D processed metal block 102
- a Front face machining of raw metal block 101.
- b Back face machining of raw metal block 101.
- c Front face machining of raw metal block 102.
- d Back face machining of raw metal block 102.
- e Side face machining of raw metal block 102.

Figure B.1 — Illustration of the machining process

In the system, the machining process is implemented by two machines. The 3-axis machining center A is used for processing raw metal block 101. The 5-axis machining center B is used for processing raw metal block 102. Table B.1 shows the starting and ending time of the subprocesses. The power of the machines is measured by the power meters attached to the power lines connected to each machine. The input power of each machine is measured periodically during the operations, together with related conditions (e.g. operation mode, spindle positions, and loads).

Table B.1 — Implementation of the machining process

3-axis machining center A		5-axis machining center B	
Time	Subprocess	Time	Subprocess
13:48 - 14:04	a) Front face machining of raw metal block 101	13:51 - 14:05	c) Front face machining of raw metal block 102
14:08 - 14:15	b) Back face machining of raw metal block 101	14:08 - 14:14	d) Back face machining of raw metal block 102
		14:16 - 14:22	e) Side face machining of raw metal block 102

B.2.3 Representing the machining process by EPE data

Figure B.2 shows the machining process under consideration using EPE data. The machining process is represented by a Compound_process. The Compound_process contains multiple subprocesses, each of which is represented by an Energy-consuming_process, which is a subclass of Elementary_process (see Figure B.6). Raw material blocks 101 and 102, as well as Electricity 103 are EPE_input of the Compound_process. Processed metal blocks 101 and 102 are EPE_output of the Compound_process. Each solid arrow represents an EPE_process_transition for indicating the execution order of the subprocesses. Each dashed arrow represents an EPE_IO_connection. Each EPE_input of the Compound_process for raw metal blocks is connected to an EPE_input of a constituent Elementary_process by an EPE_IO_connection. The EPE_input of the Compound_process for electricity is connected to an EPE_input of a Flow_control_process by an EPE_IO_connection for the distribution of the electricity to the constituent Energy-consuming_process classes. An EPE_output of the Flow_control_process is then connected to an EPE_input of each constituent Elementary_process by an EPE_IO_connection. Each EPE_output of the Compound_process is connected to an EPE_output of a constituent Elementary_process by an EPE_IO_connection. Some EPE_output classes of the constituent Elementary_process are connected to EPE_input classes of another constituent Elementary_process.

