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Geometrical product specifications (GPS) — Features utilized in specification and verification

Spécification géométrique des produits (GPS) — Éléments utilisés en spécification et vérification

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Foreword

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

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 22432 was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*.

Introduction

This International Standard is a Geometrical Product Specifications (GPS) standard and is to be regarded as a global GPS standard (see ISO/TR 14638). It influences all chain links in all chains of standards in the general GPS matrix.

The ISO/GPS Masterplan given in ISO/TR 14638 gives an overview of the ISO/GPS system of which this document is a part. The fundamental rules of ISO/GPS given in ISO 8015 apply to this document and the default decision rules given in ISO 14253-1 apply to specifications made in accordance with this document, unless otherwise indicated.

Geometrical features exist in three “worlds”:

— the world of nominal definition, where an ideal representation of the workpiece is defined by the designer;

— the world of specification, where the designer has in mind several representations of the workpiece;

— the world of verification, where one (or more) representation(s) of a given workpiece is (are) identified in the application of measuring procedure(s).

In the world of verification, mathematical operations can be distinguished from physical operations. The physical operations are the operations based on physical procedures; they are generally mechanical, optical or electromagnetic. The mathematical operations are mathematical treatments of the sampling of the workpiece. This treatment is generally achieved by computing or electronic treatment.

It is important to understand the relationship between these three worlds. This International Standard defines standardized terminology for geometrical features principally in the world of specification and the world of verification, to be used in communication between each world.

The features defined in this International Standard are well suited for the specification of rigid parts and assemblies, and may also be applied to non-rigid parts and assemblies by specifying allowable variation according to rigid solids.

Geometrical product specifications (GPS) — Features utilized in specification and verification

1 Scope

This International Standard defines general terms and types of features for geometrical features of specifications for workpieces. These definitions are based on concepts developed in ISO/TS 17450-1.

This International Standard aims to serve as the "road map" mapping out the interrelationship between geometrical features, thus enabling future standardization for industry and software makers in a consistent manner.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14660-1:1999, *Geometrical Product Specifications (GPS) — Geometrical features — Part 1: General terms and definitions*

ISO/TS 17450-1:2005, *Geometrical product specifications (GPS) — General concepts — Part 1: Model for geometrical specification and verification*

ISO/TS 17450-2:2002, *Geometrical product specifications (GPS) — General concepts — Part 2: Basic tenets, specifications, operators and uncertainties*

3 Terms and definitions

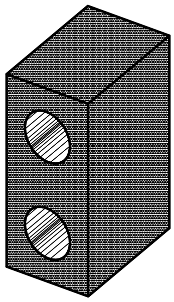
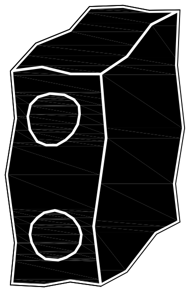
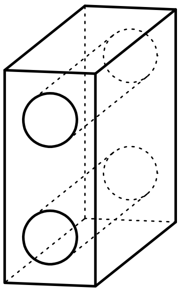
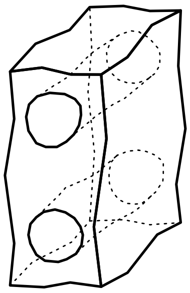
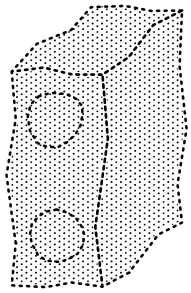
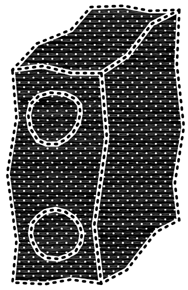
For the purposes of this document, the terms and definitions given in ISO 14660-1, ISO/TS 17450-1 and ISO/TS 17450-2 and the following apply.

3.1
surface model
model representing the set of features limiting the virtual or the real workpiece

NOTE 1 All closed surfaces (see Figures 1 and A.1) are included.

NOTE 2 The surface model allows the definition of single features, sets of features, and/or portions of features. The total product is modelled by a set of surface models corresponding to each workpiece.

EXAMPLE Case of a hollow surface.

Representation of a real surface of the workpiece		Representation of the real workpiece[a]	
			
Representation of nominal surface model	Representation of skin model	Representation of discrete surface model	Representation of sampled surface model
			
[a] For the purpose of this International Standard.			

