TECHNICAL SPECIFICATION

ISO/TS 17450-2

First edition
2002-10-15

Geometrical product specifications (GPS) — General concepts —

Part 2: Basic tenets, specifications, operators and uncertainties

Spécification géométrique des produits (GPS) — Concepts généraux — Partie 2: Principes de base, spécifications, opérateurs et incertitudes

Reference number
ISO/TS 17450-2:2002(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

Page

Foreword

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

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years with a view to deciding whether it should be confirmed for a further three years, revised to become an International Standard, or withdrawn. In the case of a confirmed ISO/PAS or ISO/TS, it is reviewed again after six years at which time it has to be either transposed into an International Standard or withdrawn.

Attention is drawn to the possibility that some of the elements of this part of ISO/TS 17450 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 17450-2 was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*.

ISO/TS 17450 consists of the following parts, under the general title *Geometrical product specifications (GPS) — General concepts*:

— *Part 1: Model for geometric specification and verification*

— *Part 2: Basic tenets, specifications, operators and uncertainties*

Annexes A, B and C of this part of ISO/TS 17450 are for information only.

Introduction

This part of ISO/TS 17450 is a geometrical product specification (GPS) document and is to be regarded as a global GPS document (see ISO/TR 14638). It influences all chain links of the chains of standards.

For more detailed information on the relationship of this part of ISO/TS 17450 to other standards and to the GPS matrix model, see annex C.

This part of ISO/TS 17450 covers several fundamental issues common to all the GPS standards developed by ISO/TC 213 and, by presenting GPS's basic tenets and specification and verification processes, explains some of the underlying ideas and indicates the starting point for the standards developed by this technical committee.

It must be pointed out that these ideas — and, for that matter, all the other ideas and concepts applied by ISO/TC 213 — are subject to development and refinement, as the TC's recognition and understanding of them further evolves during its ongoing standards work.

Geometrical product specifications (GPS) — General concepts —

Part 2:
Basic tenets, specifications, operators and uncertainties

1 Scope

This part of ISO/TS 17450 defines terms related to specifications, operators (and operations) and uncertainties used in geometrical product specifications (GPS) standards, presents the basic tenets of the GPS philosophy while discussing the impact of uncertainty on those tenets, and examines the processes of specification and verification as they apply to GPS.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO/TS 17450. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO/TS 17450 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/TS 14253-2:1999, *Geometrical Product Specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 2: Guide to the estimation of uncertainty in GPS measurement, in calibration of measuring equipment and in product verification*

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

ISO 14978:—[1)], *Geometrical Product Specifications (GPS) — General concepts and requirements for GPS measurement equipment*

ISO/TS 17450-1:2001, *Geometrical product specifications (GPS) — General concepts — Part 2: Model for geometric specification and verification*

Guide to the Expression of Uncertainty in Measurement (GUM). BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, 1st edition, 1993, corrected and reprinted, 1995

International Vocabulary of Basic and General Terms in Metrology (VIM). BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, 2nd edition, 1993

1) To be published.

3 Terms and definitions

For the purposes of this part of ISO/TS 17450, the terms and definitions given in ISO/TS 14253-2, ISO 14660-1, ISO 14978, ISO/TS 17450-1, GUM, VIM and the following apply. See annex A, Figure A.1, for a concept diagram giving an overview of the relationships between these terms, which it is recommended be read first.

3.1 Generic term

3.1.1
metrological characteristic deviation
deviation from a ideal metrological characteristic value

See ISO/TS 17450-1.

NOTE The metrological characteristic deviation of measuring equipment includes those originating from scales, guideways, software, magnification, non-stiffness of the equipment, etc.

3.2 Terms related to operations

3.2.1
specification operation
operation formulated using only mathematical or geometrical expressions or algorithms, or all these

NOTE 1 Specification operations are used in the geometrical field of mechanical engineering to specify a requirement to a product as part of a **specification operator** (3.3.3).

NOTE 2 Specification operation is a theoretical concept.

EXAMPLE 1 The association of a minimum circumscribed cylinder in the specification of the diameter of a shaft.

EXAMPLE 2 The filtration by a Gaussian filter in the specification of surface texture.

3.2.2
default specification operation
specification operation (3.2.1) required by standards, regulations etc. when the ISO **basic GPS specification** (3.5.4) is used without modifiers in the **actual GPS specification** (3.5.6)

NOTE 1 The default specification operation may be a global default (ISO default), company default or drawing default specification operation.

EXAMPLE 1 The evaluation of a two-point diameter in the specification of the diameter of a shaft using the default indication ∅ 30 ± 0,1.

EXAMPLE 2 The filtration by a Gaussian filter (default filter) with the default cut-off length given by the default rules in ISO 4288 in the specification of *Ra* for a surface.

3.2.3
special specification operation
specification operation (3.2.1) specifically required when the ISO **basic GPS specification** (3.5.4) is used with modifiers, thus overriding a **default specification operation** (3.2.2)

NOTE A special specification is a non-default specification.

EXAMPLE 1 The association of a minimum circumscribed cylinder in the specification of the diameter of a shaft, when the modifier symbol, Ⓔ, for envelope, is used (see ISO 14405).

