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ISO TS 81346-101 General modelling principles WORKING DRAFT 7_figures revised_clean

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Replaces: N 446 ISO TS 81346-101 General modelling principles WORKING DRAFT 7

Description

Dear experts of JWG 10,

Please find attached the revised draft 7 for ISO/TS 81346-101 with some changed formatting and including the revised figures.

ISO #####-#:####(X)

ISO TC ###/SC ##/WG #

Secretariat: XXXX

Industrial systems, installations and equipment and industrial products — Structuring principles and reference designations — Part 101: Power plants — Modelling principles and guidelines

WD stage

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Contents

Foreword

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This document was prepared by Technical Committee ISO/TC 10, Technical product documentation Subcommittee SC 10, Process plant documentation.

A list of all parts in the ISO/IEC 81346 series can be found on the ISO website.

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

Introduction

This document provides guidelines for the understanding and application of the ISO/IEC 81346 reference designation system (RDS) for Power supply Systems (PS). It was developed in response to a demand by the power supply sector for guidelines to the application of the ISO/IEC 81346 standard series, part 10 in particular.

Power supply System, and the target industries of this document, include but are not limited to: wind-, photovoltaic-, thermal-, nuclear- and hydropower production.

The very basics of the RDS will not be explained in this document. It will be assumed that the reader already is familiar with the major concepts detailed in ISO/IEC 81346-1 and 2. These concepts include the four RDS aspects, the basic RDS semantics and basic RDS classification rules.

Industrial systems, installations and equipment and industrial products — Structuring principles and reference designations — Part 101: Power supply systems - Modelling principles and guidelines

1 Scope

This guide will support the user in the understanding of the ISO/IEC 81346 standard series. It will also propose guidelines and best practice to its use and implementation depending on the user and situation. By following the suggestions in these supporting documents, the application of the standard should be harmonized within and between the power supply technical domains and industries.

No part of this document is normative, only rules of thumb, proposed solutions and general guideline on the application of the standard series on power supply systems.

An introductory example of the use of RDS can be found in annexes A and B (informative).

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.

EC/ISO 81346, *Industrial systems, installations and equipment and industrial products — Structuring principles and reference designations (all parts).*

IEC 61850-7, *Communication networks and systems in substations — Basic communication structure for substation and feeder equipment (all parts).*

ISO 4157-2, *Construction drawings — Designation systems — Part 2: Room names and numbers*

ISO 26324*, Information and documentation — Digital object identifier system.*

IEC 61360-4 DB, *Common Data Dictionary Database*

IEC 61987, I*ndustrial-process measurement and control - Data structures and elements in process equipment catalogues*

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

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

IEC 61175-1, *Industrial systems, installations and equipment and industrial products - Designation of signals - Part 1: Basic rules*

3 Terms and definitions

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

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

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

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

3.1
horizontal system
system which has an impact or supports one or more *vertical systems (3.3)* without being one

EXAMPLE Managing systems (e.g. =F1) or supporting systems (e.g. =D1)

Note 1 to entry: There can be supporting systems within core process (vertical) systems (e.g. the monitoring system of the generator =A1.RA1.LE1).

3.2
preferred reference designation
PRD
reference designation (RD) used as the main key to identify an object within a database

3.3
vertical system
system that is a part of the core process of the power production, distribution or transmission for power supply systems

EXAMPLE Production unit systems (e.g. =A1) or energy transport systems (e.g. =C1).

4 Abbreviations

BIM	Building Information Modelling
CB	Circuit breaker
CW	Construction Works
DB	Database
DOI	Digital Object Identifier
GIS	Geographic Information System
HSE	Health Security and Environement
IOD	Individual Object Database
P&ID	Piping and Instrumentation Diagram
PRD	Preferred Reference Designation
PS	Power supply Systems
RD	Reference Designation
RDS	Reference Designation System
SCADA	Supervisory Control And Data Acquisition

5 Modelling principles

5.1 Design for purpose

A system can be a constituent of a large and complex system. If so, it will often have a multi-levelled reference designation (RD). Or it can be such a simple overall system, and the constituents will be represented by a single level RD. It is the designers responsibility to select the appropriate structure to reflect the complexity of the system in question.

The depth and complexity of a structured representation will be influenced by the innate complexity of the overall system in question. A nuclear power plant will need many levels to correctly represent and model all the functionality within it. Not all systems will need that level of details. Note that the representation of highly complex systems can often benefit from simplifications. It would probably not make sense to include every single system down to individual bolts and screws when modelling a complete nuclear power plant.

The purpose of creation of the structure (also called model in this document) should also influence the complexity and granulation of the representation of the system. A model designed to provide an overview of a chemical park main processes, does not need to include a detailed overview of the layers in the roof construction of the gardening equipment shed.

Also keep in mind the framework set by the selection of aspect when designing a structure. When structuring a system based on the functional aspect, the system functional complexity and process criticality should be look at, not physical size or cost. Large and/or costly objects are not always complex from a functional point of view. A transformer could be considered quite simple in the functional aspect, no matter what physical size, complexity of construction or costs it has. It usually has few functional sub-systems, and a simple functionality. With an RD-based model, depth and level of details should be influenced by its intended use. The structure should be a tool to benefit the user, not an absolute mirror of reality and all its tiny details.

EXAMPLE 1
A component in the lower levels of a complex structure (e.g. a motor within a critical sub-system for the process, =A1.KA1.KK1.MAA1) can be of such importance to the process that a data collecting system could be required and of interest to the operating party (e.g. =A1.KA1.KK1.MAA1.KED1). Even the sensors connected could be of interest and could be represented (e.g. =A1.KA1.KK1.MAA1.KED1.BTA1) if useful.

EXAMPLE 2
A simple gate can be represented by a simple structure e.g. only two levels, all within the component system:

=C1.QQF1 – Gate system
    =C1.QQF1.MAA1 - Gate motor

or it could be a complex system with heating system, auxiliary power supply, monitoring systems and so on....

=C1.KA1 – Gate system
        =C1.KA1.LE1 - Gate system monitoring system
            =C1.KA1.LE1.BPA1 - Upstream pressure monitoring system
                =C1.KA1.LE1.BPA1.BPA1 - Upstream pressure monitoring 1
                = C1.KA1.LE1.BPA1.BPA2 - Upstream pressure monitoring 2
                = C1.KA1.LE1.BPA1.BPA3 - Upstream pressure monitoring 3

= C1.KA1.HE1 - Gate heating system
...

The structure gives the proper representation of the system, and lets the reader understand the system complexity through the model complexity.

5.2 The receiver’s ownership principle

As shown Figure 1 and Figure 2 when a system is intended to link two other systems on the same hierarchical level, and when it is unclear to which system it belongs, the linking system should be part of the receiving system (in terms of information, matter or energy of any kind).

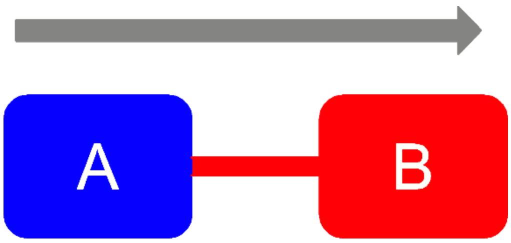


Figure 1— Illustration of the receiver ownership principle

EXAMPLE 1

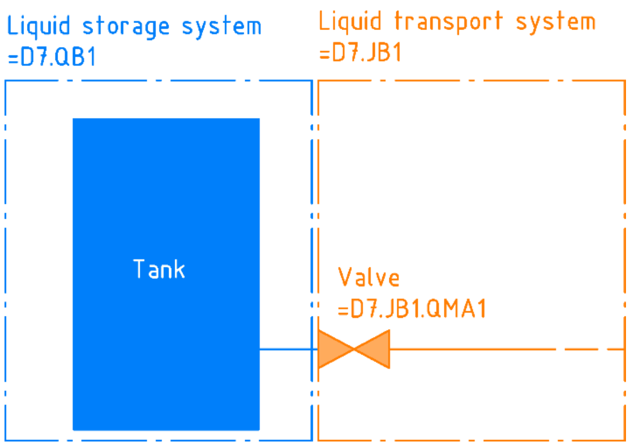


Figure 2— Example of the receiver ownership principle

A valve is the separating agent between a liquid storage system (=D7.QB1) and a transport system (=D7.JB1). The valve is a sub-system of the transport system, not the storage system, because the transport system is the receiving system.

The principle is to be used in situations when doubt arises**Fehler! Verweisquelle konnte nicht gefunden werden.**. Common sense and intuitive ownership should come first. The main goal is that systems should be where a future user would expect them to be.

EXAMPLE 2
The cord between a laptop and its charger constitutes the connecting agent between these two systems, with the laptop being the receiving system. The charger cord is however still a part of the charger, not the laptop.

Note that this principle can be used for all aspects.

5.3 Collector system principle

An exception to the receiver's ownership principle, in the functional aspect, is where multiple systems meet in a new system where energy, data or matter is collected. Examples are systems where a dominant feature is a busbar (i.e. collecting / distributing power to multiple other systems), or a liquid collection/distribution system.

For these systems the flow control system separating each supplying system to the collecting system should belong to the former. This is exemplified in Figure 3**Fehler! Verweisquelle konnte nicht gefunden werden.**.

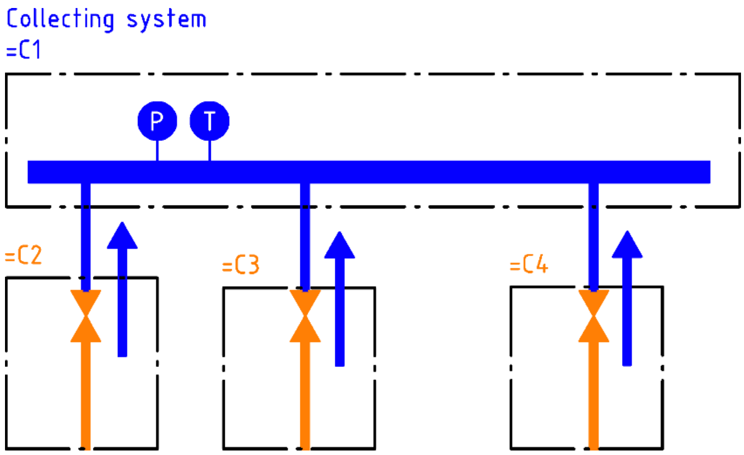


Figure 3— Example of the collector system principle

This is a useful feature as it is often useful, from a process (or even safety) point of view to know which system is being isolated.

Note that this principle only applies to the functional aspect, not the product aspect, where an array of valves, such as the ones depicted in Figure 3 could be part of the collecting system -C1 (pointing to the same object individual as =C1).

This situation will often occur for switchgear systems, where breakers isolating a certain larger system are, in the product aspect, part of the switchgear system. However, in the functional aspect the breakers will be part of the systems to which the flow of electrical power is being controlled.

5.4 Classification according to inherent functionality

According to the principles stated in IEC 81346-2, the object should always be classified according to what it was designed to do, not what it is being used for in a particular case.

EXAMPLE 1
Even if the overall function of the lubrification oil system is to reduce friction, the system supplying the lubrification oil does not see the final use of the oil, it just supplies it. It is a liquid matter supply system (JB), not a friction reduction system (KJ).

EXAMPLE 2
A valve opening the flow of the sprinkler system will have the effect of fighting fire. But the valve is a valve, it is a controlling device for flow, a QMA.

Note that the overall use of a system will often be reflected by a parent system. In the case of example 2 above, the valve (QMA) will most likely be a constituent of a firefighting system (PB).

5.5 Immaterial Instantiation

In accordance with the principles of IEC 81346-1, instantiating the occurrences (object reference designations) should avoid situations where the numbering in itself carries meaning, including leading zeroes. Such information is considered metadata/properties of the object.

EXAMPLE

=RA2

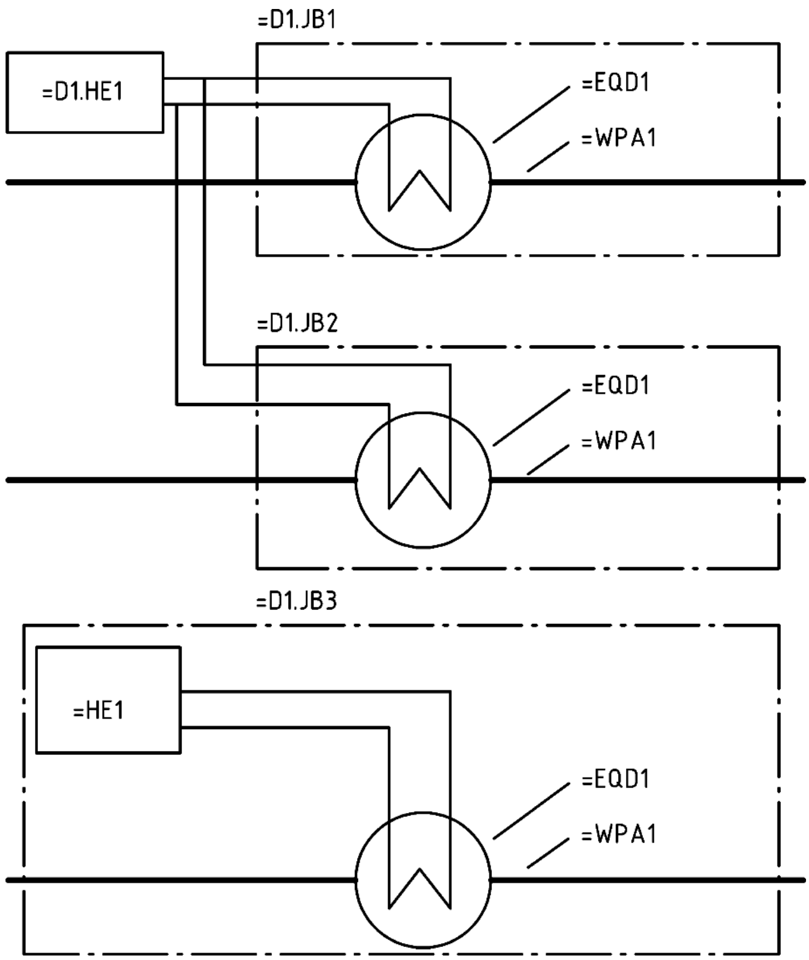
"=RA2" is not necessarily the second generator (in any sense of the word).

The primary concern is to avoid situations where the instantiation carries technical information about the object in question that should be covered by the type aspect. Certain exceptions are acceptable for grouping/clustering purposes (see 5.7) and the type aspect (see 7.3). If a company selects to employ meaningful numbering, the rule should be well documented.

5.6 Parent system and sub-systems

If a system (e.g. HE) primarily affects a larger system (e.g. =D1.JB3) - and only that, the former (HE) should be a sub-system of the latter (=D1.JB3). See Distribution system 3, the lower systems in Figure 4.

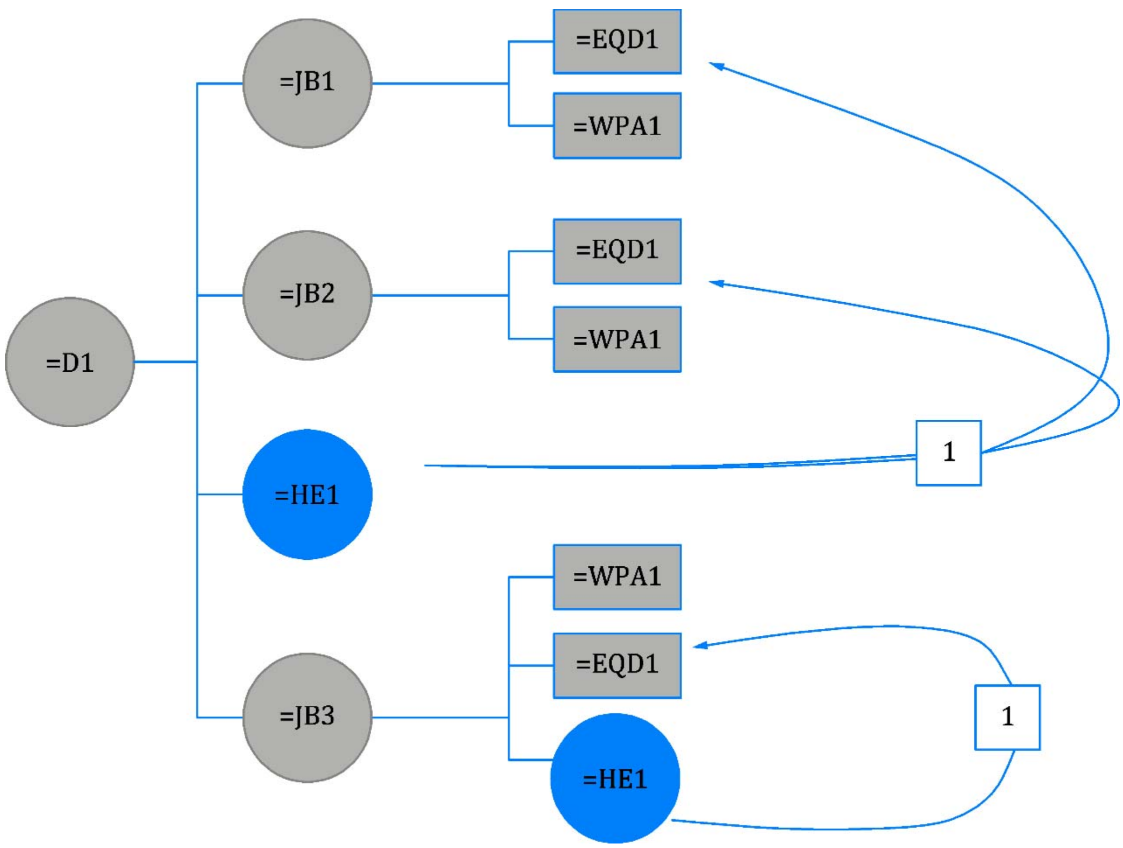
If a system (HE) affects multiple larger system (e.g. =D1.JB1 and =D1.JB2), that system should be consider lifted to the same level as the two latter systems (=D1.JB1 and D1.JB2). See "Distribution system 1 and 2", the two upper systems in Figure 4.



Key

=D1.JB1	cooling water distribution system 1
=D1.JB1.EQD1	cooling water distribution system 1, cooling system
=D1.JB1.WPA1	cooling water distribution system 1, distribution pipe
=D1.JB2	cooling water distribution system 2
=D1.JB2.EQD1	cooling water distribution system 2, cooling system
=D1.JB2.WPA1	cooling water distribution system 2, distribution pipe
=D1.HE1	cooling water supply (supplying distribution systems 1 and 2)
=D1.JB3	cooling water distribution system 3
=D1.JB3.EQD1	cooling water distribution system 3, cooling system
=D1.JB3.WPA1	cooling water distribution system 3, distribution pipe
=D1.JB3.HE1	cooling water distribution system 3, cooling water supply

Figure 4— Example of structure showing cooling systems on different levels – P&ID



Key

1 Supplying cooling water

Figure 5— Example of structure showing cooling systems on different levels – System structure

Figure 5 shows a model of an auxiliary water distribution system with its cooling system. Each of the major piping systems (=D1.JB1, =D1.JB2 and =D1.JB3) have their own cooling systems (=D1.JBn.EQD1). Each of the (EQD) cooling systems are sub-systems dedicated solely to their respective (JB) piping systems.