NOTE It is impossible to predict the total geometry of the real workpiece due to its geometrical imperfections. In this International Standard, a real surface of the workpiece is illustrated in solid black.

Figure 1 — Example of real surface of the workpiece and its models

3.1.1
nominal surface model
surface model of ideal geometry defined by the technical product documentation

NOTE 1 A nominal surface model is an ideal feature (See Figure 1 and Table 1).

NOTE 2 A nominal surface model is a continuous surface composed of an infinite number of points.

NOTE 3 Any feature on the nominal surface model (skin model) contains a continuous infinite number of points.

3.1.2
skin model
surface model of non-ideal geometry

NOTE 1 The skin model is a virtual model used to express the specification operator and the verification operator considering a continuous surface (see Table 1 and ISO/TS 17450-1).

NOTE 2 A skin model is a non-ideal feature (see Figure 1).

NOTE 3 A skin model is a continuous surface consisting of an infinite number of points.

NOTE 4 Any feature on the skin model contains a continuous infinite number of points.

3.1.3
discrete surface model
surface model obtained from the skin model by an extraction

NOTE 1 In addition to the required points, the extraction implies an interpolation.

NOTE 2 The discrete surface model is used to express the specification operator and the verification operator considering a finite number of points (see Table 1).

NOTE 3 A discrete surface model is a non-ideal feature (see Figure 1).

3.1.4
sampled surface model
surface model obtained from the real workpiece model by a physical extraction

NOTE 1 In addition to the sampled points, the verification may imply an interpolation.

NOTE 2 The sampled surface model is used in verification by coordinate metrology, not, for example, in verification by a gauge because gauging makes no measurement of points. In verification by a gauge, the real surface of the workpiece is directly considered (see Table 1).

NOTE 3 A sampled surface model is a non-ideal feature (see Figure 1).

3.2
geometrical feature
point, line, surface, volume or a set of these previous items

NOTE 1 The non-ideal surface model is a particular geometrical feature, corresponding to the infinite set of points defining the interface between the workpiece and the surrounding.

NOTE 2 A geometrical feature can be an ideal feature or a non-ideal feature, and can be considered as a single feature or a compound feature.

3.2.1
nominal feature
geometrical feature of ideal geometry defined in the technical product documentation by the product designer

NOTE 1 See Figure B.1.

NOTE 2 A nominal feature is defined by the technical product documentation. See Table 1.

NOTE 3 A nominal feature can be finite or infinite; by default it is infinite.

EXAMPLE A perfect cylinder, defined in a drawing, is a nominal feature obeying a specific mathematical formula, which is defined in a coordinate system related to the situation feature, and for which dimensional parameters are associated. The situation feature of a cylinder is a line which is commonly called “its axis”. Taking this line as an axis of a Cartesian coordinate system leads to writing $x^2 + y^2 = D/2$, D being a dimensional parameter. A cylinder is a feature of size, of which the size is its diameter D.

3.2.2
real feature
geometrical feature corresponding to a part of the workpiece real surface

3.2.3
discrete feature
geometrical feature corresponding to a part of the discrete surface model

3.2.4
sampled feature
geometrical feature corresponding to a part of the sampled surface model

3.2.5
ideal feature
feature defined by a parameterized equation

[ISO/TS 17450-1:2005, definition 3.13]

NOTE 1 The expression of the parameterized equation depends on the type of ideal feature and on the intrinsic characteristics.

NOTE 2 By default, an ideal feature is infinite. To change its nature, it is appropriate to specify it by the term "restricted", e.g. restricted ideal feature.

NOTE 3 For a complex surface defined by a cloud of points and an interpolation method, the cloud of points is considered the parameter.

NOTE 4 This definition is also contained in ISO/TS 17450-1:2005. It is envisaged that it will be deleted from ISO 17450-1:2011.

3.2.5.1
attribute of an ideal feature
property intrinsically attached to an ideal feature

NOTE 1 Four levels of attributes can be defined for an ideal feature: shape, dimensional parameters from which a size can be defined in the case of a feature of size, situation feature and skeleton (when the size tends to zero).

NOTE 2 If the ideal feature is a feature of size, then one of the parameters of the shape can be considered as a size.

3.2.5.1.1
feature of size
geometrical feature having one or more intrinsic characteristics, only one of which may be considered as a variable parameter, that additionally is a member of a "one-parameter family", and obey the monotonic containment property, for that parameter

NOTE 1 A feature of size can be a sphere, a circle, two straight lines, two parallel opposite planes, a cylinder, a torus, etc. In former International Standards a wedge and a cone were considered as features of size, and a torus was not mentioned.