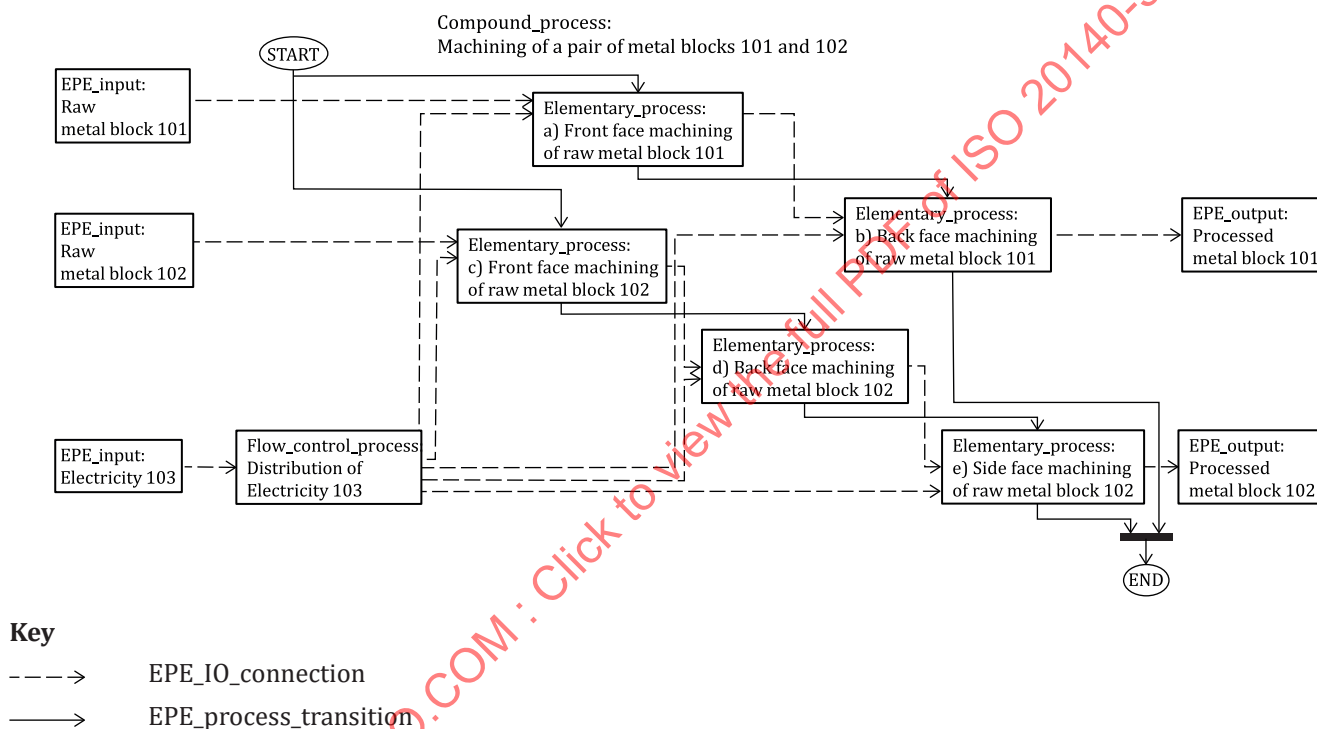


Figure B.2 — Description of the machining process under consideration

B.2.4 Analysis of the environmental influence of an elementary process

Figure B.3 shows the measured power of the 3-axis machining center A during front face machining of raw metal block 101, which is a subprocess of the machining process. The execution of the subprocess starts at 13:48 as shown in Table B.1. At the start of the execution, the quantity of the measured power immediately reaches 1,5 kW due to acceleration of the rotational speed of the main spindle of the machining center. During the execution, the quantity of the measured power is around 0,5 kW. Some peaks of the quantity of the power indicate moments of large acceleration and deceleration of the rotational speed. A negative quantity of the measured power indicates the recovery of electricity stored in the machining center.