Cooling water on the other hand is supplied to systems =D1.JB1 and D1.JB2 by a common cooling water supply system (=D1.HE1). Because this system is common to multiple systems on the second level of the structure it is also on the second level. The third distribution system (=D1.JB3) is particular in that it has a dedicated cooling water supply system (=D1.JB3.HE1). It is only supplying cooling water to this particular distribution system and is therefore a sub-system of it.

Note that this proposed design guideline is not absolute. The second cooling water supply system (=D1.JB3.HE1) could already at this point be elevated to the second level of the structure (=D1.HE2) if, e.g.

- It is expected (in the future) to feed a fourth piping system
- It could be used as auxiliary supply systems to the other distribution systems
- In similar situations, it is expected to feed multiple distribution systems

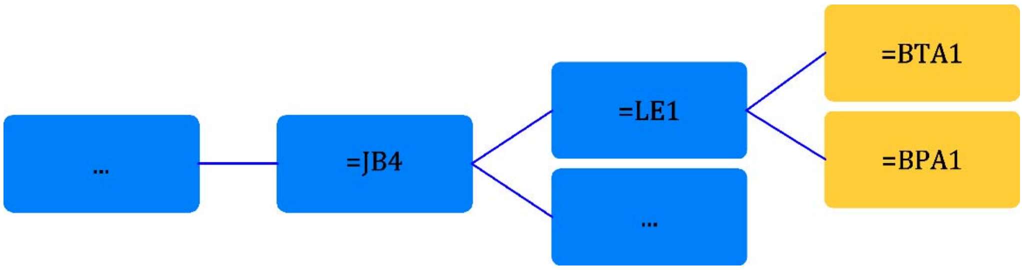
5.7 Limited constituent systems

The RDS-structures provide the users with a clear overview of the object/system of interest and its constituent sub-systems. To ensure readability and use friendliness, the system should contain between 5 and 25 sub-systems.

About the lower limit:

In cases with systems that contain less than five sub-systems, it is recommended to review the structure and consider lifting the few sub-systems up one level. Such as illustrated by the two figures below, where the LE1 / monitoring system was superfluous.

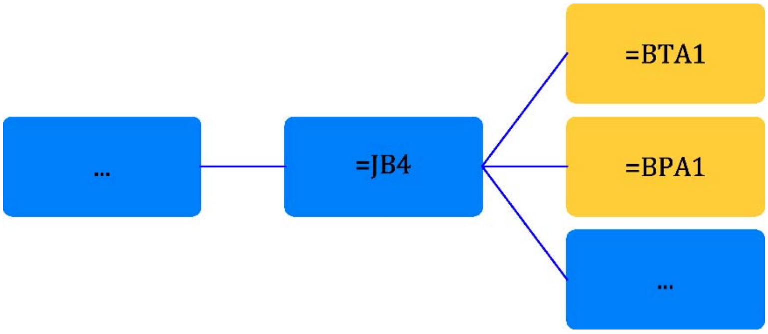
EXAMPLE



Key

...=JB4	oil distribution system
...=JB4.LE1	oil distribution system, monitoring system
...=JB4.LE1.BTA1	oil distribution system, monitoring system, temperature measurement
...=JB4.LE1.BPA1	oil distribution system, monitoring system, pressure measurement

Figure 6— Example of a potentially unnecessary system



Key

...=JB4	oil distribution system
...=JB4.LE1.BTA1	oil distribution system, temperature measurement
...=JB4.LE1.BPA1	oil distribution system, pressure measurement

Figure 7— Example of a simplified and improved structure

This principle shall never be forced, it is a general recommendation. There are many situations where only a few, or even a single sub-system should figure in the structure.

EXAMPLE
If the oil distribution system 4 (=JB4) only had the one single temperature sensor system (=BTA1) as a child system, it could still belong there. The placement would indicate that the temperature sensor system is a sub-system of that particular oil distribution system.

About the upper limit:

Many industrial systems include extreme numbers of similar systems, such as lithium battery racks, solar panel arrays, or individual pipes or poles in a large distribution line. In these cases, the proposed upper limit of 25 can be difficult to follow.

To handle the potentially extreme number of sibling systems can be done by creating multiple instances of parent systems and distributing the siblings between them by clusters. This can be done either by using the existing parent classes, or by creating a new level in the structure.

5.8 modelling for the future

Modelling the systems should be done in accordance with the principles of the ISO/IEC 81346 standards and this guide. Modelling with the intent to retrofit old systems, or simply to appease old habits which can force a suboptimal solution, should be avoided.

EXAMPLE 1
It has often been a norm to group systems according to deliveries (e.g. hydropower generator bearings are often grouped with the generator because they are supplied together) which shall be avoided in aspects that do not take this into account (e.g. functional aspect separates the bearings from the generator system).

EXAMPLE 2
Some older SCADA systems are not able to handle object references (TAGs) of more than 30 characters. A reference designation shall not be forcefully shortened to meet such outdated requirements.

5.9 Preferred semantics

For multi-level reference designations, full stop "." can be used between elements with only the first prefix as lead, as illustrated in Figure 8. This is in accordance with the rules of IEC 81346-1.

EXAMPLE

=A1=KA1=JB1=QNA2

=A1.KA1.JB1.QNA2

Figure 8— Preferred syntax

Although the readability is unaffected by the selection of one or the other, full stop (".") are more commonly accepted by IT systems than equal, minus or plus signs.

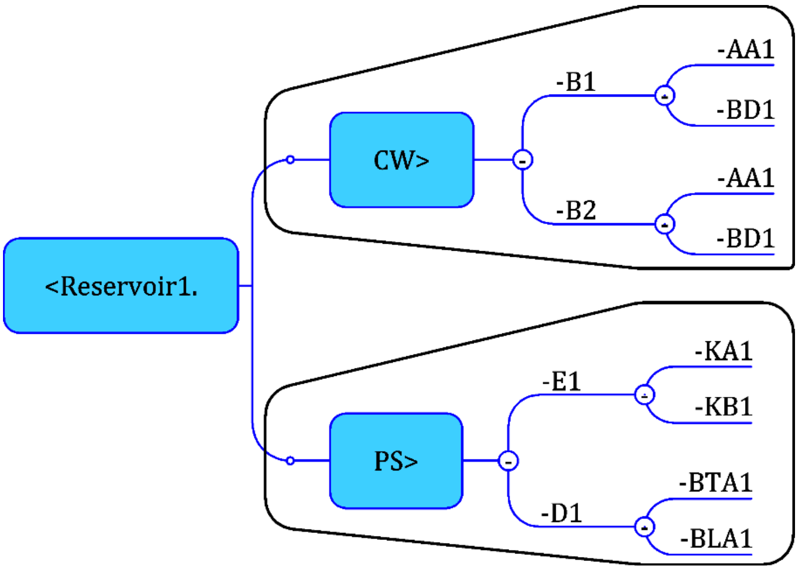
5.10 RDS implemented to multiple domain (RDS-PS and RDS-CW)

When modelling systems using the RDS, some class libraries will be better suited than others depending on the nature of the system in question. In particular ISO 81346-10 (RDS-PS) and ISO 81346-12 (RDS-

CW) provide different tables for functional (“main”) systems and technical systems, corresponding to the power supply domain (PS), or the construction works domain (CW), in order. These will be called “RDS libraries” in this section.

RDS-CW should be used for all systems belonging to the construction work domain. This includes buildings, general housing, garages and workshops, roads, access tunnels and so on.

Within the hydro power domain it also includes dams, which should be considered wall systems (“B” CW system in accordance with ISO 81346-12). With regards to the water storage system, the *reservoir* function (i.e. the body of water behind the dam) and all sub-systems related to water management (even those located within the dam itself) should be considered part of a power supply storage system (E-systems, the reservoir system) and should be modelled using RDS-PS.



Key

<Reservoir1.CW>-B1	Dam1
<Reservoir1.CW>-B1.AA1	Dam1, top/road
<Reservoir1.CW>-B1.BD1	Dam1, dam structure
<Reservoir1.CW>-B2	Dam2
<Reservoir1.CW>-B2.AA1	Dam2, top/road
<Reservoir1.CW>-B2.BD1	Dam2, dam structure
<Reservoir1.PS1>-E1	Reservoir
<Reservoir1.PS1>-E1.KA1	Reservoir, flood gate system1
<Reservoir1.PS1>-E1.KB1	Reservoir, overflow control system
<Reservoir1.PS1>-D1	Auxiliary monitoring
<Reservoir1.PS1>-D1.BTA1	Auxiliary monitoring, atmospheric temperature monitoring
<Reservoir1.PS1>-D1.BLA1	Auxiliary monitoring, snow depth monitoring

Figure 9— Example of a reservoir, modelling the constituent power supply systems using ISO 81346-10 and the constituent construction works systems using ISO 81346-12

As illustrated in Figure 9, to distinguish and ensure unambiguity when reading the reference designations, the top node should reflect what RDS library has been used. More on this in clause 6.

In situations where multiple domains/libraries are used, you will often have situations where certain systems could rightfully belong to both structures and/or constitute the meeting point between the two domains.

Another example is shown in Figure 10.

EXAMPLE
The heat-exchanger system in a plant extracts heat from process oil. This is part of the power supply system domain (RDS-PS). The heat is in turn extracted from the cooling water and used to pre-heat ventilation air in the building - a system within the construction works domain.

The heat exchanger between these two systems, the water-air heat exchanger, can have two reference designations, one in each domain.

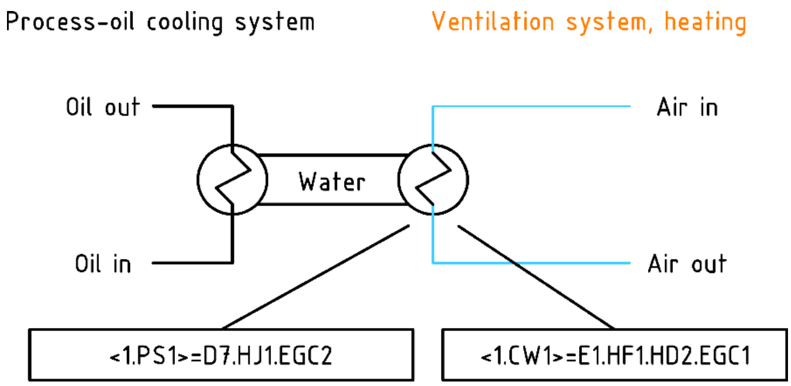


Figure 10— Example of an object with both a PS and CW reference designation

Methods and principles to handle multiple reference designations to the same object are proposed in clause 12.2.

5.11 Use of the symbol "?"

In situations where component-systems are required and should be added to a model, but details about them are yet undecided, there can be difficulties in assigning them a class.

EXAMPLE
Is a certain temperature sensing object going to be a system with boolean output – **BTB,** used to trigger alarms?

OR

Is the temperature sensing object going to be a system with scalar output – **BTA**, where the alarm is triggered by another system (potentially based on this scalar output)?

In these situations, one can use the question mark "?" in the last position of the reference designation, to indicate that the last letter is yet to be determined. This is illustrated in Figure 11.

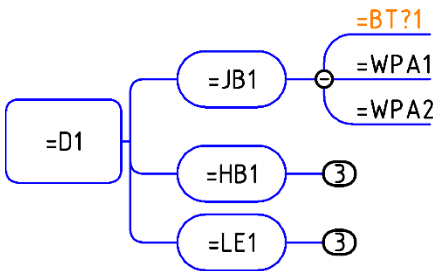


Figure 11— Example of the use of the question mark within reference designation

EXAMPLE
=BT?1

Note that e.g. **BT?** is not a "Sensing object for temperature", which is the group definition for all component systems that start with **BT**. It means that the **BT?** system is either a **BTA** or a **BTB**.

This distinction is important.

5.12 Structuring guidelines

For all systems, the user shall choose a class level, i.e. choose whether the object be designated by a prime system [_], technical system [_ _] or component system [_ _ _]. Some guidelines to support the choice are provided below.

A. **Only one prime system** should exist in any multi-level reference designation.

OK	Not Recommended
=**A1**.KA1.WPA1	=A1.**B1**.KA1.WPA1

Potential exceptions are large, complex compact systems within power production facilities such as wind turbines.

B. When working with structures modelling whole power plants (or systems of equivalent complexity), a multi-level RD should always **start with a prime system class**. With the exception of the application of RDS-CW on power supply systems (see structure identifier principles in clause 10.2)

OK	Not Recommended
=**A1**.KA1.WPA1	=**KA1**.WPA1

C. It is the designer's choice to model a second level (after a prime system) as a technical or component system. The complexity of the objects and the depth of the structure should be taken into consideration.

OK	Not Recommended
=A1.**KA1** =A1.**WPA1**	not applicable

D. It is suggested not to exceed three levels of *technical systems* before using *component systems*

OK	Not Recommended
=A1.KA1.KA1.LE1.WPA1	=A1.KA1.KA1.LE1.JB1.WPA1

E. Once the structure reaches an object which can be characterised as an “of the shelf product” it should be modelled as a Component System (e.g. a small general-purpose pump, a smart-sensor or a small valve).

Subject: standard, **off the shelf** valve

OK	Not Recommended
=A1[...]**QMA1**	=A1[...]**KA1**

F. A reference designation identifies systems on all levels. A reference designation does not need to end with a component system level.

OK	Not Recommended
=A1 =A1.KA1 =A1.KA1.WPA1	not applicable

6 Top node

To discern similar systems from another, the RDS provides **unambiguous** object identifiers.

An unambiguous reference designation implies certainty to which single object/system the object points to within a given larger system (often a plant or a station). And the larger systems can themselves be designated by the top nodes, see Figure 12.

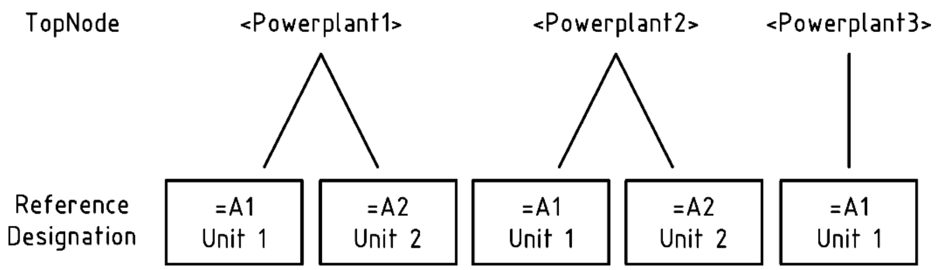


Figure 12— The top node is the key to differentiate between similar systems in a full fleet/ machine park overview

The top node is what gives any reference designation its context. The information contained within the top node is not regulated by the standard, but metadata information about the structure is (see IEC 81346-1:2022, annex K). It is suggested that certain elements of the structure metadata should be found in the top node. This will help the readability and usability of the structures and provide unambiguity on a larger scale.

The following sections propose elements to be added to the top node, depending on the aspect chosen and the situation.

Each piece of information presented in this clause will also have a recommended metadata tag among the ones listed in IEC 81346-1:2022, annex K (e.g. “ReferencedObjectid”).

6.1 Top nodes identifying large systems (stations, plants, and factories)

This is the proposed method to use the top node in the case where a large system (such as a photovoltaic power station, a hydro power station or a large stand-alone substation) is modelled by the RD hierarchical structure.

<SiteIdentifier.*Profile*.RDS-library>
<Sophie11. *HP1*. PS1>

1. Site identifier (ReferencedObjectId)
The ReferencedObjectId identifies the object represented by the structure (the modelled system), the powerplant/station/windfarm/transmission line site. Geographic location name or code, a powerplant name or a code-id associated to it can be used. The identifier should end with a number but does not have to contain letters.

EXAMPLE
Sophie11, Viking11, Itaipu1 or 2109

2. *Profile* (StructureId) - *Optional*
The StructureId should refer to an application profile used for RDS modelling. This information can aid in the understanding of the structure. To differentiate according to the technology type, The proposed syntax is “HP” for HydroPower, “WP” for Wind Power, “PV” for PhotoVoltaic, “SS” for SubStation, etc can be used. The numbering in the end should reflect the edition of the profile.

EXAMPLE
HP1 or WP1

3. RDS-Library (RdsDomainId)
The RdsDomainId should point to the reference designation classes domain used (also known as “RDS library” in this document). Within ISO 81346, parts 10 and 12 defines classes for Power supply Systems and Construction Works. The abbreviations PS and CW could be used along with a number indicating the edition of the standard parts (the StructureVersionId).

EXAMPLE
PS1, CW1

Each variation of the top node represents it’s own model. For a single powerplant (same site identifier), each profile, RDS-Library, or indeed aspect will present a different model of the same powerplant, such as exemplified in .

Table 1 — Example of systems represented in different models, of the same powerplant

Top node site identifier	Top node profile	Top node library	Aspect	Example of RD
PowerPlant1	HP1	PS1	= (Functional aspect)	<PowerPlant1.HP1.PS1>=A1
PowerPlant1	HP1	PS1	- (Functional aspect)	<PowerPlant1.HP1.PS1>-A1
PowerPlant1	HP1	PS1	+ (Functional aspect)	<PowerPlant1.HP1.PS1>+A1
PowerPlant1	HP1	CW1	= (Functional aspect)	<PowerPlant1.HP1.CW1>=A1
PowerPlant1	HP1	CW1	- (Functional aspect)	<PowerPlant1.HP1.CW1>-A1
PowerPlant1	HP1	CW1	+ (Functional aspect)	<PowerPlant1.HP1.CW1>+A1

6.2 Other purpose top nodes – temporary structures

Some structures are created to meet a need of limited temporary purpose. The context and therefore the temporary reference designation structures / models will depend greatly on the nature of the creation/use of the structure.

Some examples are provided below.

Orders and bills of materials

EXAMPLE
list of materials provided by a supplier for the construction of a particular system (see example in clause 7.4)

<ProjectID/RecurID.OrderID. Profile.RDS-library >
<HDrefurb2020.Order023. HP1.PS1 >

1a. ProjectID (StructureIdDomainId)
The ReferencedObjectId should identify the time-dependent context, such as a project identifier or a contract number. The identifier should end with a number but does not have to contain letters.
EXAMPLE
HDrefurb2020, B2054 or 6112020

1b. RecurID (StructureIdDomainId)
StructureIdDomainId could be used to identify recurrent tasks and potentially locations. The identifier should end with a number but does not have to contain letters.
EXAMPLE
A1001 or B1003 with
Class A: replenishment of workshop reserve-parts stock
Class B: replenishment of workshop tools and consumables
1001/1004: identifier of the workshop/location

2. OrderID (ReferencedObjectId)
The ReferencedObjectId should identify the object described by the structure (the modelled system). This could be an order identifier, contract number or equivalent. To be able to separate this identifier from the others in the top node it is recommended to start the id with a letter and end it with a number.
EXAMPLE
Order023, TX3456, nr12345

3. *Profile* (StructureId) - *Optional*
The StructureId should refer to an application profile used for RDS modelling. This information can aid in the understanding of the structure. To differentiate according to the technology type, The proposed syntax is “HP” for Hydropower, “WP” for Wind Power, “PV” for PhotoVoltaic, “SS” for SubStation, etc. The numbering in the end should reflect the edition of the profile.
EXAMPLE
HP1 or WP1

4. RDS-Library (RdsDomainId)
The RdsDomainId should point to the reference designation classes (domain) used. ISO/IEC 81346, parts 10 and 12 define class-tables for Power supply Systems and Construction Works. The abbreviations PS and CW should be used along with a numbering indicating the edition of the standard parts (the StructureVersionId).
EXAMPLE
PS1 or CW1

NOTE If a material order contains items belonging to both domains (e.g. pumps, valves and joins but also concrete, plugs and steel framework), then two structures should be created.
EXAMPLE
<A1001.Order345.PS1> and <A1001.Order345.CW1>

Modular tasks and views, temporary structures

For some projects and tasks system grouping and modularization can be helpful for the organization of information, tasks and work.