NOTE 2 There are restrictions when there is more than one intrinsic characteristic (e.g. a torus).

NOTE 3 Relative to the function, a feature of size is particularly useful for the expression of material requirements (LMR and MMR, see ISO 2692).

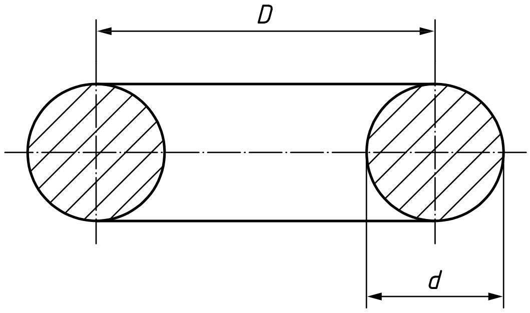
EXAMPLE 1 A single cylinder constituting a hole or a shaft is a feature of size. Its size is its diameter.

EXAMPLE 2 A compound feature of two single parallel plans constituting a groove or a key is a feature of size. Its size is its width.

3.2.5.1.1.1
one-parameter family
set of ideal geometrical features defined by one or more dimensional parameters whose members are generated by varying one parameter

EXAMPLE 1 A set of o-rings (torus-shaped) with the same fixed median-ring diameter and different cross-sectional diameters is a one-parameter family (see Figure 2).

EXAMPLE 2 A set of gauge blocks defined by the gauge blocks' thickness is a one-parameter family.



Key

D median-ring diameter

d cross-sectional diameter

Figure 2 — Example of one-parameter family

3.2.5.1.1.2
monotonic containment property
property of a one-parameter family where a member with a given size contains any member with a smaller size

EXAMPLE 1 A torus belonging to a one-parameter family, corresponding to a set of o-rings (torus-shaped) with the same fixed median-ring diameter and different cross-sectional diameters, respects the monotonic containment property, because from an ideal point of view, the larger family member completely envelopes the smaller family member (see Figure 3).

EXAMPLE 2 A torus belonging to a one-parameter family, corresponding to a set of o-rings (torus-shaped) with different median-ring diameters and the same fixed cross-sectional diameter, does not respect the monotonic containment property and therefore cannot be considered as a feature of size.

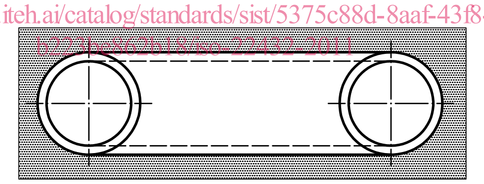
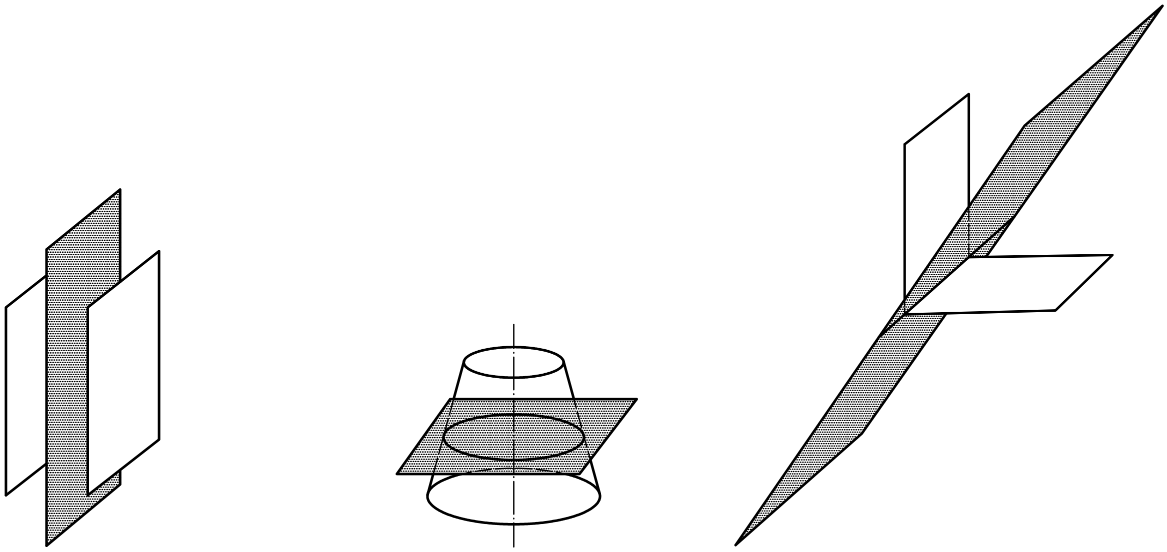