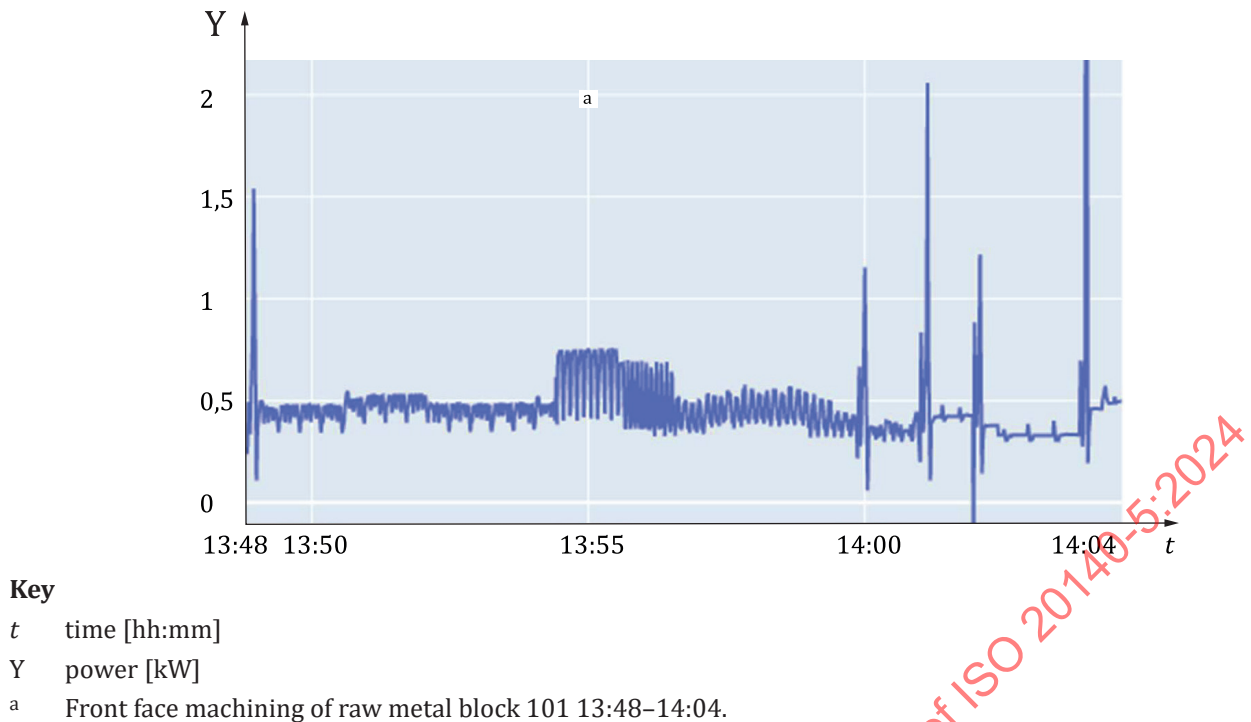


Figure B.3 — Measured power during the execution of an elementary process

[Figure B.4](#) shows the structure of a data element representing a power consumed by a machine measured by a given power meter at a certain time. The data element is a `Measured_EPE_data` using EPE data. `Measured_EPE_data` is a subclass of `Elementary_EPE_data`, and it is defined by `EPE_data_value` and EPE data description. Its `EPE_data_value` is the one-dimensional quantity 0,761 kW. The EPE data description is a set of property and property value pairs. For example, the value of a property `Way_for_generating` is `Measured`, the value of a property `Quantify_identifier` is `UAD003` (active power). Some of the other properties and their values are shown in [Figure B.4](#).

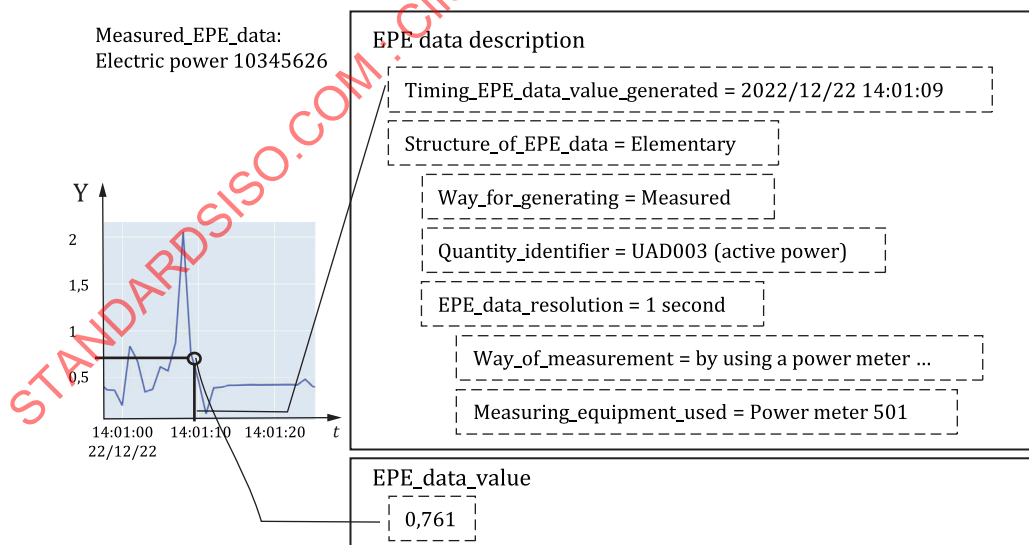


Figure B.4 — Structure of a `Measured_EPE_data`

The environmental influence of the machining process addressed here, in this use case, is the quantity of the energy consumed by the machining process. The quantity of the energy consumed is calculated by summation of the quantity of the energy consumed by each subprocess, which is calculated with the quantity of the power measured during the machining process in two steps. First, the quantity of the measured value