Structures could be created to clarify and/or support the work if:

- Different actors work on different parts of a system (e.g. entrepreneur X is responsible for systems -A1, and entrepreneur Y for -A2)
- A difference in timeline of the project shall be visible (e.g. -A1 systems will be constructed during the first month of the project, then -A2 and -A3)
- HSE issues should be grouped (e.g. -A1 systems are to be created in a temporary potential toxic environment (marsh gases))
- Other structuring needs based on other factors than physical assembly or function.

<ProjectID.TaskID. Profile.RDS-Library >
<B2345.03.HP1.PS1 >

The structure of the top node would look similar to the one described above (for bills of materials) with a TaskID (ReferencedObjectId - instead of an OrderID), selected to represent the temporary task within the project.

EXAMPLE
01: Design and planning
02: Purchase and delivery
03: Construction on site A
04: Construction on site B

6.3 Top nodes for cataloguing purposes

This application would typically come from supplier documentation, describing a certain system in details without allocating it in a larger functional structure whichwould reflect what it is being used for.

EXAMPLE
A pump is be supplied with a full set of documentation describing in detail its parts and assembly. The drawings and documentation all refer to the structure in the product aspect modelling the pump.

<CompanyID.SystemID.Profile.RDS-Library >
<SuperSupplier1.Pump6300.HP1.PS1 >

CompanyID (StructureIdDomainId)
The StructureIdDomainId could be used to identify the supplier of the system. This piece of information could be added by a client after purchase to help identify the modelled system.
EXAMPLE
SuperSupplier1, s987876

SystemID (ReferencedObjectId)
The ReferencedObjectId identifies the object described by the structure (the modelled system). This could be done in numerous ways depending on each company's internal information structure principles. Internal designations such as asset codes, a reference to a catalogue or systems library.
EXAMPLE
SnowRacer5000, B1A1AA1

Note that once the system has been purchased, the reference designation structure could be appended to the larger system structure.

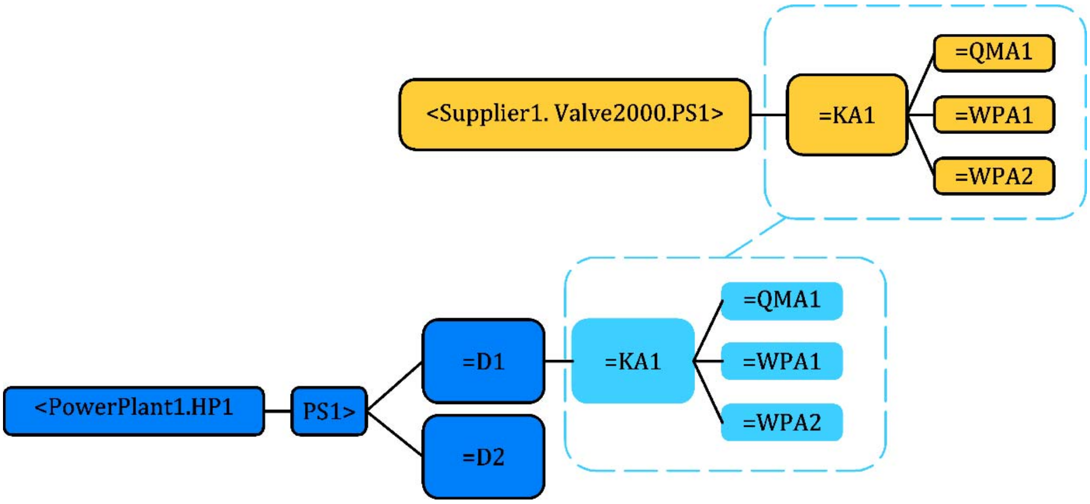


Figure 13— Example of an integration of a lesser system into a larger system

A supplier of a given system (e.g. a valve) can, along with the delivery, supply a full **RDS-structure modelling the component in question**. This will be useful for cross-reference and identification in the documentation attached to the object.

The operator incorporating the new system in a larger scheme (e.g. a powerplant), can directly incorporate the **suppliers RDS-structure** into the **full structure of the larger system**. This is illustrated in Figure 13.

This will be useful for both the operator and the supplier as the supplied documentation will still refer to the structure in use by the operator. This will minimize errors in identification of subcomponents and systems during later operation and maintenance.

6.4 Other purpose top nodes – (%) type aspects top nodes

The type aspect provide a mean to classify further within the common RDS classes. It is a tool for information structuring, organizing, filtering and sub-grouping. There are many ways the aspect can be employed to aid an organization, as such it needs a flexibility of use. There is however a need to contextualize the type aspect, as there multiple different interpretations of the type classes.

EXAMPLE
A KA system could have different types defined, depending on the information user – defined for different purposes. E.g. the **HydrType** could have been created by the hydrology department, and the **MaintType** by the maintenance department.

HydrType	***MaintType***
%KA1 – Water control systems for flows below 1m3/s	%KA1 - Gates

%KA2 – Water control systems for flows above 1m3/s	%KA2 - Valves

A dedicated top node could be used to contextualise / identify tables of class types.

<DomainID.RDS-Library >
<MaintType.PS1>

DomainID (StructureIdDomainId)
The StructureIdDomainId could be used to identify the type aspect tables. Note that in addition to internal types, system suppliers could have their own definitions. That information could be relevant to add to the RD-set of the object of interest.

EXAMPLE
The Inlet gate system of "PowerPlant 4" has the following RD-set:

<PowerPlant4.PS1>=C1.KA1
<PowerPlant4.PS1>-C1.KA1
<HydrType.PS1>%KA2
<MaintType.PS1>%KA2
<SupplierCompanyX.PS1>%KA34

7 Aspects

7.1 Reference designation sets

The use of the reference designations of an object within different aspects creates a a clear overview of the systems unencumbered by irrelevant information for specific tasks. Depending on the IT-tool, the setting, or the type of information you are seeking, one aspect is likely to be better suited than the others. E.g. the location aspect would be best suited for any map-based application (notably GIS-systems).

The collection of reference designations designating a particular object, called a Reference Designation set (RD-set), can be created stepwise in a project. Identifying an object at an early stage (often using the functional or product aspect) helps to keep track of the object in question, as other designations can be added to the RD-set as the project moves along.

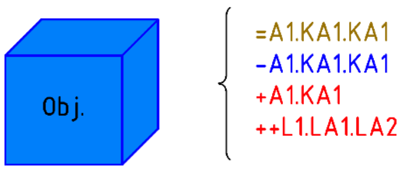
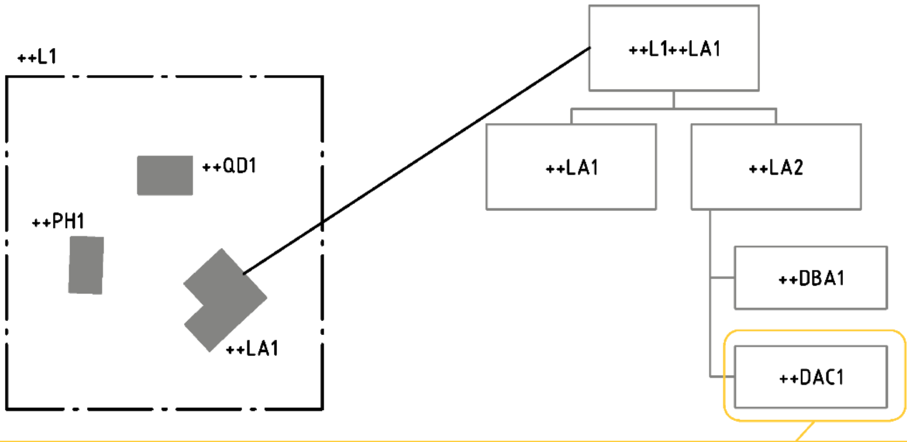


Figure 14— Illustration of an RD-set

It is the RD-sets (see Figure 14) that will be the key to navigate different systems and domains. In any given situation, one aspect is going to be dominant (e.g. for maps, where navigating the physical locational structures would be based on the ++site of location). Once an object/space of interest has been reached, the other aspect RD will be the key to gather information about the object/space in other systems.

EXAMPLE
All systems, identifiable by their reference designation in the functional aspect (e.g. =A1.RB1 and =A1.KA1 in Figure 15*) located in a specific space, would share a location reference designation.*

By using the location aspect in e.g. a Building Information Model (BIM) system, to navigate to a specific room ++L1.LA1.LA2.DAC1, where functions performed within that location would be grouped.



Location RD	Location name	Functional RD	Function name
++L1.LA1.LA2.DBA1.DAC1	2nd flr, mech eq. space	=A1.RB1	Turbine 1
++L1.LA1.LA2.DBA1.DAC1	2nd flr, mech eq. space	=A1.KA1	Main valve 1
++L1.LA1.LA2.DBA1.DAC1	2nd flr, mech eq. space	=A1.RB1.BPA11	Turbine inlet pressure
++L1.LA1.LA2.DBA1.DAC1	2nd flr, mech eq. space	=A1.RB1.BPA21	Turbine outlet pressure

Key

++L1	Power plant complex
++L1.QD1	Garage
++L1.PH1	Workshop
++L1.LA1	Hydro power plant
++L1.LA1.LA1	Hydro power plant, first floor
++L1.LA1.LA2	Hydro power plant, second floor
++L1.LA1.LA2.DBA1	Hydro power plant, second floor, control equipment space1
++L1.LA1.LA2.DAC1	Hydro power plant, second floor, mechanical installation space

Figure 15— Functions located in a specific room

A note on semantics

Usually RD-sets are expressed by dedicating a new line to each RD. RDs part of an RD-set can however be expressed in one line when separated with a slash “/”. Note that RDs in a RD-set will not always have the same top node, if this is the case the top node shall also be indicated.

EXAMPLE
If top nodes are the same: ++D1.DD1.DDD2/-B2.BB2.DDD1
If not: <TopNode1>++D1.DD1.DDD2/<TopNode2>-B2.BB2.DDD1

Annex A and B show other examples of the creation and use of an RD-set.

7.2 Functional aspect [=]

The proposed use for the functional aspect is in **P&IDs, general process diagrams, topology overviews or overview diagrams (single-line, multiline, …)**. With regards to **signals** and data tags, it is recommended that the functional aspect structure is used to identify the relevant owning asset. A signal tag should be created by combining an reference designation with another standardized tag, such as the signal modelling system of the IEC 61850-7 standard series.

The functional aspect structure shows the hierarchical structure of systems functionalities. In layman's terms, it will show what systems are intended to do, and how they do it (what functions work together to accomplish a more aggregated function).

The functional aspect will mainly be used to structure systems related to process flow. As such, a rule of thumb when selecting what systems to model:

Systems related to a signal or measurement (systems related to the "process" point of view) should be modelled. I.e. systems expected to be part of a P&ID or a single-line diagram. Other systems, although having a functionality, will be visible only in the product aspect (e.g. covers, support beams, wires). Asset data (mechanical attributes or object individual related data) is information usually held by systems where the product aspect is prominent.

In Figure 16, only process-related levels are visible (no cover, housing, screws, or other mechanical components exist in the structure).

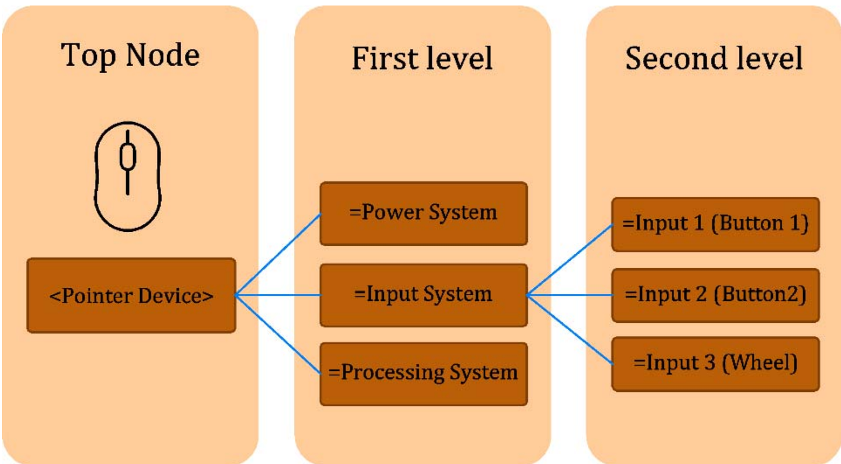
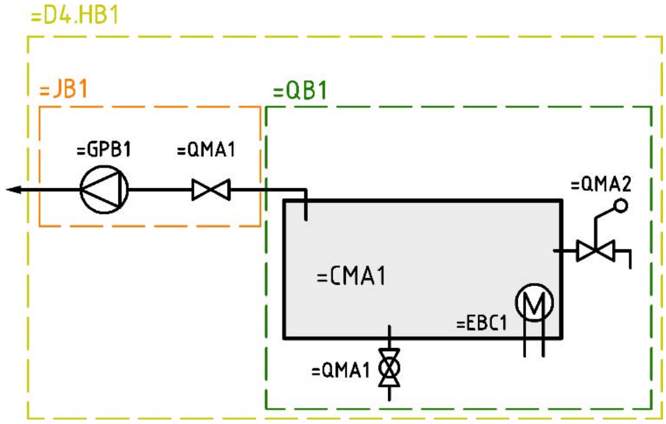


Figure 16— Functional aspect illustration 1 – A computer mouse

The functional aspect structures are generally reliably stable, because the functional requirements for a process are stable. While the choice of equipment type, applied physical solution and geographic location of any given system can vary and evolve over time. E.g. an elevator system will always need a driving function (motor), whether it is hand-driven, located at the top or bottom of the building, and regardless of how it is assembled.

The functionals structure will often be similar to the product aspect, especially for the upper levels. It will however likely have fewer constituent systems and likely fewer levels to the full model.

The function aspect offers a way of structuring the system functionalities in a way that both supports and adds to the understanding the role of the object within a larger system.



Key

=D4.HB1	Aux syst. 4, oil supply
=D4.HB1.JB1	Aux syst. 4, oil supply, oil transport
=D4.HB1.JB1.GPB1	Aux syst. 4, oil supply, oil transport, Pump
=D4.HB1.JB1.QMA1	Aux syst. 4, oil supply, oil transport, Valve
=D4.HB1.QB1	Aux syst. 4, oil supply, oil storage
=D4.HB1.QB1.CMA1	Aux syst. 4, oil supply, oil storage, tank
=D4.HB1.QB1.CMA1	Aux syst. 4, oil supply, oil storage, heater
=D4.HB1.QB1.QMA1	Aux syst. 4, oil supply, oil storage, drain valve
=D4.HB1.QB1.QMA2	Aux syst. 4, oil supply, oil storage, overflow valve

Figure 17— Functional aspect illustration 2 – An oil supply system

In Figure 17, the overflow valve =D4.HB1.QB1.QMA2 is a sub-system to the oil storage system.

7.3 Type aspect [%]

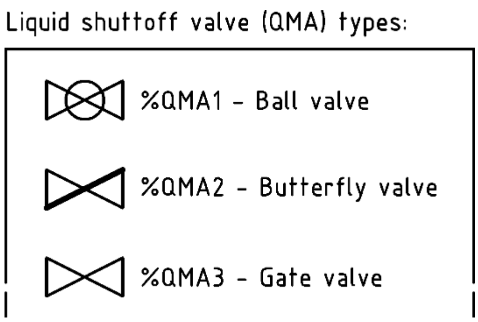


Figure 18— Type Aspect Illustration

The use of the type aspect, exemplified in Figure 18, provides the means to subdivide the classes defined in the ISO/IEC 81346 series. It is a handy tool to provide additional information about the object of interest while remaining in the RDS framework.

Note that the type aspect can be useful both in applications where the functional- and where the product aspect is predominant.

The aspect is suited for situations and application when **listing requirements** whichcan be associated to certain system types.

EXAMPLE
Electronic equipment can be designed to work with either AC or DC currents,
“%XDA1” for AC type electrical terminal, and “%XDA2” for DC type electrical terminal.

It could also be used in the setting of **grouping for comparison**. E.g. to be able to compare the age of all slide-gates in a portfolio, it would be useful to be able to detail the gate class (KA), which is the class generic for all gates, valves, breakers and more. It would be useful to sort out all KA-systems by types to provide useful comparisons. E.g. by picking and comparing all %KA1.KA2 (Gate systems, slide gates).

The type structure is a natural part of an **ontology** to define type-of associations.

Types classes are not defined by the ISO/IEC 81346-standard series; this means that a type library can be tailored for specific purposes or deliveries. The type aspect is an information holding tool, but the regulations and rules of application are practically non-existent. Different parties confronted with the type aspect should not assume a shared understanding of the classes. The type-library should be clearly stated, see suggestions on the use of the top node for this purpose in clause 6.4.

A suggested type structure for power supply equipment is to couple equipment types to the ones listed in the IEC Common Data Dictionary (CDD). Four domains are available through the CDD:

- electric/electronic components (IEC 61360-4 DB)
- process automation (IEC 61987 series)
- low voltage switchgear (IEC 62683)
- measuring equipment for electrical quantities (IEC 63213)

The type aspects should, as far as possible, be employed to mirror and fill the structure of the CDD.

Table 2 — CDD/RDS conversion table example

CDD - IEC 61360 motor classes	RDS - IEC 81346 motor class types
AAA160 - motor	NA
AAA161 - linear motor	MBA - electromagnetic linear driving object providing a continuous movement
AAA162 - linear ac motor	%MBA1 - linear ac motor
AAA163 - linear dc motor	%MBA2 - linear dc motor
AAA165 - linear universal motor	%MBA3 - linear universal motor
AAA164 - linear stepping motor	MBB - electromagnetic linear driving object providing a continuous movement
AAA166 - rotational motor	MAA - electromagnetic rotational driving object providing continuous rotation
AAA167 - rotational ac motor	%MAA1 - rotational ac motor
AAA168 - rotational dc motor	%MAA2 - rotational dc motor
AAA170 - rotational universal motor	%MAA3 - rotational universal motor
AAA169 - rotational stepping motor	MAB - electromagnetic rotational driving object providing discrete rotational steps

Some classes have their equivalent in both standards and do not require the creation of a new type.

EXAMPLE 1
Linear stepping motors, which are represented by the AAA164 classes in IEC 61360-4 DB and by the MBB class in the IEC 81346-2). See **Fehler! Verweisquelle konnte nicht gefunden werden.**.

Because the CDD is much more detailed in their equipment classifications, there are many classes who’s equivalent will have to be created as type-classes of the generic IEC 81346-2 classes.