Figure 3 — Monotonic containment property

3.2.5.1.2
situation feature
geometrical feature defining the location or orientation of an ideal feature and which is a geometrical attribute of the ideal feature

See Figures 4 to 7.



a) Pair of parallel planes b) Cone c) Two non-parallel planes

Figure 4 — Example of situation planes

a) Axis of a cylinder b) Axis of a cone

Figure 5 — Example of situation lines

a) Situation point of a cone b) Situation point of a sphere

Figure 6 — Example of situation points

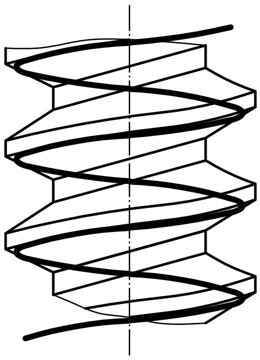


Figure 7 — Example of situation helix

NOTE In many cases, instead of using the situation helix, the axis of the situation helix is used.

3.2.5.2
shape of an ideal feature
mathematical generic description defining the ideal geometry of a feature

NOTE An ideal feature of a preset shape can be qualified or named.

EXAMPLE 1 Planar shape, cylindrical shape, spherical shape, conical shape.

EXAMPLE 2 A surface can be qualified “planar surface” or be directly named “plane”.

3.2.5.3
skeleton feature
reduction of an ideal feature when its size is equal to zero

NOTE In some cases, the skeleton feature is identical to the situation feature. In the case of the cylinder, the skeleton feature is identical to the situation feature, which is not the case for the torus.

EXAMPLE In the case of a torus, there are two dimensional parameters of which one is a size (the cross-sectional diameter of the torus). Its skeleton is a circle and its situation features are its plane and a perpendicular line.

3.2.6
non-ideal feature
imperfect feature fully dependent on the non-ideal surface model (skin model)

[ISO/TS 17450-1:2005, definition 3.19]

NOTE 1 A non-ideal feature is, by default, of finite dimension. To change this nature, it is appropriate to specify it by associating the restricted term.

NOTE 2 This definition is also contained in ISO/TS 17450-1:2005. It is envisaged that it will be deleted from ISO 17450-1:2011.

3.2.7
specification feature
geometrical feature identified from the skin model or from the discrete surface model and defined by the specification operator

See Table 1 and Figure B.2.

NOTE Specification and verification operators are defined in ISO/TS 17450-2.

EXAMPLE 1 In the process of specification, an ideal cylinder identified from the skin model by an association is an ideal specification feature.

EXAMPLE 2 In the process of specification, a non-ideal cylindrical surface identified from the skin model by a partition is a non-ideal specification feature.

3.2.8
verification feature

geometrical feature (identified from the skin model, the discrete surface model or the sampled surface model) or real feature defined by the verification operator

See Table 1 and Figure B.3

NOTE 1 In the world of verification, mathematical operations can be distinguished from physical operations. These physical operations are based on physical procedures; they are generally mechanical, optical or electromagnetic. The complete specification operator includes the type of physical property to which the specification applies.

NOTE 2 The geometrical feature identified from the skin model or from the discrete surface model is used to define the verification operator. The geometrical feature identified from the sampled surface model and the real feature are used to implement the verification operator.

EXAMPLE 1 In the process of verification, a perfect cylinder identified from the workpiece by an association is an ideal verification feature.

EXAMPLE 2 In the process of verification, an imperfect cylindrical surface identified from the workpiece by a partition is a non-ideal verification feature.