is integrated over the duration of the machining process. Second, the unit is converted from [W] to [kWh]. As a result of the calculation, the quantity of the energy consumed by the subprocess is 0,434 kWh. These steps are referred to as conversion subprocess in ISO 20140-3:2019, Clause 8. Other subprocesses presented in ISO 20140-3 are introduced in this use case in [B.2.5](#).

[Figure B.5](#) shows the structure of a data element of the energy consumed by a process. The data element is a Calculated_EPE_data, which uses some EPE data, including the Measured_EPE_data representing the power consumed which was explained before, according to the given formula. Similar to Measured_EPE_data, Calculated_EPE_data is a subclass of Elementary_EPE_data, and it is defined by EPE_data_value and EPE data description. Its EPE_data_value is the scalar value 0,195. The EPE data description is a set of property and property value pairs. For example, the value of a property Way_for_generating is Calculated, the value of a property Quantify_identifier is UAD046 (energy content). Some of the other properties and their values are shown in [Figure B.5](#).

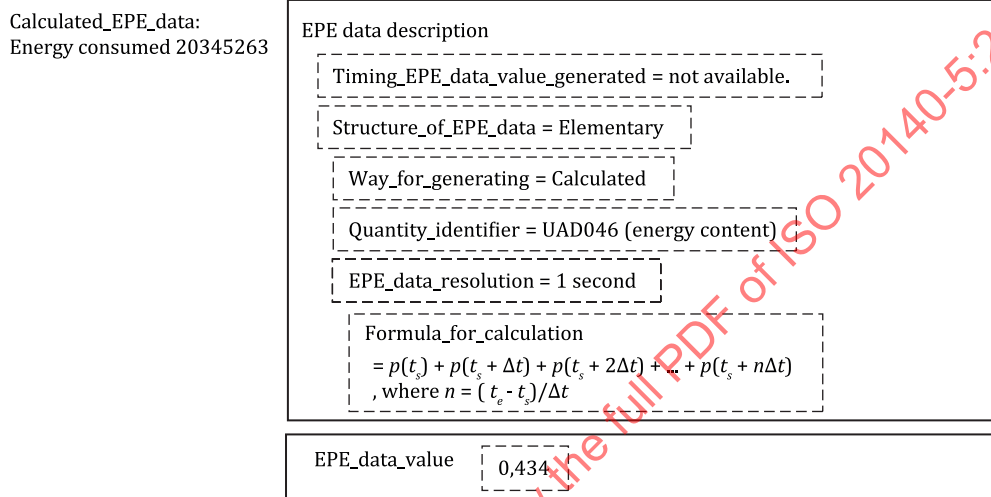


Figure B.5 — Structure of a Calculated_EPE_data

[Figure B.6](#) shows relationships between some key EPE data for the use case, together with the mapping to an implementation. The upper part of [Figure B.6](#) shows the composition relationship among Elementary_EPE_data, EPE_input, EPE_process, and EPE_mechanism with reference to the concept hierarchy of EPE data. The lower part of [Figure B.6](#) shows the implementation. Front face machining of raw metal block 101 is Energy_consuming_process in which Type_of_energy is Electricity, that is a subclass of Energy_consuming_process, and it is a subclass of Elementary_process. The Calculated_EPE_data (Energy demand 203563) represents the quantity of the Input energy (Electricity 103-1), which is consumed by the Electricity_consuming_process (Front face machining of raw metal block 101). Furthermore, the Measured_EPE_data is a measured quantity of the power of the EPE_equipment, which is the EPE_mechanism of the Electricity_consuming_process. The Measured_EPE_data is used to obtain the Calculated_EPE_data.