EXAMPLE 2

Linear DC motor, AAA163 in the CDD, but this is a narrower description of the IEC 81346 class MBA. To correctly mirror the class definition a type of MBA must be defined. See **Fehler! Verweisquelle konnte nicht gefunden werden.**.

7.4 Product aspect [-]

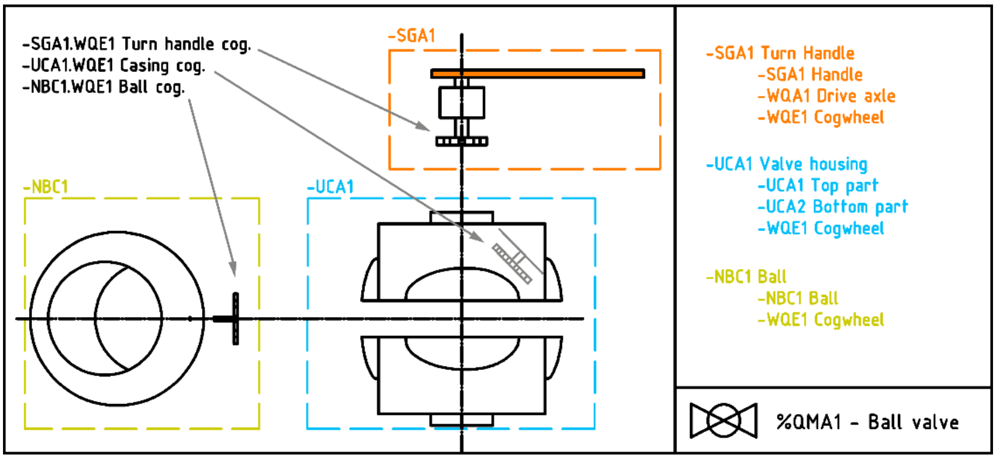


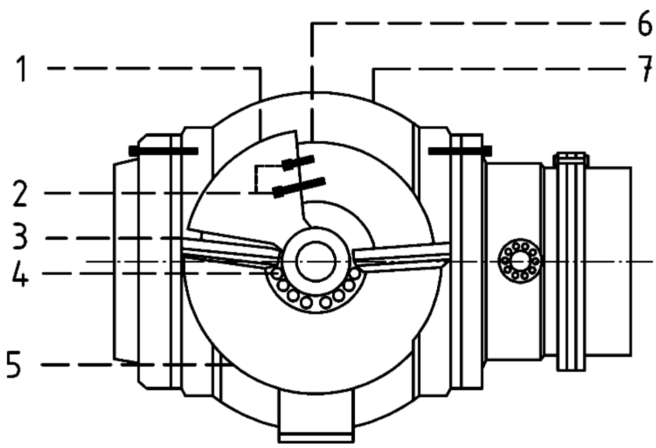
Figure 19— Product aspect illustration

The product aspect, exemplified in the Figure 19, must not to be confused with the type aspect. The product aspect does not present a view of "products" fulfilling specific functions, it provides the means for modelling systems by the nature of their composing systems. I.e. systems are grouped to constitute their parent-systems.

There are several ways of interpreting/using the product aspect, they are detailed in the chapters below.

7.4.1 Assembly structure

The most common use of the aspect (denoted here as the "assembly" take on the aspect), will be used to represent the physical associations between systems in a hierarchical structure, such as shown in the two figures below. This take on the product aspect is well suited for e.g. **assembly drawings** where the physical construction of machines or assemblies is viewed and explained.



Key

1 Force link

2 Pin Bolt
3 Axle
4 Bolt system
5 Piston housing
6 Piston shaft
7 Valve Body

Figure 20— Example of the use of the product aspect to structure a physical component - Drawing

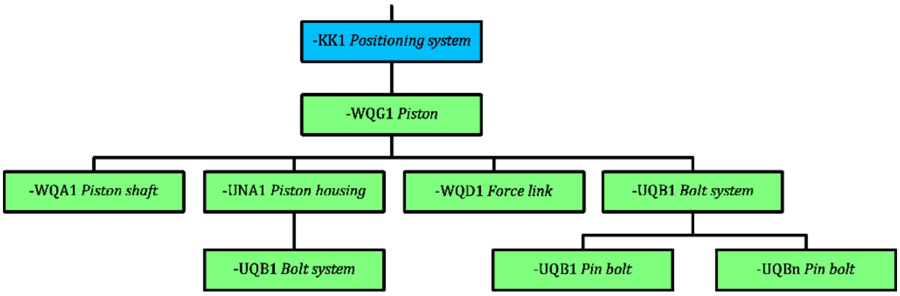


Figure 21— Example of the use of the product aspect to structure a physical component - Structure

This aspect is useful for the production and assembly stages of a component life cycle, but also for most **maintenance and work planning**. Typically this aspect would be preferred by maintenance staff and for system suppliers as it is well suited for identification of components not typically relevant in the functional aspect models.

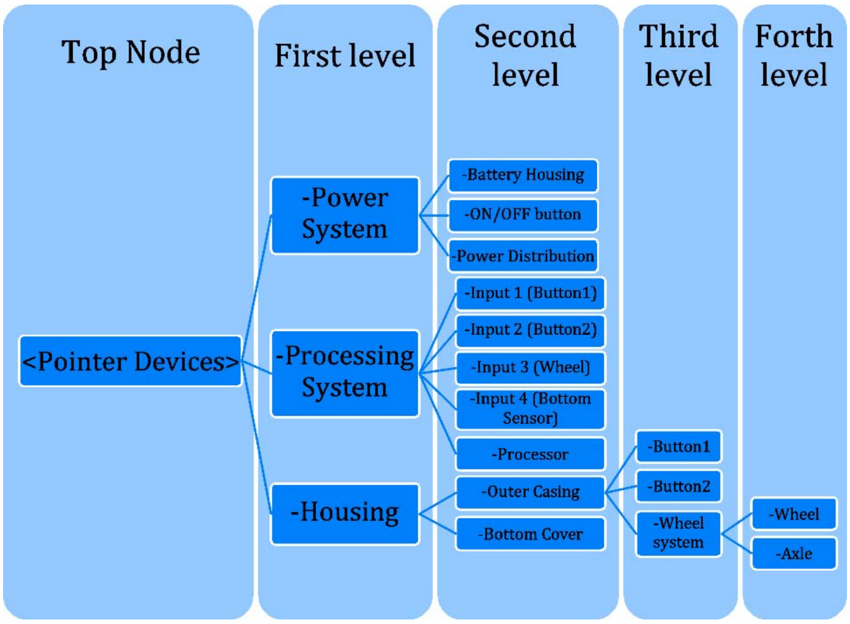


Figure 22— Product aspect illustration – A computer mouse

As one could see by comparing the example in the Figure 22, to the functional structure in Figure 16, the product structure is more complex and displays more constituent systems than the functional aspect. Some of the subsystems are obviously related (button input for instance) and will be part of the same RD-sets.

Cubicles and power component cabinets will see the benefits of the product aspect, as they are often manufactured/assembled prior to installation. The product aspect will provide the means to create a descriptive structure limited to the cubicle and its components, disregarding the components placement in a larger structure in the functional aspect.

7.4.2 Bill of material structures

The product aspect is also relevant for **purchasing/ordering purposes** e.g. for bills of materials or when a supplier proposes a detailed offer featuring many systems, which when employed can be functionally unrelated and/or geographically separated.

EXAMPLE

Offer from supplier **RDS-Master inc.**

Group 1 – Pipes and valves 1 (JB1) - 1000£ -Pipe 1 (-JB1.WPA1) -Pipe n (-JB1.WPAn) -Valve 1 (-JB1.QNA1) Group 2 – Pipes and valves 2 (JB1) - 1000£ -Pipe 1 (-JB2.WPA1) -Pipe n (-JB2.WPAn) -Valve 1 (-JB2.QNA1) Group 3 – Filters (KC1) - 500£ - Oil filter 1 (-KC2.HQB1/%HQB1) - Oil filter n (-KC2.HQBn/%HQB1) - Water filter 1 (-KC2.HQBn+1/%HQB2) Sum(-JB1, -JB2 & -KC1) : 2500£	%HQB1 – Filter type 1: Oil filter %HQB2 – Filter type 2: Water filter

Figure 23— Example of the use of the product aspect to structure content

The Figure 23 shows the example of an order for a multitude of plumbing components, organized in an offer where groups of components have been grouped according to project specific needs (e.g. shipment waves or locations).

Once shipped and installed, the components will likely be part of different models and acquire new reference designations.

EXAMPLE

A certain pipe could have the RD-set below

<Owner1>=D1.HB1.WPA1
<Owner1>-D1.HB1.JB1.WPA1
<MasterInc.Purchace1234>- JB1.WPA1

7.5 Location aspect [+Host of installation]

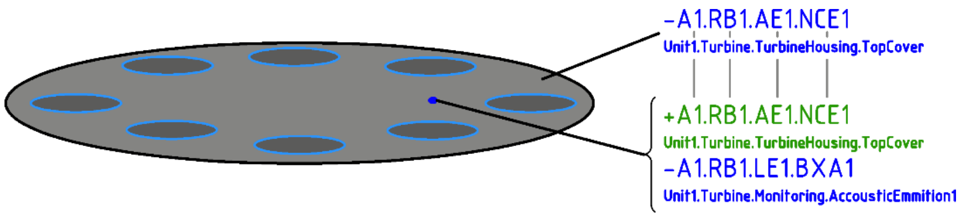


Figure 24— Host of installation illustration

The host of installation system (see ISO 81346-10), provides information about objects physical situation. This is done by designating the **system physically hosting the object of interest**, i.e. the object of interest is physically placed either *on* or *inside* the hosting system.

The hosting system is identified using its product reference designation. To indicate that the reference designation is the host of installation aspect, the product aspect prefix "-" is replaced with the location aspect prefix "**+**".

EXAMPLE
A control unit -D8.[…].KEB1, is located inside one of the control system cubicles of another system: -F4.[…].UCA2

The cubical is hosting the control unit.

(Part of) the RD-set for the control unit:
-D8.[…].KEB1
+F4.[…].UCA2

The aspect is useful for a number of situations and cases, notably to **identify the cubicle** in which electro component (such as a fuse, breaker or control unit) can be found, or sensor placements.

7.6 Location aspect [++Site of installation]

Site of installations, exemplified by Figure 25, provides the means to point out a physical location (without referring to any other structure defined by another aspect).

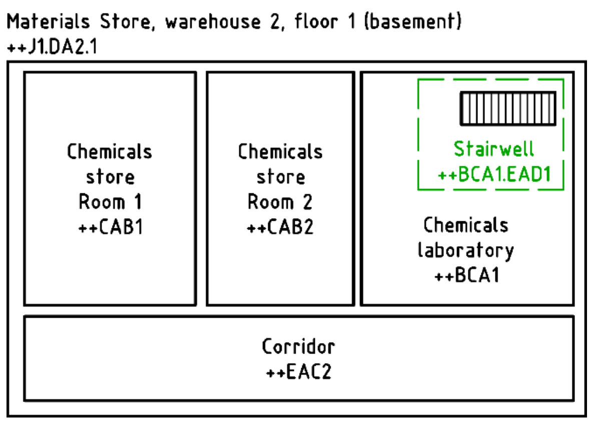


Figure 25— Site of Installation Aspect

The site of installation is different from the other aspects in that it employs its own distinct class tables. Figure 26 illustrates the three classes representing the different levels of abstraction available: construction complexes, -entities and installation spaces (one, two or three letter codes, in order).

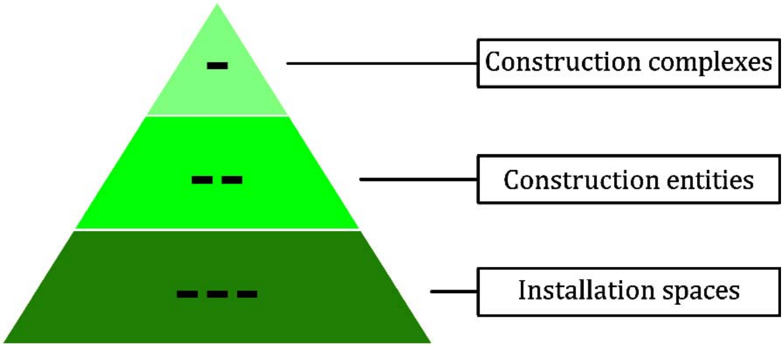
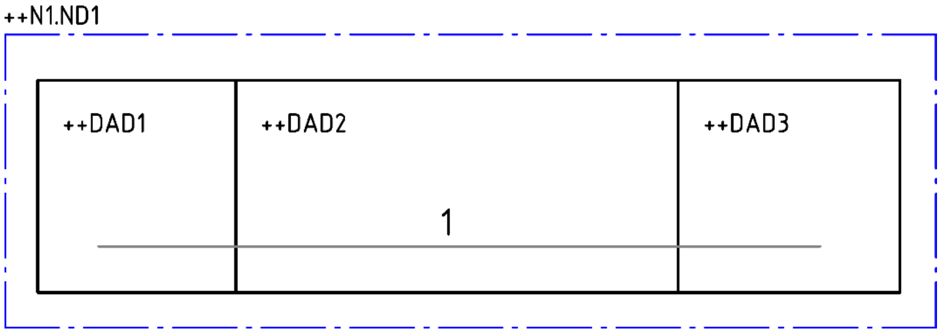


Figure 26— RDS-libraries for host of installation aspect

All are available in IEC 81346-2.

The site of installation is typically the aspect preferred for **3D-representation, maps and geographic location-based information systems such as** a **Geographic Information System (GIS) or Building Information Model (BIM)** systems (ISO 19650).

Figure 27 illustrates a situation where an electrical cable is stretched over three different spaces.



Key

1 Electrical cable =D1.JE1

Figure 27— Example of the benefit of the use of the full RD-set

The part of the cable in each of the three spaces have the following RD-sets:

=D1.JE1 ++N1.ND1.DAD1	=D1.JE1 ++N1.ND1.DAD2	=D1.JE1 ++N1.ND1.DAD3

By labelling the cable with its functional (or product-) aspect reference designation, one can identify the cable across the spaces it goes through.

A note on levels and floors:

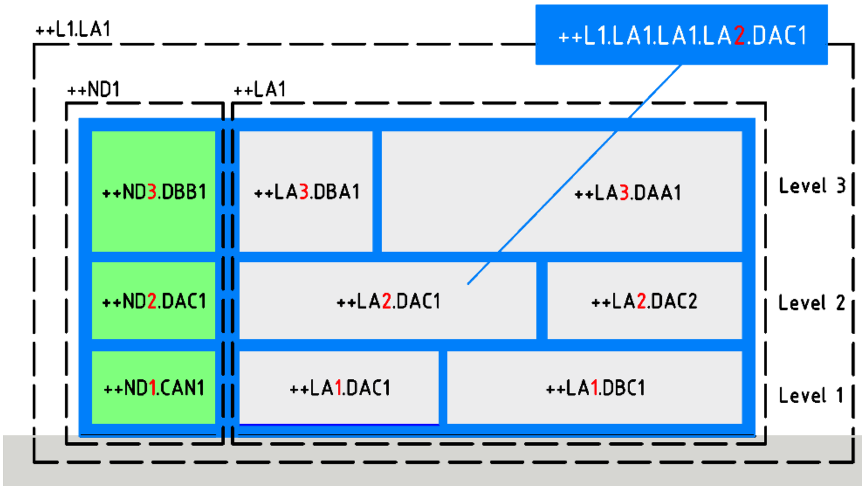
It is in the nature of the location aspect that the RD of an object should also contain information about the floor/level in which the object can be found. This causes a dilemma. The floor level is represented by a number, and according to best practice, numbers should not hold any meaning, nor should numbers alone be used to represent a level in a reference designation.

The level can be introduced into the object RD in three ways. All represent exceptions in the application of general modelling principles regarding the use of numbering.

1- **The repeated entity level**
A first solution, illustrated in Figure 28, is to add a distinct level in the RD as the last technical system level (i.e. the last construction entity (two-letter code) level before the space of installation (three letter code) levels). This will often refer to a repetition of the formers class-code.

EXAMPLE
*++L1.LA1.**LA2**.DAC1*

The use of this concept does have some requirements, as the last entity-level (the second "LA" level in the example) must be understood as bearer of the floor level information.



Key

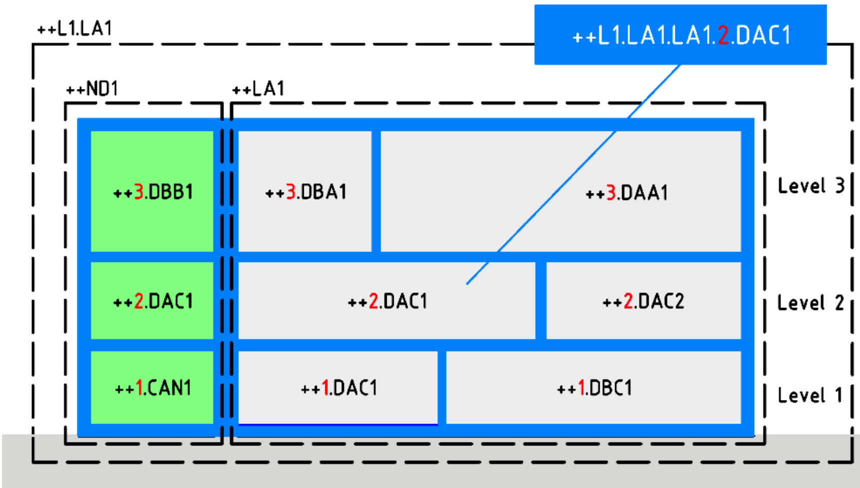
++L1.LA1	power plant
++L1.LA1.ND1	power plant, workshop
++L1.LA1.ND1	power plant, power plant

Figure 28— Illustration of the first principle for level numbering in the RDS location aspect

This is the recommended solution for use on power plants, even if this level-instantiation does carry meaning. It is an unavoidable problem as levels in a building are of a numeric nature.

2- **The stand-alone level**
The potentially most user-friendly solution, illustrated in Figure 29, is to add the level in the building as a distinct level in the RD. It should still be placed between the last construction entity (two-letter code) level and the first space of installation (three letter code) level.
EXAMPLE
*++L1.LA1.LA1.**2**.DAC1*

Although this choice provides an easy distinction of the level, it does require all digital applications to accept the use of the separating character ("." or "++"). The floor shall remain a distinct level, and not an additional digit in the parent-level numbering (e.g. A1CA**11**CAB1).



Key

++L1.LA1	power plant
++L1.LA1.ND1	power plant, workshop
++L1.LA1.ND1	power plant, power plant

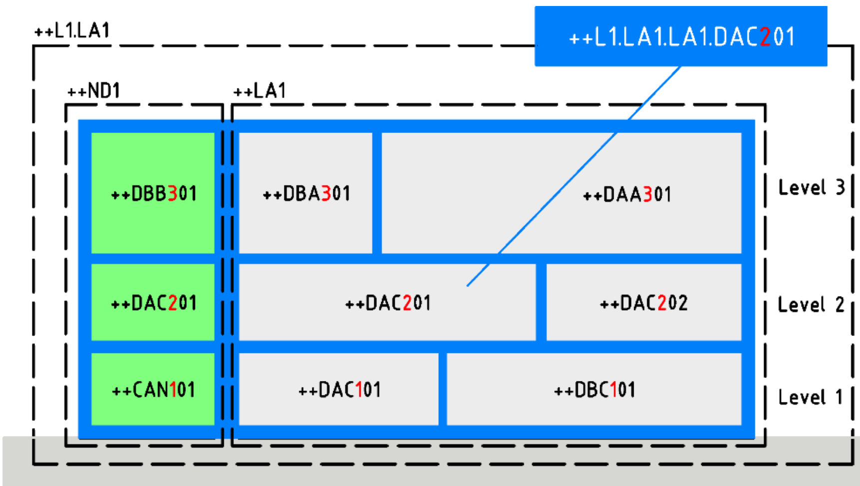
Figure 29— Illustration of the second principle for level numbering in the RDS location aspect

3- Space numbering including level

The solution following the ISO 4157-2, illustrated in Figure 30 is to add the level into the instantiating number of the different spaces.