Table 1 — Use of surface models

Field of use	Surface model				Real surface
	Nominal surface model	Skin model	Discrete surface model	Sampled surface model	
Technical product documentation	Applicable	Non-applicable	Non-applicable	Non-applicable	Non-applicable
Specification operator	Non-applicable	Applicable	Applicable	Non-applicable	Non-applicable
Verification operator	Non-applicable	Applicable	Applicable	Applicable	Applicable

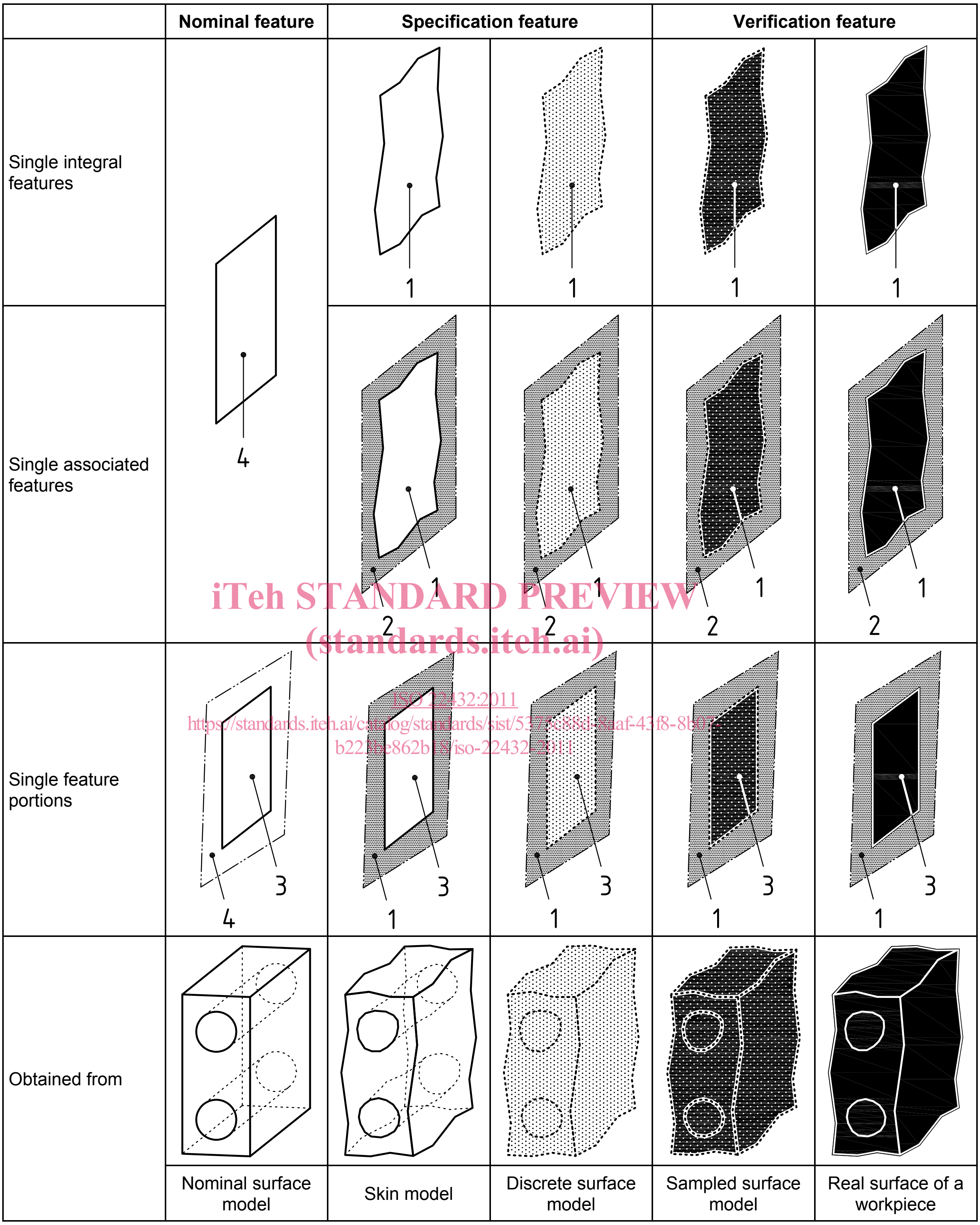
3.2.9
single feature

geometrical feature which is a single point, a single line, or a single surface

NOTE A single feature can have none, or one or more intrinsic characteristics, e.g.:

- a plane is a single feature but has no intrinsic characteristic;
- a cylinder has only one intrinsic characteristic;
- a torus has two intrinsic characteristics.

EXAMPLE A cylinder is a single feature (see Figures 8 and 9). A set of surfaces made up of two intersecting planes is not a single feature, because one plane has a greater invariance degree than two planes (see 3.2.9.4, Note 3).



Key

1 single integral features

2 single associated features

3 single feature portions

4 single nominal features

Figure 8 — Examples of single features built from the same nominal plane