EXAMPLE
*++A1.CA1.CAB**1**01*

The standard is generally applied on hotel/building room numbering and should feel familiar (see ISO 4157-2). The major flaw of this is meaningful numbering.



Key

++L1.LA1	power plant
++L1.LA1.ND1	power plant, workshop
++L1.LA1.ND1	power plant, power plant

Figure 30— Illustration of the third principle for level numbering in the RDS location aspect

Level 1 is defined as the lowest level in a construction entity where activities can be performed (including below ground level). This means that while there can be negative floor numbering (subterranean floors), there can never be negative levels. Buried objects such as pipes or cables can be considered placed on level 0.

The choice of method to represent the level in a construction entity should be well documented, and detailed, either through a description or through a reference to one of the tree methods proposed in this document ("The repeated entity level", "The stand-alone level" or the "the space numbering including level").

A note on syntax:
In many situations a location RD will point to a space/system containing multiple objects of interest, e.g. it will point to the room where a list of functions are located. Each of which share the same location RD. This location RD is *ambiguous* to these objects, as it doesn't identify each of the systems within. The RD will unambiguously identify the space containing them all.

The location aspect RD of an object will usually identify a parent level to the object of interest (e.g. the room where a cabinet is located, not the space that the cabinet represents). In accordance with IEC 81346-1, such a reference designation shall end the space/host system designation with a horizontal ellipsis ("…"), see the example below.

EXAMPLE

RD-set:
=A1.XXX1
*++A1.AAA12***…**

Because the location aspect is most often used in this manner (no confusion is likely), the ellipsis may be omitted for this aspect (see IEC 81346-1:2022, rule 32).

7.7 Location-type aspect [%%]

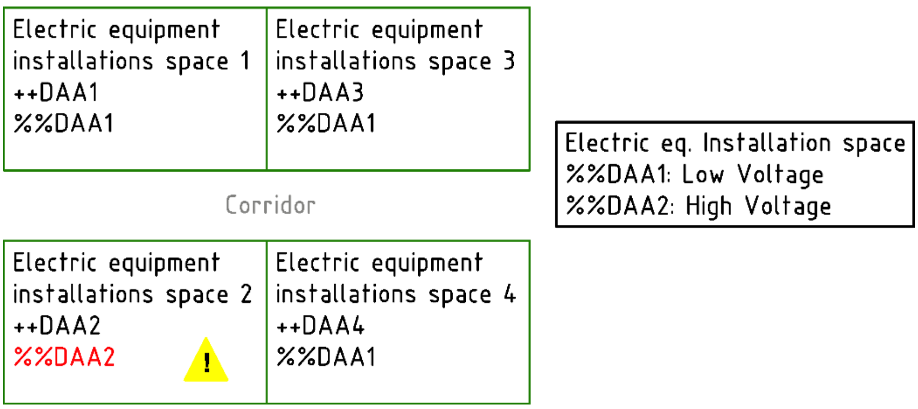


Figure 31— Location-type aspect example illustration

The site of installation aspect classes are different from the other aspects. While the regular (%) type aspect is to be employed for types of Power supply Systems, the location-type aspect is reserved for types of construction complexes, construction entities and activity spaces as defined by the tables used by the site of installation aspect. As illustrated in in the Figure 31 and , the location-type refers to the site of installation aspect classes (construction complex, -entity and installation space).

Table 3 — Type and location-type applications

(%) Type		
A	Prime Systems	%A1 Hydro Power Plant
AA	Functional Systems	%HB1 Liquid supply system (Oil)
AAA	Component systems	%WPA1 Water pipe

(%%) Location-Type		
A	Construction Complex	%A1 Apartment Residential Area
AA	Construction Entity	%HG1 Ball sport facility (Tennis)
AAA	Space	%CAE1 fluid storage space (Water)

All other principles for the type aspect (see clause 7.3) are valid and useable for the location-type aspect as well.

8 System associations and relationship classification

8.1 Implicit association of the hierarchical structure

An RD-based hierarchical structure is created by classifying its constituent systems, and defining part-of relationships between them.

EXAMPLE

-D1-JB2-WPA3 is the reference designation of a pipe, *part of* a water distribution system (-D1-JB2), *part of* an auxiliary system (-D1).

“Sibling” relationships between systems (multiple systems part of the same larger system), is another relationship type implicitly derived from the hierarchical structure.

These are the most basic of association principles, implicitly given by the object reference designations themselves. The following clauses discuss explicit relationships between systems.

8.2 RD-set

One of the primary benefits of the RD-sets is that they enable the linking of information about a certain system throughout different domains and IT systems.

Within a company, different IT-tools/software/system will base their information structures on *one* of the RDS aspects (e.g. map-based systems will most likely be based on the location aspect structures, while automation processes will be built on the functional aspect). Other types of information about the object of interest can be found on other platforms. Because of the RD-set of the object in question, it can be located on any platform, even those based on another aspect.

EXAMPLE

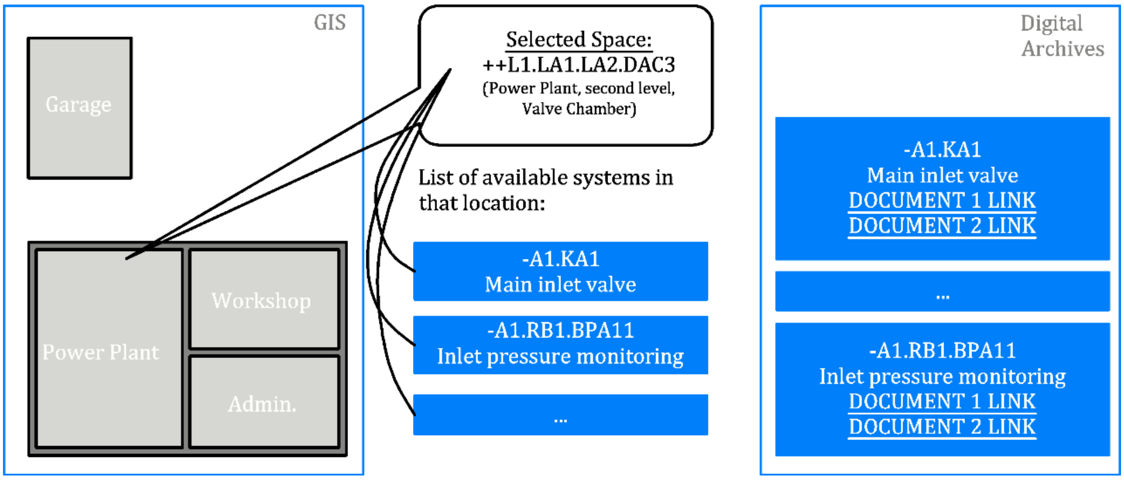


Figure 32— Navigating between systems (geographic information system and digital archives) using RD-set

Figure 32 illustrates how using the RDS to navigate a Geographic Information System (GIS) and locating a certain space (a valve chamber in the example above), the GIS database can reveal all systems with that particular location occurrence (i.e., the available list of systems in that location).

Once a system among them is selected (e.g. the inlet pressure monitoring system) the RD in another aspect (-A1.RB1.BPA1 in Figure 32) will link to e.g. the system documentation, stored in the digital archives, organized using the product aspect.

A requirement for object recognition over IT systems is the possibility to associate/attach information about the other RDs to the object of interest (usually as attributes/metadata).

8.3 Relationship classification

IEC 81346-1:2022 (annex I) proposes a method to designate and classify the relationship between object occurrences, it allows relationships between different objects to be established and classified.

The relationship is identified by inserting the relationship class between the two occurrence RDs, separated by the "|"-character on both sides, such as in the example below.

Some few relationship classes are provided as examples in IEC 81346-1.

EXAMPLE

=A1.KA1|DB|=A1.RB1

Relationship where matter flows between two systems in in liquid form, between the main inlet valve and the turbine (receiving system is on the right side of the relationship class).

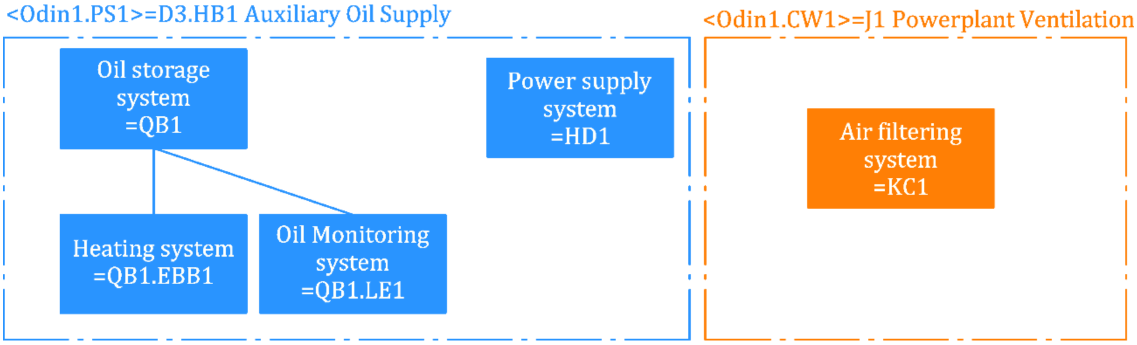


Figure 33— Example of use of the association classification on a system – system description

In Figure 33 an auxiliary oil supply system (<Odin.PS1>=D3.HB1) has its own dedicated power supply system (<Odin.PS1>=D3.HB1.HD1). The relationship within the oil supply system could be classified as such:

=D3.HB1.HD1|CA|=D3.HB1.QB1.EBB1

The power supply system |supplies power to| the oil heating system

=D3.HB1.HD1|CA|=D3.HB1.QB1.LE1

The power supply system |supplies power to| the oil monitoring system

As an HSE action, the power plant ventilation system (<Odin.CW1>=J1) was equipped with an air filtering system. For convenience, power to the filtering system is supplied by the auxiliary oil supply system power supply (<Odin.PS1>=D3.HB1.HD1).

<Odin.PS1>=D3.HB1.HD1|CA|<Odin.CW1>=J1.KC1

The auxiliary oil supply power supply system |supplies power to| the ventilation System

With this information stored and made available, HSE and root cause analysis could be helped by the classification of the system dependencies. As an example, one would in the case above be made aware that maintenance tasks involving the auxiliary oils supply system and its power supply, could impact the air in the powerplant. Precautions should be taken.

8.4 Relationships between aspects

One object individual may or may not be represented uniformly in the different aspects.

There will be cases where an object individual, as referred to unambiguously in the product aspect (e.g. a sensor), may in fact perform multiple functions. In which case, each of these functions exist, and can be identified by their reference designations in the functional aspect.

EXAMPLE

<u>RD-set 1</u>

-D1.LE1.BTA4	auxiliary system 1, monitoring system 1, temperature sensor 4
=D1.PF1.BTA3	auxiliary system 1, protection system 1, temperature sensor 3

<u>RD-set 2</u>

-D1.LE1.BTA4	auxiliary system 1, monitoring system 1, temperature sensor 4
=D1.HE1.BTA2	auxiliary system 1, Cooling system 1, temperature sensor 2

In the example above, the same sensor (-D1.LE1.BTA4) fulfils two functions (=D1.PF1.BTA3 and =D1.HE1.BTA2). There is a one-to-many relationship between these occurrences.

There will be occasions where the situation is reversed, and many objects (with individual product occurrences) fulfils one single function. such as one may find in a stretch of pipes, where the full stretch is modelled as e.g. =D1.JB1, while every single pipe-segment could be individually identified in the product aspect (-D1.WPA1, -D1.WPA2, …).

An equivalent one-to many relationship will exist regarding the location aspects as well, as some object are large enough to exist in multiple defined spaces at the same time (e.g. cables stretching over multiple rooms in a building).

In any given systems where these one-to many relationships exist, the one is the unambiguous reference designation of the object in question (i.e. that points specifically to the object in question, and only that object).

9 Classification guidelines – Power supply Systems

9.1 Prime systems (Main systems)

9.1.1 General

Prime systems, formerly known as "power supply systems" are reference designations of the highest level of abstraction. Prime system classes are represented by one letter codes.

The classes discussed can be found in ISO 81346-10:2022, table B.1.

9.1.2 Electric power transporting system (B-system)

B-systems are difficult to model in a uniformed manner because of their great variety. This clause proposes some rules of thumb that can help users to model systems in a homogenous way.

- The separating system between electrical systems is often a circuit breaker (CB). If in doubt, the ownership of the separating/connecting system is given by the receiver's ownership principle (see 5.2) or the collector system principle (see 5.3).

- A power distribution system collecting power from the process and submitting it to the grid should be modelled as B system. A power distribution system submitting power for internal- or secondary purposes (notably local power supply), should generally be modelled as a D system.

9.1.3 Supporting systems (D-systems)

Systems supporting the main process, in particular systems that potentially support several units at once should be modelled as D-systems.

Below is a list of some of the proposed systems classified as support systems:
- Multi-purpose hydraulics oil supply systems
- Main Cooling water supply system (Hydro)
- Auxiliary power supply system

Note that many auxiliary systems would naturally fit in the construction works structure (see clause 10), they would therefore **<u>not</u>** figure as D-systems within the power supply hierarchy. Examples of these are:

- Building ventilation
- Building heating/cooling
- Access control
- General firefighting systems
- Local alarm systems (sound/light)

Some systems, such as station power self-supply systems or earthing systems, may exist in both domains. This is allowed and supported if required (see clause 5.10).

9.1.4 Managing systems (F-systems)

Power supply systems are complex and hold a great many sub-systems that require some sort of control system. A control system could be considered a part of the object of interest itself (e.g. the manual control system of a motorized crane) or it could be a dedicated external system (e.g. a plant management automation system).

Below are some proposed guidelines for determining what systems should be part of dedicated F systems, and what shouldn't.

- If a control system Alpha is solely dedicated to a single system Beta, then the control system Alpha is part of system Beta. This situation will often apply to local control systems.
- If a control system Alpha is dedicated to multiple dispersed systems (*functionally* dispersed) it should probably consider to be / be part of- an F system. This situation will often apply to remote control and overall plant automation systems.
- If a system is dedicated to, or supports general information flow, it could be considered part of an F system, e.g. signal transmission systems.
- If a cubicle/rack/equipment housing system holds information handling equipment dedicated to multiple functionally dispersed systems, it should be considered part of an F system.

Note that especially within these F-systems there will likely exist functions that are, at least partly, performed by non-physical devices (software), such as IT networks.

9.2 Technical systems

9.2.1 General

Technical systems can be found in ISO 81346-10:2022, table B.2.

9.2.2 Consecutive duplicated classes

The RDS hierarchies are created by structuring systems within systems. Any given system has an essence to its functionality that leads to the selection of its classification. A gate in a waterway controls the flow of water, it is a KA technical system.

Some systems can be complex, with many sub-systems reflecting that complexity (see 5.1). In such a situation one can also wish to designate the part of a larger system that incorporates the essence of the parent system functionality. In these cases, it is natural to find a reference designation with a duplicated class.

EXAMPLE
A gate system =KA1 can be a complex system with multiple gates such as in Figure 34. It is essential for the control system to be able to reference each individual gate within the larger gate system (=KA1.KA1 and =KA1.KA2), as exemplified in Figure 35.

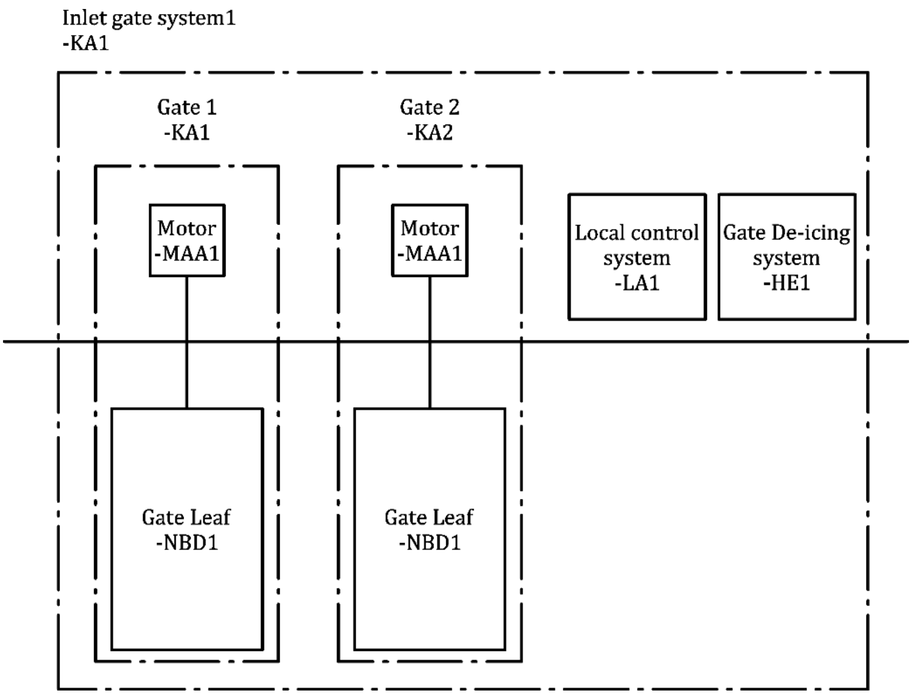


Figure 34— Gate system example

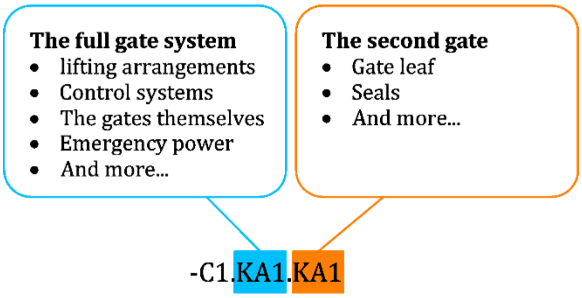


Figure 35— Gate system example details

Duplicated classes can also be used to group large quantities of similar systems.

EXAMPLE
For a long and complex oil distribution system, there could be hundreds of pipe sections attached in a complicated network. It is sensible to group sections of pipes into meaningful systems:

[...]-JB1 Oil distribution system
-JB1.WPA1 Pipe system leading oil to customer systems on first floor
-JB1.WPA1.WPA1 Pipe section 1
-JB1.WPA1.WPA2 Pipe section 2
-JB1.WPA1.WPAn Pipe section n
-JB1.WPA2 Pipe system leading oil to customer systems on second floor
-JB1.WPA2.WPA1 Pipe section 1
-JB1.WPA2.WPA2 Pipe section 2
-JB1.WPA2.WPAn Pipe section n
...

9.2.3 AA-AE Structural support classes

For PS systems, the functional aspect is proposed to be used primarily for process related tasks (signals, automation, process control). Because of the mechanical nature of the AA-AE structural classes, they may not figure in the functional aspect model at all.

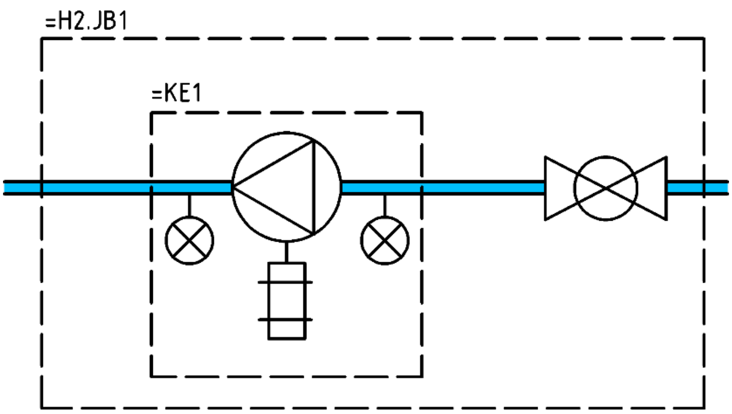
There are however some exceptions. Notable among these are dams. It is proposed to model dams, and the dam sub-systems using the following classes:

AE Dam
AA Dam Structure
AB Dam Foundation

9.2.4 KE pumping systems or JB liquid matter transport systems

Pumping systems (KE) are treatment systems, they increase pressure. The overall purpose of the increased pressure is often used to lift/transport matter, when that is the case, it is recommended to model a liquid matter transportation system (JB) to model the overall system function, and then add the pump as a sub-function to it.

Figure 36 provides an example.



Key

=H2.JB1	Drain water ejection (transport) system
=H2.JB1.KE1	Pump system

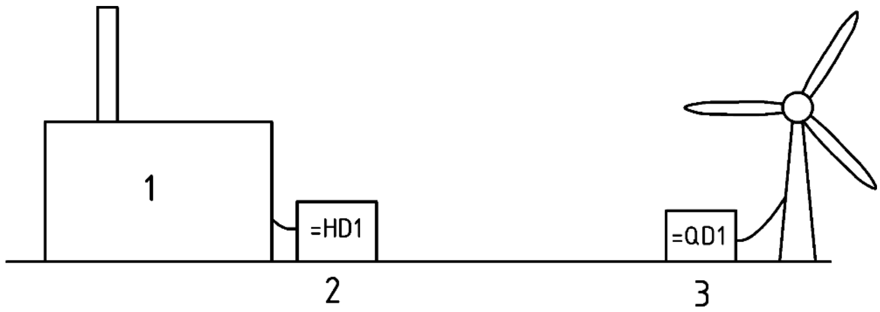
Figure 36— Pump system =H2.JB1.KE1 within a liquid transport system =H2.JB1

9.2.5 Electrical Power supply HD or Electrical energy storage system QD

Electrical power supply (HD) or Electrical energy storage system (QD) could both be applied to Battery-system.

The selection of class shall come from the primary intended use:

- If the systems goal is to supply energy in need (blackouts/start-up), it should be a power supply system (HD). See Figure 37.
- If the system was installed to be a temporary recipient of energy for subsequent retrieval and use (e.g. a lithium-based battery system installed to store surplus energy from a wind power farm) it should be a storage system, i.e. a QD system.
- If both uses can be claimed as equally important, it is suggested that QD is selected.



Key

1 Hydro power plant

2 Auxiliary power supply

3 Surplus energy storage

Figure 37— HD or QD illustration

It is not suggested to use both HD and QD if both uses are relevant. "=HD1.QD1" is not both a power supply system and an energy storage system, it is an energy storage system within an energy supply system (i.e. the battery arrays within the power supply system).

Note that battery systems can be used to provide grid frequency restoration services (i.e. fast power supply to the grid to stabilize the frequency, when the power output suddenly is higher than the produced power). The full system providing the power to the grid could be considered an A-system, however the battery arrays themselves would still be energy stores (i.e. "QD" class systems).

9.2.6 Electrical energy flow control system KL or electrical power distribution system JE

A switchgear (or equivalent) system e.g. collecting power from multiple units (such as the ones you can find on a Photovoltaic Power Plant) should be classified as electrical power distribution system (JE), even if it mainly consists of a set of circuit breakers or disconnectors.

A proposed rule of thumb is to use the classes as described below:
- KL systems are controlling electricity flow (e.g. a breaker bay)
- JE systems are conducting electricity flow (e.g. a busbar system)

Note here the relevance of the two ownership principles (5.2 and 5.3) in determining the structural part-of relationships of these systems. Figure 3 could just as well be about circuit breakers and busbars.

9.2.7 Power system phases

To accommodate the need to separate systems into three phases, the system in question should be followed by a second level (repeated class) instantiated using the phase number.

EXAMPLE
=B1.JE1.JE1 (Phase 1)

=B1.JE1.JE2 (Phase 2)
=B1.JE1.JE3 (Phase 3)

9.3 Component systems

9.3.1 General

Component systems can be found in IEC 81346-2:2019, table 3.

9.3.2 WB?/WD? High voltage systems

Voltage levels above 1kV AC or 1.5kV DC are considered “high-voltage”.

9.3.3 QMA/QNA/RNA Valves

IEC 81346-2 proposes many solutions for valve modelling. For liquid flow control in particular the options are proposed used as described below:

- QMA – Liquid shutoff valve
  Proposed to be used for valve systems that are primarily designed to be either fully open or fully closed
- QNA – Liquid control valve
  Proposed to be used for valve systems that are designed to be partially opened to control the flow through the valve, with the possibility of fully opening or closing the waterway.
- RNA – Regulating valve
  Proposed to be used for valve systems that are designed to be partially opened to control the flow through the valve, without the possibility of fully opening or closing the waterway.

9.3.4 System phases

Same principle as for technical systems, see 9.2.7.

10 Classification guideline – Construction Works

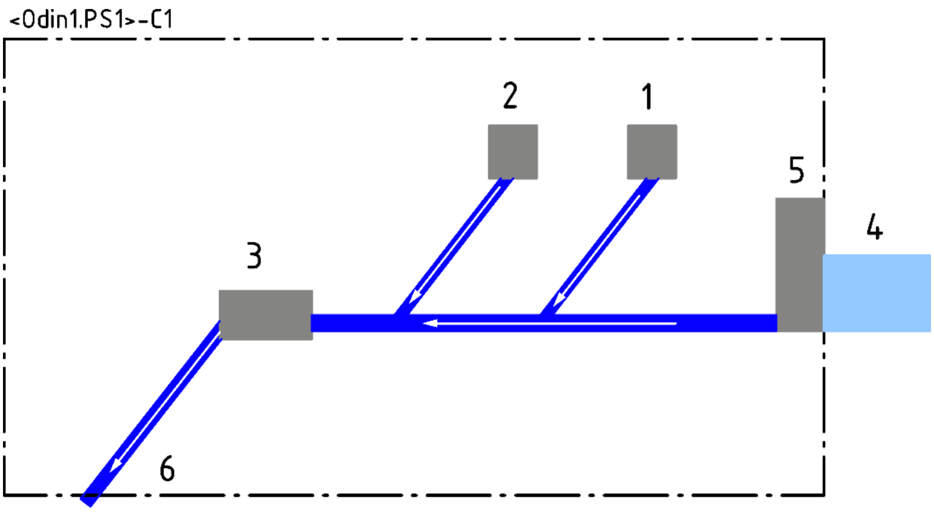
10.1 General

Powerplant are composed of power systems as well as construction works systems. It can be useful to create hierarchical structures (models) of a plant using both the classes in ISO 81346-10 (RDS-PS) and ISO 81346-12 (RDS-CW). Where each model represents the systems naturally belong to their domain. See clause 5.10 for more details.

10.2 Structure Identifier

ISO 81346-10 (RDS-PS) of the standard proposes tools to model power production and transmission schemes. The upper level of a multi-level structure can point to systems spread over multiple location.

Figure 38 shows an example of such a system with a water transport system containing an inlet structure, gates for additional water input from “creek intakes”, and an emergency closing valve chamber).



Key

1 Creek intake 1, gatehouse
2 Creek intake 2, gatehouse
3 Emergency closing valve chamber
4 Main intake, gatehouse
5 Reservoir
6 Towards the powerplant

Figure 38— Example of a water transport system in a hydro power plant – Power supply System point of view

Within this system, each of the main sub-systems will be identified with a technical system (each of the creek intakes, the inlet, the emergency closing valve, the tunnels, etc…). The Power Supply System classes (see ISO 81346-10) were created to fit this level of abstraction.

ISO 81346-12 (RDS-CW) upper levels were created with the assumption that only *one* structure entity would be modelled by the structure (i.e. the upper level of part 12 are wall-, roof-, ventilation systems and so on). The classes are not made to be able to handle the same level of abstraction as in part 10.

There is a hierarchical discrepancy between the two parts.

To identify the construction entity before employing ISO 81346-12 (Construction Works, CW) classes, it is proposed to add a Structure Identifier (CID) based on the construction entity classification found in 81346-10:2022, table C.2. The CID should be added to the top node.

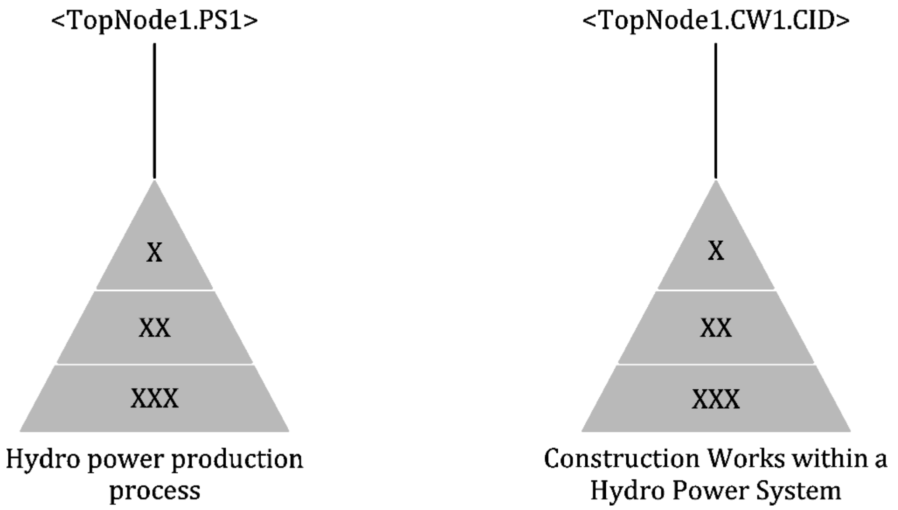
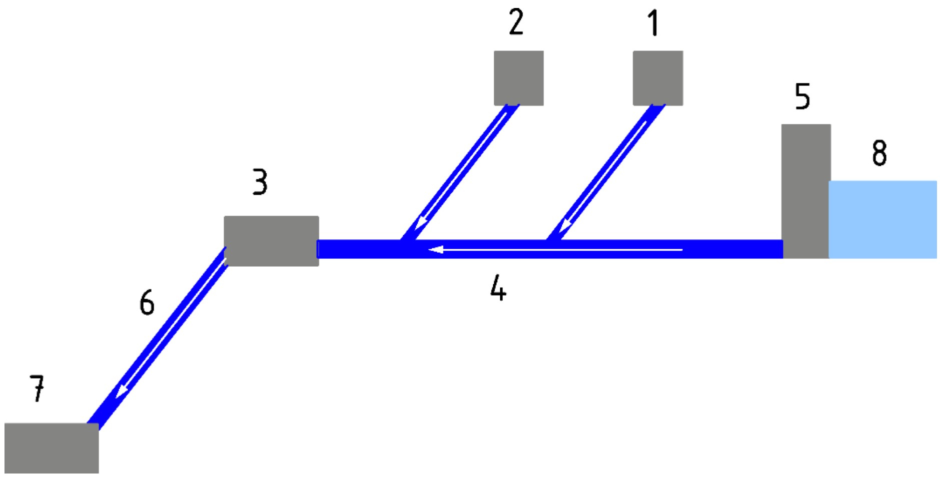


Figure 39— Addition of the Construction Identifier (CID) to the top node

By adding the CID as illustrated in the Figure 39, each building /construction entity can be identified before using the CW-classes (Found in ISO 81346-12) for further modelling of the systems.

Because the CID is part of the top node, any system for identifying the construction entities could theoretically be used (e.g. just naming the entities such as “Main Inlet Gatehouse” could be adequate), however such a long name would be pushing the length of the full RD as well as being subjective to the reader. The construction entity classification is ideal for the identification of the entities and is strongly recommended.



Key

1	Creek intake 1, gatehouse
2	Creek intake 2, gatehouse
3	Emergency closing valve chamber
4	Inlet tunnel
5	Main intake, gatehouse
6	Penstock
7	Powerplant
8	Reservoir (body of water)

Figure 40— Example of a water transport system in a hydropower plant – Construction Works point of view

Figure 40 depicts the same example water transport system as, with the added CID for the different construction entities.

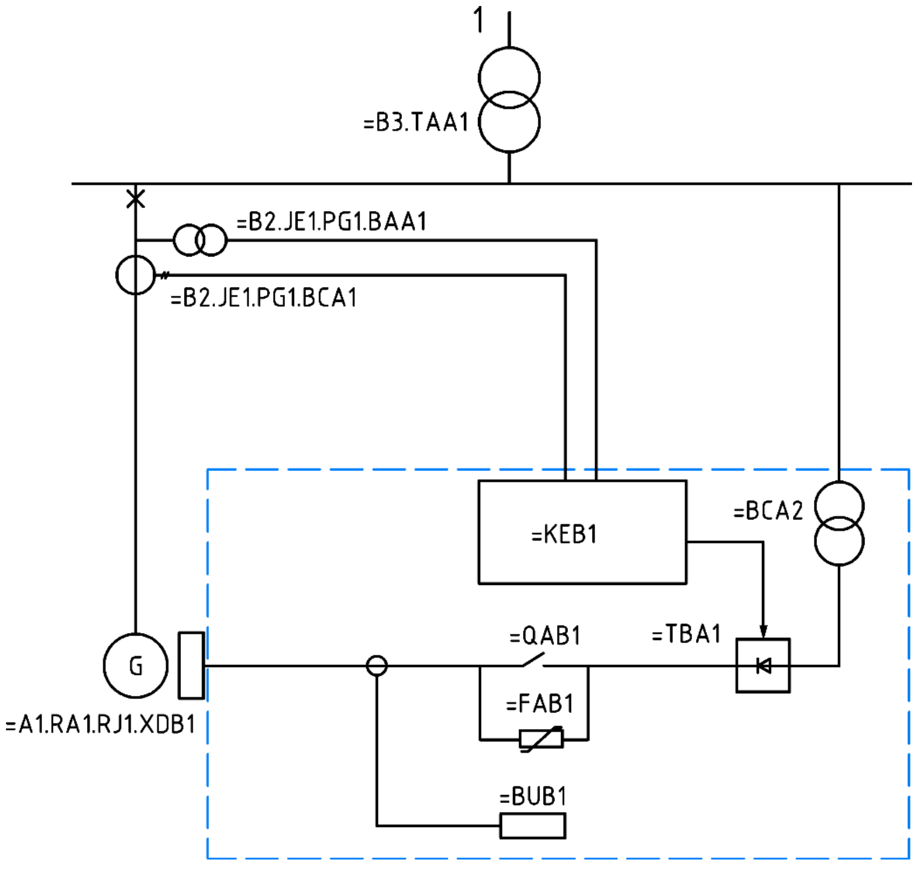
Note that one could also employ the construction complex level (one letter code) to the CID if necessary (presumably for very large systems.

EXAMPLE
<Odin1.CW1.M1.UH2>

11 Examples

11.1 Generator Excitation System

Figure 41 shows an example of a generator excitation system in what could be a part of a single line diagram.



Key

1	Grid
=B3.TAA1	Transformer
=B2.JE1.PG1.BAA1	Voltage measuring transformer
=B2.JE1.PG1.BCA1	Current measuring transformer
=A1.RA1.RJ1.XDB1	Generator brush
=A1.RA1.LD1	Unit 1, generator excitation system
=A1.RA1.LD1.KEB1	Automatic voltage regulator
=A1.RA1.LD1.BCA2	Field current transformer

=A1.RA1.LD1.QAB2	Field breaker
=A1.RA1.LD1.TBA1	AC/DC converter (Tyristor – rectifier)
=A1.RA1.LD1.FAB1	Varistor
=A1.RA1.LD1.BUB1	Loss of magnetic overcurrent, under current

Figure 41— Example of a generator excitation system

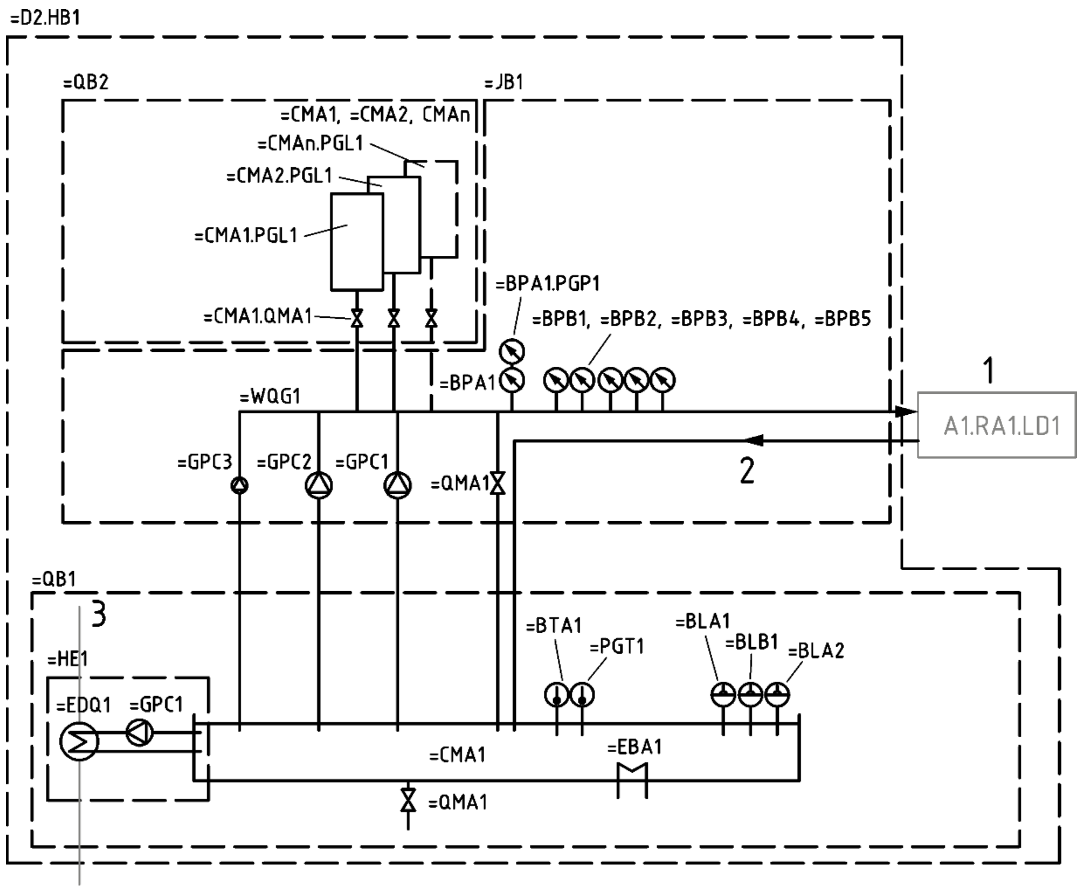
The following reference designations are visible in the figure:

Table 4 — Example of a generator excitation system

Parent level	4th level	5th level	Description
=A1.RA1.LD1			Unit 1, Generator, excitation system
=A1.RA1.LD1	=KEB1		Automated Voltage Regulator (AVR)
=A1.RA1.LD1	=KEB1	=BCA2	Field Current Transformer
=A1.RA1.LD1	=KEB1	=TBA1	Rectifier (AC/DC)
=A1.RA1.LD1	=QAB1		Field breaker
=A1.RA1.LD1	=FAB1		Varistor
=A1.RA1.LD1	=BUB1		Protection, detector

11.2 High pressure oil supply system

Figure 42 shows an example of an oil supply system in what could be a part of a Piping and Instrumentation Diagram.



Key

1 Turbine governing system

2 Returning oil

3 Air

Figure 42— Example of an oil supply system in the functional aspect

The following reference designations are visible in the figure:

- =D2.HB1 - High pressure oil system - supply system 1
  - =JB1 – Oil distribution system
    - =WQG1 – Main distribution pipe
    - =CMAn – Oil tank n
      - =PLG1 – Tank n, level indicator
      - =QMA1 – tank n, shuttoff valve
    - =BPA1 – Pressure sensor
      - =BPA1.PGP1 – Pressure sensor, pressure indicator
    - =BPBn – Pressure switch n
    - =GPC1 – Circulation pump 1
    - =GPC2 – Circulation pump 2
    - =GPC3 – Circulation pump 3 («Jockey» pump)
  - =QB1 – Oil storage system
    - =CMA1 – Oil sump
    - =BTA1 – Temperature measurement
    - =PGT1 – Temperature indicator
    - =BLA1 – Level measurement
    - =BLB1 – Level switch (L<L)
    - =BLB2 – Level switch (L<LL)
    - =EAB1 – Oil sump heater
    - =QMA1 – Sump draining valve
    - =HE1 – Oil cooling system
      - =GPC1 – Pump
      - =EDQ1 – Cooler (heat exchanger)

12 Implementation guidelines

12.1 A recommended aspect

The RDS provides the means to identify any given object through its multiple occurrences in the different aspects. All IT systems handling large quantities of information requires a structure to organize the information it uses and potentially creates. Depending on the nature and purpose of the IT system, one aspect can be more adequate than the others.

Below are some suggested predominant aspect for different purpose IT systems:

Table 5 — Recommended aspects for different uses

(=) Functional Aspect	(-) Product aspect	(++) Location aspect	(%) Type aspect
• Automation systems • Data historians • Condition monitoring systems • Process models (e.g. production planning systems) • Supervisory Control And Data Acquisition (SCADA)	• Assembly schematics • Maintenance systems • Spare part systems • Asset documentation archive	• 3D-visualization systems • GIS systems • Maps	• System catalogues • Requirement databases • Variant library

The information structures within a system (using predominantly one aspect), will provide the means to identify systems within that aspect. Once reached, the object of interest should be represented by an information node, to which information can be attached. Depending on the nature of the IT system, this can be information such as the system vendor, size, datapoints, maintenance history, etc…

Also attached to the nodes should be the object occurrences in the other aspects. E.g. as you search through the data historian for data on a particular temperature measurement, the temperature sensor occurrence in the product aspect should be added. This would provide a link to the maintenance system and the sensor calibration history.

12.2 Depth and structure complexity

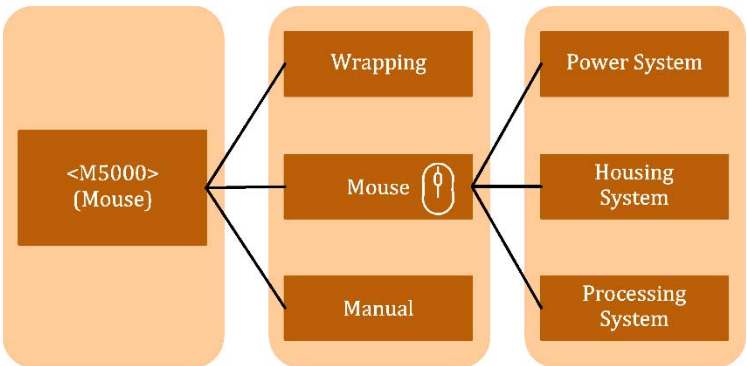
System models should contain subsystems in levels down to the lowest level of interest, and never further. The product aspect *can* be used to model and structure the most minute details in a system. The structures can in fact provide a RD to every single bolt and screw. It is useful to keep in mind that a model can be expanded whenever a need arises.

A *master model* (see clause **Fehler! Verweisquelle konnte nicht gefunden werden.**) including minute details about mostly insignificant components such as couplings, bolts and screws should probably be avoided on power plant sized models. The wealth of information on a mostly insignificant detail level would likely not be worth the creation nor the upkeep.

Any system supplied with an RDS model by the manufacturer, could be modelled differently when applied in a larger system. System manufacturers and operators will have different sets of needs and requirements to the depth of the structure.
The object in question would in a such a case be part of different structures:

- One created by the system supplier
- One created by the system operator

These two structures should be distinguished by their top node, and metadata attached.



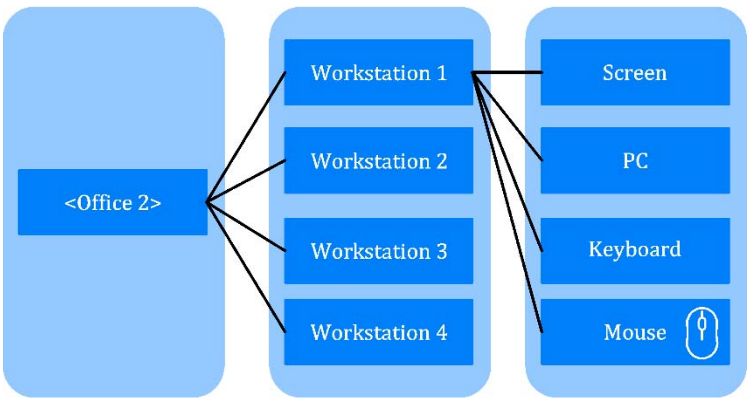


Figure 43— Model comparison between a computer mouse supplier (upper) and user (lower), both figuring a computer mouse

Figure 43 shows the difference between the structure of a computer mouse, and the structure of the user workstation in which the mouse is incorporated.

It would be possible to add all details provided by the supplier to the operator model (e.g. adding reference designations for every input on every mouse in the company workstation model).

-Office2.Workstation1.Mouse1.InputSystem1.Input2

However, the full structure of the mouse sub-components (the part provided by the supplier) is not of any interest to most users. It should be kept in the data archives for future.

Identifying the different structures should be done with the use of the top-node. An RD-set

EXAMPLE

<Office2>-Workstation1.Mouse1
<M5000>-Mouse1

More principles about the handling of the different models and the use of the master model will be provided in clause **Fehler! Verweisquelle konnte nicht gefunden werden.**.

12.3 One object performing multiple functions

12.3.1 Multiple functions and Single Source of Truth within one system

Two distinct occurrences within one structure fulfilling different functions, are occurrences of two distinct objects. However, it is not uncommon that one object individual performs multiple tasks. For the functional aspect, this is irrelevant: if two different functions are performed, they should be represented by two distinct occurrences in the functional aspect.

This is not the case for the product aspect, where only one occurrence can exist for any given object.

EXAMPLE

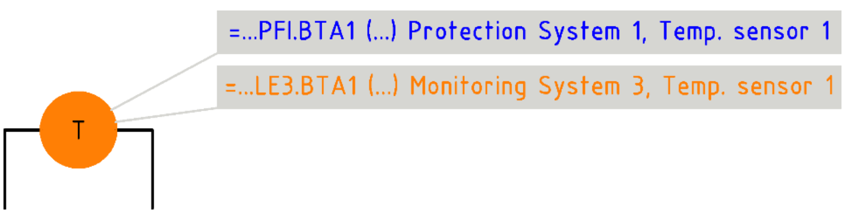


Figure 44— **Example of an object individual performing multiple functions**

Figure 44 shows an oil temperature measurement system is part of a bearing protection system. The bearing oil outlet runs to an automated oil quality monitoring system, which also uses the oil temperature measurement.

These temperature measurement systems have distinct RDs (within the same structure), one belonging to a protection system (=...PF1.BTA1), one to a condition monitoring system (=...LE3.BTA1). Two different object *occurrences, two different reference designations. Even if, in fact it is one single physical object individual (asset), with the temperature measurement data branching out to two different functions.*

Although unproblematic from an RDS point of view, multiple functions associated with one single system can present problems in a digital system. Both occurrences represent information nodes where the same information would figure twice.

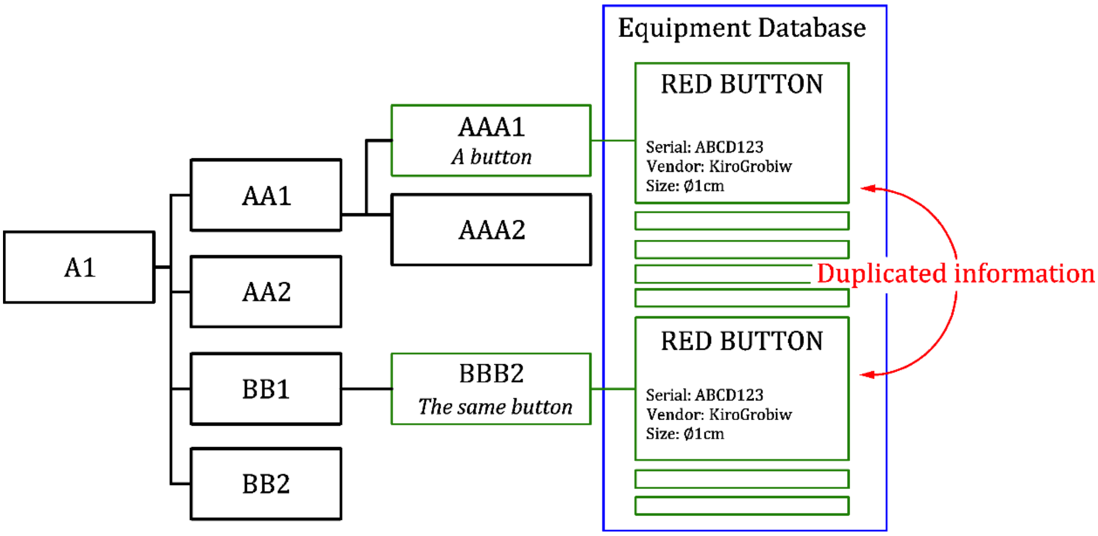


Figure 45— Illustration of the problem attaching information to multiple RDS occurrences referring to the same object individual

As illustrated in Figure 45, the information attached to the device could in this case potentially be duplicated (two sets of information belonging to the same object individual could be attached to each occurrence in the structure). This is usually quite problematic and a severe liability to the information quality, as nothing stops these two entries from being handled differently (e.g. an updated piece of information could be added to only one of the entries).

This is a specialized case where there the Single Source of Truth (SSOT) can be determined within a specific system.

There are several ways of handling the issue, they will be presented in this chapter.

Note that to designate the relation between two RDs sharing the same object individual, the relationship classification system (see clause 8) can be used, specifically the class QA, indicating "shared object individual".

=...PF3.BTA1|QA|=...LE1.BTA1

12.3.2 Strict singular product aspect occurrence

Unlike the functional aspect, the product aspect should not accept multiple occurrences from the same object individual (within one model/structure).

As illustrated in Figure 46, then all information related to the object individual ("asset information") relevant to a system in the functional aspect, is kept in a system based on the product aspect, no duplication of this information should be possible.

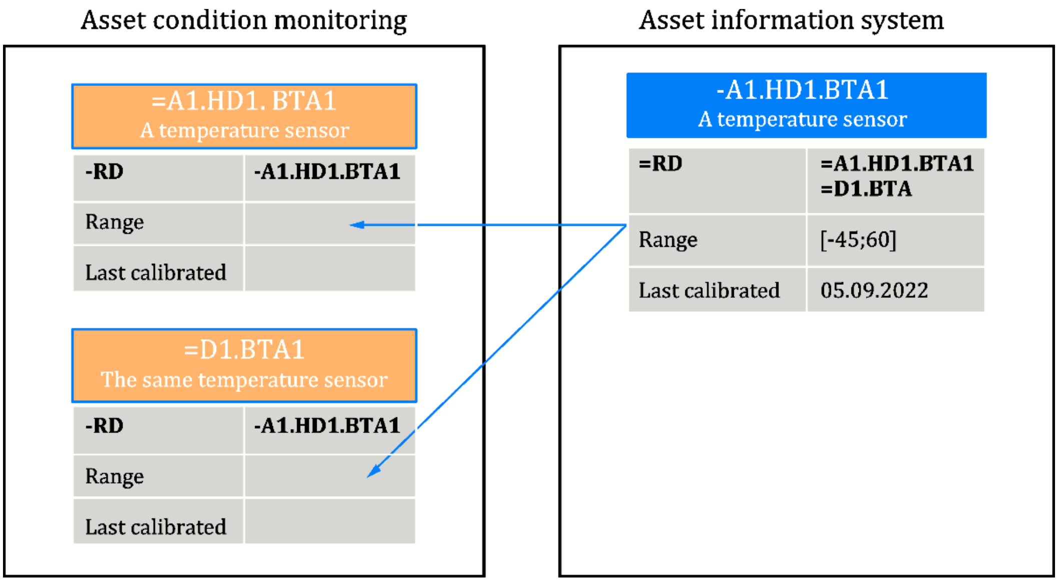


Figure 46— Example of use of a singular product aspect occurrence based information system

Some attributes will be of a strictly functional nature, and should be attached to the relevant function occurrence (e.g. alarm thresholds of a temperature sensor). Depending on the function, a setting or attribute can be different from occurrence to occurrence even if they both designate the same object individual (e.g. a temperature threshold can trigger a heating system in a local automation system, but the same measurement can trigger a shutdown for another threshold in a protective system). The chances for duplicated information is smaller when all information related to the object individual ("asset" information) is owned by a product aspect based information system (since multiple occurrence for the same individual should not occur in this aspect).

Some functional occurrences do not have an occurrence in the product aspect. If this is the case, the functional occurrence will likely not require any asset information (weight, dimensions, vendor, etc…) as it probably won't have a physical presence (e.g. an aggregated alarm function).

12.3.3 Digital Object Identifier (DOI)

The standard *ISO 26324 Information and documentation — Digital object identifier system* proposes a method to create a Digital Object Identifier (DOI), a persistent identifier (handle) that can be used to uniquely identify object individuals.

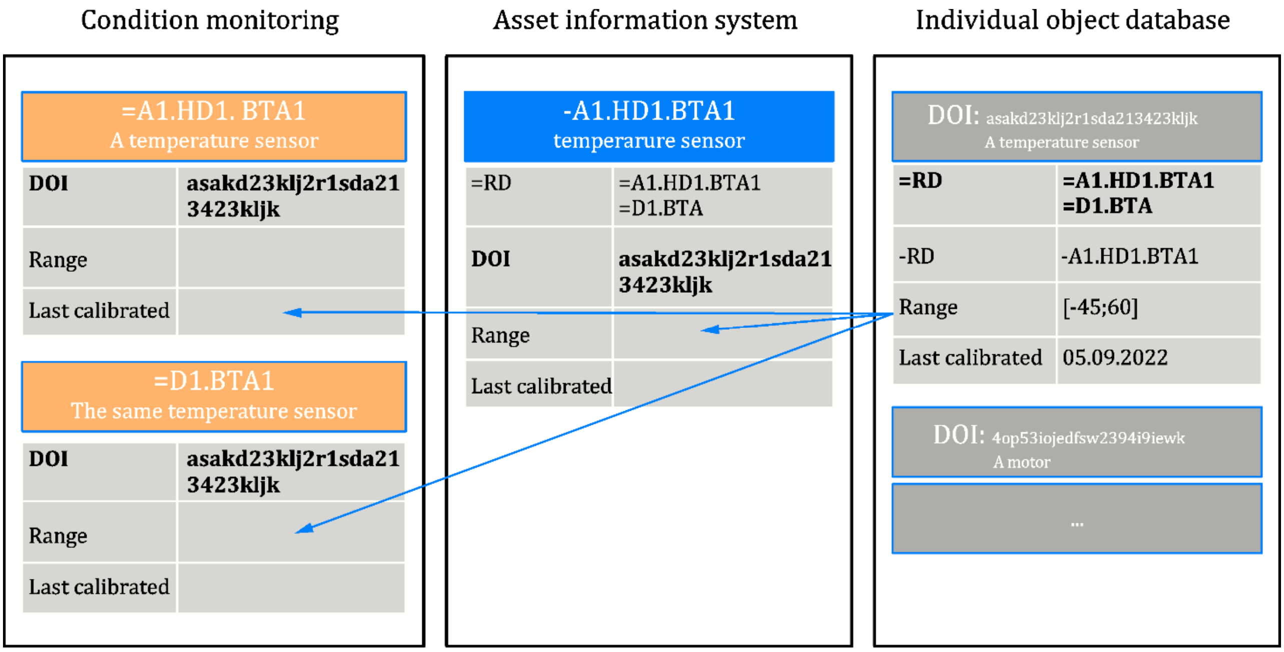


Figure 47— Example of use of a DOI system to avoid duplicated information problems in databases

By using the DOI as an intermediate between the object occurrence and the information attached to the object individual ("asset information") no information will be duplicated.

The DOI and RDS are complementary, as the RDS identifies and structures object occurrences, while the DOI identifies single object individuals in a flat structure (i.e. which requires a mean to identify and retrieve the information in a structured manner).

The example shown in Figure 47 shows how two RD-based systems pull data from the "individual object database" (IOD). This last system, IOD, contains potentially many millions of entries in a flat structureless database. The RD-based systems linked to the IOD provides a tool for navigating the assets and retrieving information from the IOD. In turn, the IOD provides the SSOT for data used/made available on many other platforms and systems.

12.3.4 Preferred reference designations (PRD)

Should there still be issues concerning potential information duplication within a system, then the ***Preferred Reference Designation (PRD)*** should be the preferred repository of information.

Among the function occurrences of any one object within the same system, one (the PRD) should be selected as the owner of common attributes and information. All other RDs should mirror / refer to the PRD.

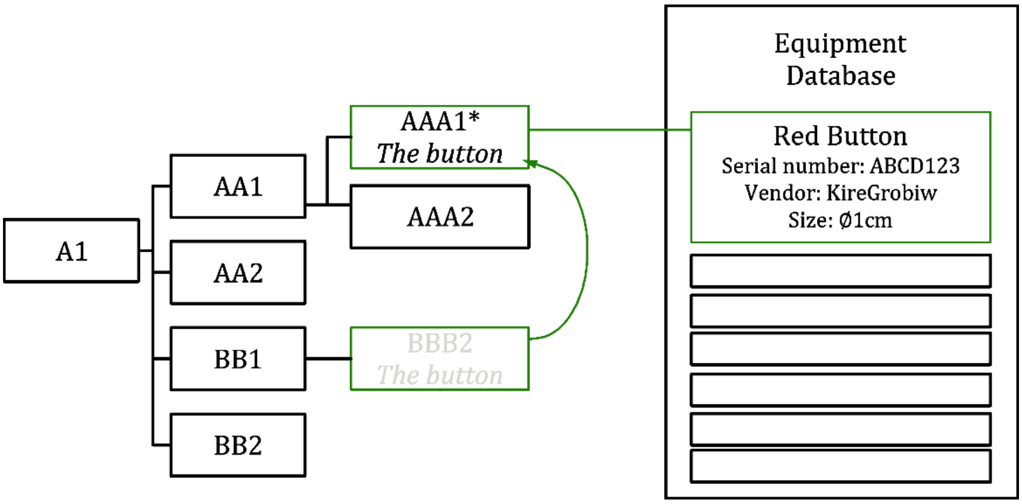


Figure 48— Example of use of a PRD system to avoid duplicated information problems in databases

Figure 48 shows how data should be made available (referred to) by the secondary occurrences by pointing to the PRD, instead of having information associated to it directly.

Below are a set of suggestions to determine which of the occurrences should be the PRD.

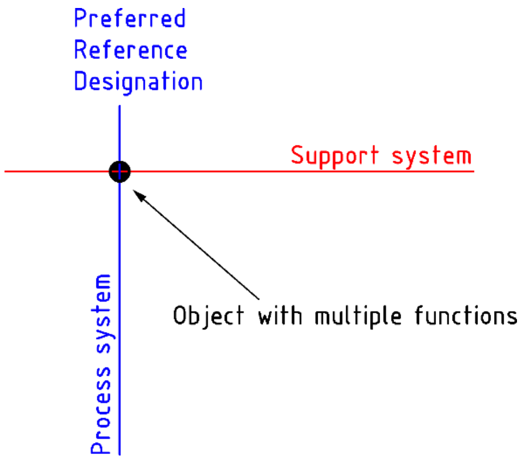
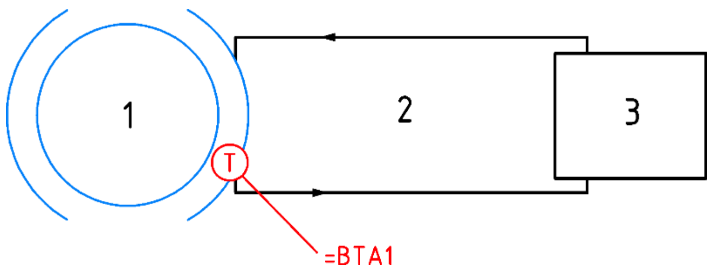


Figure 49— Preferred reference designation illustration

1. As a general guideline the allocation of data should go to ***vertical* systems** (i.e. systems that follow the process flow) before *horizontal* ones (i.e. systems supporting the main process, or common to several main processes) i.e. for the prime systems (one-letter code classes in ISO 81346-10, RDS-PS), A-, C- and B-systems will be prioritized before D- or F-systems.

2. Within them, the one closest (within the chosen aspect) to the central process should be the *primary RD*. For RDS-PS the central process of any system is the energy conversion / electricity production and/or transmission. This means that the one e.g. physically closest to the turbine shaft in a location aspect or, for the functionally aspect, the one closest (or part of) the energy conversion process.

EXAMPLE
In Figure 50 an oil temperature sensor (BTA) exist within the functional structure of the bearing itself (e.g. = A1.JF1.KJ3.BTA1). The same sensor fulfils another role as the temperature measurement function for the return oil in the oil supply system (e.g. = D1.HE1.JB3.BTA1).



Key

1 Bearing system =A1.JF1.KJ3

2 Lube oil supply system1, circulation system 3 =D1.HE1.JB3

3 Heat exchanger

Figure 50— Bearing oil exit temperature measurement system

These are two separate functions, even part of two different prime systems (=A1 and =D1). It is however, by coincidence, the same sensor that provides the information to both systems. From a functional point of view, it is irrelevant (i.e. these are two distinct objects since they perform two distinct functions), but it does present a challenge when information is to be added to the model.

The RD pointing to the sensor as a part of the unit 1 system (**= A1.JF1.KJ3.BTA1**), i.e. part of an A-system, is a vertical system, it is the primary RD. The oil supply system (=D7.HE1.JB3) is a horizontal system.

12.4 Simplification/adaptation guideline

Reference designations can be required to be simplified for specific uses within certain software or digital systems, e.g. for systems that do not permit the use of the prefix-characters (=, -, +, %). The user should be aware that when simplification rules are applied, the tags are not in accordance with ISO/IEC 81346 standard series. Simplifications should only be used when strictly necessary. If relevant, simplified RD tags should only feature in official documentation when describing the simplification itself, along with a mandatory listing of the simplification rules applied.

Some simplification rule suggestions are proposed in this section.

12.4.1 Function aspect for signal structuring

When using the RDS as object reference for signal tags, the prefixes are often not accepted (as in the case of IEC 61850-7 standard series). A simplification to avoid the problem is to only allow the use of the functional aspect for signal structuring. With this rule established, the prefix is superfluous and can be omitted.

The same rule can also be applied for the angle brackets ("< ... >") identifying the top node of a reference designation, if the top node structure allows it.

Omitting full stops "." in-between RDS levels.

Since every level of a reference designations start with letters and end with numbers, full stops in between levels can be omitted, and the reference designations would still be machine-readable. This harms the readability of the tag but allows the use of them in demanding digital tools.

The same rule can also be applied to:

- the aspect prefix, if the setting makes the chosen aspect certain.
- the top node of the Reference designations, if the top node structure allows it. This is why it is suggested that all top-node information follow the same pattern of starting a piece of information with letters and ending with numbers.

EXAMPLE
<PP1.PS1>=A1.KA1, can be reduced to: PP1PS1A1KA1

Annex A
(informative)

Example of use – The circuit breaker

This example should provide a more detailed example of the designation and use of the aspects for a particular component. The object of interest is a circuit breaker (“CB”).

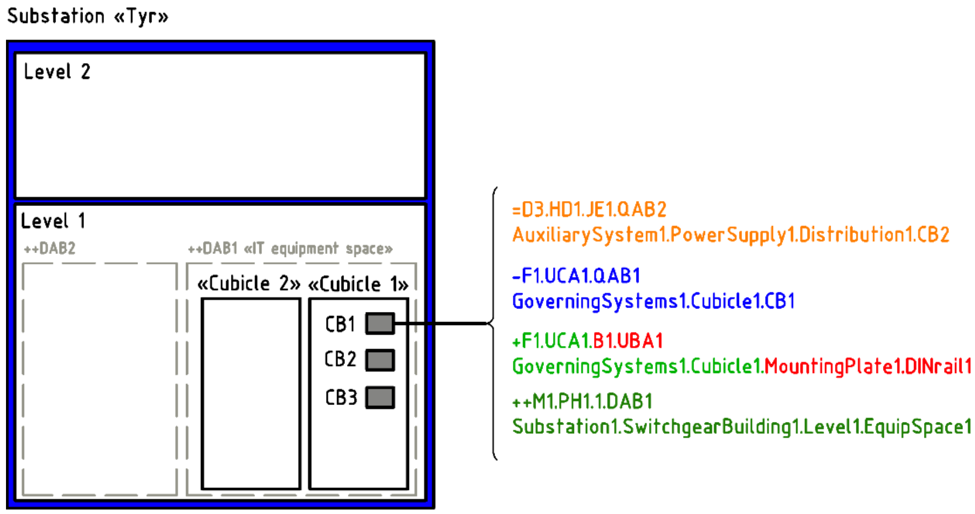


Figure A-1 Illustration of the RD-set of a circuit breaker

=Function aspect
AuxiliarySystem1.PowerSupply1.CircuitBreaker2
The CB is a part of an auxiliary power supply system (=D3.HD1) in substation “Tyr”. The function aspect reference designation of the CB will be used in e.g. single line diagrams of the power distribution system.

-Product aspect
GoverningSystems1.Cubicle1.CB1
The CB is a part of the cubicle 1(=F1.UCA1). The cubicle is a generic cubicle used for hosting miscellaneous objects part of different systems. This will not be visible from the product point of view, which presents a structure of the physical constituents within the cubicle. All items placed inside the cubicle will be a part of the cubicle (=F1.UCA1), also CB3 (=F1.UCA1.QAB3), which is a part of the building ventilation system).

+Host of installation aspect
GoverningSystems1.Cubicle1.MountingPlate1.DINrail1
The host of installation will tell where the CB is mounted. The first part points to the cubicle. This is repeating the product designation of the cubicle (our host).

++Site of installation aspect
Substation1.SwitchgearBuilding1.Level1.EquipSpace1
The site of installation contains general information of the location of a system. The aspect designates a space (in contrast to the other aspects designating systems/objects). It is an aspect which should remain on a high granulation level designating larger spaces (rooms and potentially zones within the plant).

Annex B
(informative)

RD-set Example of use

This appendix aims at describing the creation and evolution of a system (in this case a pump) throughout the system lifetime.

Step 1:

Early in the design phase, one knows that a pumping system (two redundant pumps) will be needed to evict drain water from the plant. This information is enough to designate the pumps within a product structure, e.g. -H2.JB1.KE1.GPA1 (Plant drainage system 1, drain water transportation system 1, pump system 1, pump 1).

In this situation the functional aspect would follow the structure of the product aspect and the pump functional aspect reference designation would be the same as the product aspect =H2.JB1.KE1.GPA1

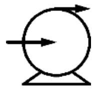


Figure B.1 - Step 1

Drain Pump 1 - RD-set:
-H2.JB1.KE1.GPA1
=H2.JB1.KE1.GPA1

Step 2:

A rough sketch of the plant has been made, it is assumed that the pumps will be standing on a platform within the drain water collection system itself, the “sump” (-H2.QB1 Plant drainage system 1, Liquid storage system 1).
A location (point of installation) reference can be set, as the hosting system is defined in the product structure.

Note that the platform on which the pumps are placed will be modelled (in the product aspect) as sub-systems of the pump system (-H2.JB1.KE1.AA1). This because the platform is a support system dedicated to the pumps.

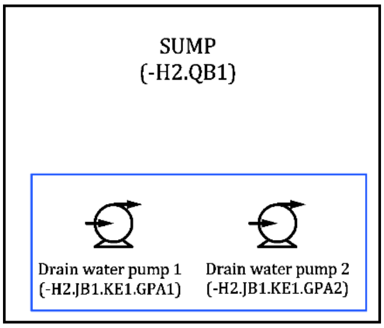


Figure B.2 - Step 2

Drain Pump 1 – RD-set
-H2.JB1.KE1.GPA1
=H2.JB1.KE1.GPA1
+H2.QB1

Step 3:

The design and planning phase (step 2) goes into more details. There is delivery time for these large pumps so orders to suppliers should preferably be made quite fast. Different pump types are available

Drain Pump 1 – RD-set
-H2.JB1.KE1.GPA1
=H2.JB1.KE1.GPA1
+H2.QB1
%GPA2

(%GPA1, %GPA2, ...). Type %GPA2 was selected and deemed well suited for the task.

Step 4:

Plans are being drawn for the power station. The sump is obviously placed at the power station bottom level, which has the following site of installation reference: ++C1.CA1.1. The space allocated to the sump is given the reference ++CAE1. Since the pumps are within this space, it is this space that also represents their site of installation.

For further information, it is being stated in the documentation that the sump represents a storage space for water, i.e. %%CAE3.

Note that one could also give the pump system platform its own site of installation reference, within the sump-system (e.g.: ++C1.CA1.1.CAE1.DAC1) however the reference pointing to the sump was considered accurate enough.

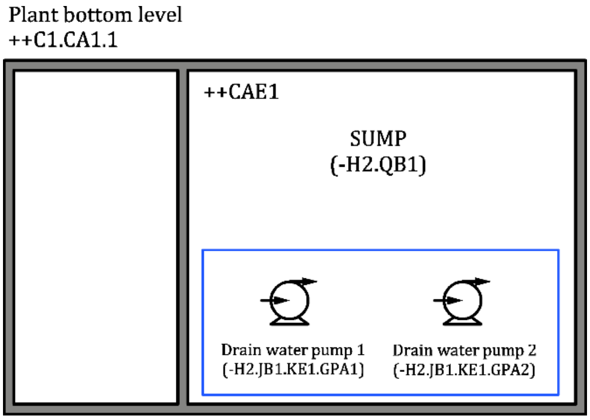


Figure B.3 - Step 4

Drain Pump 1 – RD-set
-H2.JB1.KE1.GPA1
=H2.JB1.KE1.GPA1
+H2.QB1
%GPA2
++C1.CA1.1.CAE1

Step 5:

In an effort to avoid expensive system redundancy (Drain pump 2 =H2.JB1.KE1.GPA2), a monitoring system was ordered for the pump system (=H2.JB1.KE1.LE1). The redundant pump 2 was removed and replaced with a cheaper emergency back-up system. This system is considered an automated reservoir overflow protection system. It is functionally a sub-system to the sump system (=H2.QB1), the backup system reference designation is =H2.QB1.PF1 / -H2.QB1.PF1.

This choice also affected the type of pump 1, as a more sturdy and reliable type was chosen (%GPA7). No other consequences for the other aspects.

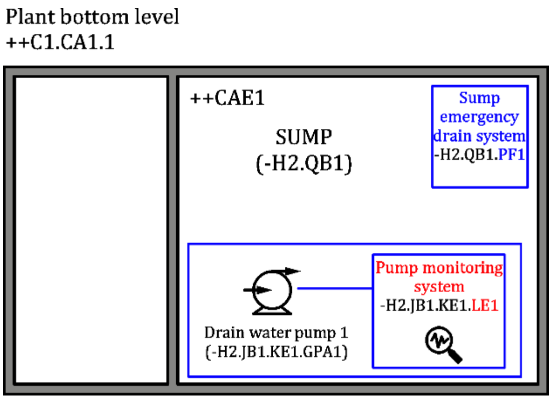


Figure B.4 - Step 5

Drain Pump 1 – RD-set
-H2.JB1.KE1.GPA1
=H2.JB1.KE1.GPA1
+H2.QB1
%GPA7 ~~%GPA2~~
++C1.CA1.1.CAE1

Step 6:

During the construction process a choice was made to create a separate technical space (++C1.CA1.1.DBA1) next to the sump

(++C1.CA1.1.CAE1) to host the sump monitoring and control system systems (=H2.QB1.LA1). This is also where an individual emergency off-switch (SJA) for **pump 1** was to be placed.

Because of the existing structures and the placement of the switch within the hierarchies it is was easy task to allocate reference designations to the switch:

- Functionally it is a sub-system of the **pump** (**=H2.JB1.KE1.GPA1.SJA1**)
- Within the product aspect the switch is part of the Control system cabinet
- The point of installation (the physical host-system) is also the control system cabinet*
- No SJA-type has been selected
- The site of installation (reference designation of the space where the object can be found) is the technical space created for the control equipment (++C1.CA1.1.DBA1).

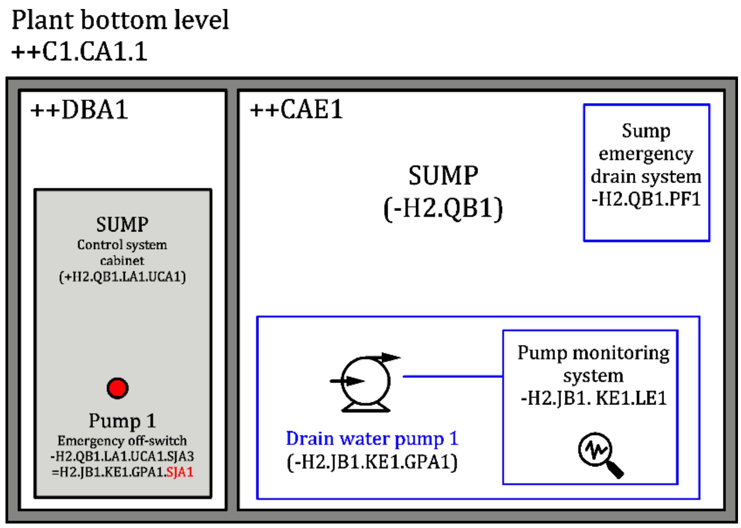


Figure B.5 - Step 6

Drain Pump emergency off-switch - RD-set
=H2.JB1.KE1.SJA1
-H2.QB1.LA1.UCA1.SJA1
(+H2.QB1.LA1.UCA1)
NO TYPE
++C1.CA1.1.DBA1

*No relevant information comes from the point of installation RD in this case, as the switch is located in the parent system in the product aspect. One could consider omit the RD in the RD-set.

Step 7:

It was decided to divide the sump into two (connected) chambers. By creating two spaces a renaming of the site of installation aspect of the pump was necessary.
The change was only of a physical geographic nature, i.e. only the one aspect representing this view of the object (the point of installation aspect) was changed.

No changes had to be done to the maintenance system, based on the functional system, the support documentation in the product aspect, the BIM model based on the point of installation.

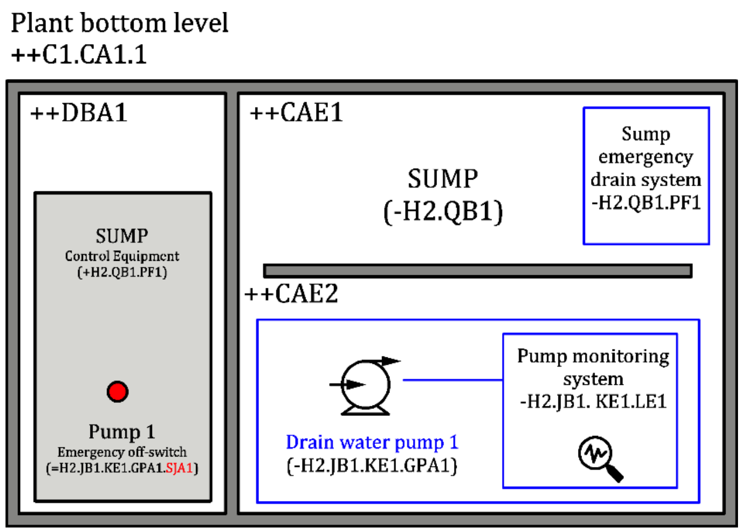


Figure B.6 - Step 8

Drain Pump 1 – RD-set
=H2.JB1.KE1.SJA1
-H2.QB1.LA1.UCA1.SJA1
+H2.QB1
%GPA7
++C1.CA1.1.CAE2 ~~++C1.CA1.1.CAE1~~

Annex C
(informative)

Class conversion table example

Below is an example of a conversion table between the proposed classes of a structuring system and the ISO/IEC 81346 standard series classes.
[PS-PP]

Bibliography

[1] ISO 19650, Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling

[1] SGAM User Manual - Applying, testing & refining the Smart Grid Architecture Model (SGAM) Version 3.0 - SG-CG/M490/K_ SGAM usage and examples