EXAMPLE 2 The filtration by a Gaussian filter (default filter) with a special cut-off length of 2,5 mm in the specification of *Ra* for a surface, when the appropriate indication is used to override the default rules in ISO 4288.

3.2.4
actual specification operation
specification operation (3.2.1) indicated implicitly or explicitly in the technical product documentation at hand

NOTE An actual specification operation can be

— indicated implicitly by an ISO **basic GPS specification** (3.5.5),

— indicated explicitly by a **GPS specification element** (3.5.1),

— missing.

EXAMPLE 1 The evaluation of a two-point default diameter in an actual specification operation, such as when the specification ∅ 30 ± 0,1 is used (see ISO 14405).

EXAMPLE 2 The filtration by a Gaussian filter (default filter) with a special cut-off length of 2,5 mm and the calculation by the *Ra* algorithm are two actual specification operations, when the specification indicates *Ra* 1,5 using a 2,5 mm filter.

3.2.5
verification operation
operation implemented in a measurement or measurement apparatus, or both, of the corresponding **actual specification operation** (3.2.4)

NOTE Verification operations are used in the geometrical field of mechanical engineering to verify a product to the corresponding **specification operation** (3.2.1).

EXAMPLE 1 The evaluation of a two-point diameter when verifying the diameter of a shaft — using a micrometer, for instance.

EXAMPLE 2 The extraction of data points from a surface for surface finish verification using a nominal stylus tip radius of 2 µm and a sample spacing of 0,5 µm.

3.2.6
perfect verification operation
verification operation (3.2.5) with no intentional deviations from the corresponding **actual specification operation** (3.2.4)

NOTE 1 The only measurement uncertainty contributions from a perfect verification operation are from **metrological characteristic deviation**(s) (3.1.1) in the implementation of the operation.

NOTE 2 The purpose of calibration is generally to evaluate the magnitude of these measurement uncertainty contributors originating from the measuring equipment.

EXAMPLE The extraction of data points from a surface using a nominal stylus tip radius of 2 µm and a sample spacing of 0,5 µm during the verification of the surface finish, when this is the extraction operation indicated in the specification.

3.2.7
simplified verification operation
verification operation (3.2.5) with intentional deviations from the corresponding actual **specification operation** (3.2.4)

NOTE These intentional deviations cause measurement uncertainty contributions in addition to the measurement uncertainty contributions from the **metrological characteristic deviation(s)** (3.1.1) in the implementation of the operation.

EXAMPLE The association of a two-point diameter in the verification of the size of a shaft — using a micrometer, for instance — when the specification indicates that the minimum circumscribed cylinder association is to be used.

3.2.8
actual verification operation
verification operation (3.2.5) used in the actual measurement process

3.3 Terms related to operators

3.3.1
operator
ordered set of operations

See ISO/TS 17450-1.

3.3.2
functional operator
operator (3.3.1) with perfect correlation to the intended function of the workpiece/feature

NOTE 1 While a functional operator in most cases cannot formally be expressed as an ordered set of well-defined operations, it can conceptually be thought of as a set of **specification operation(s)** (3.2.1) or **verification operation(s)** (3.2.5) that would exactly describe the functional requirements of the workpiece.

NOTE 2 The functional operator is an idealized concept used, for comparison purposes only, to evaluate how well a **specification operator** (3.3.3) or **verification operator** (3.3.9) expresses the functional requirements.

EXAMPLE The ability of a shaft to run in a hole with a seal for 2 000 h without leaking.

3.3.3
specification operator
ordered set of **specification operation(s)** (3.2.1)

NOTE 1 The specification operator is the result of the full interpretation of the combination of the **GPS specification**(s) (3.5.3) indicated in the technical product documentation according to ISO GPS standards.

NOTE 2 A specification operator can be incomplete and could, in such case, introduce **specification uncertainty** (3.4.3).

NOTE 3 A specification operator is intended to define, for example, a specific possible "diameter" in a cylinder (two-point diameter, minimum circumscribed circle diameter, maximum inscribed circle diameter, least squares circle diameter, etc.), and not the generic concept "diameter".

NOTE 4 The difference between the specification operator and the **functional operator** (3.3.2) causes **correlation uncertainty** (3.4.4).

EXAMPLE If the specification for a shaft were ∅ 30 h7 (see ISO 286-1 and ISO 14405), then the specification operators for the upper and lower limits would be

— partition from the skin model of the non-ideal cylindrical surface,
— association of an ideal feature of type cylinder with the least squares criteria of association,
— construction of straight lines perpendicular to and penetrating the axis of the associated cylinder,
— extraction of two points for each straight line, and
— evaluation of the distance between each set of two points, the largest distance being compared to the upper limit and the smallest distance to the lower limit.

3.3.4
complete specification operator
specification operator (3.3.3) based on an ordered and full set of completely defined **specification operation(s)** (3.2.1)

NOTE A complete specification operator is unambiguous and therefore has no **specification uncertainty** (3.4.3).

EXAMPLE 1 The specification of local diameter, defining which two points are to be extracted and how the association is to be done (distance between the two points).

EXAMPLE 2 See the example for 3.3.3.

3.3.5
incomplete specification operator
specification operator (3.3.3) with one or more **specification operation(s)** (3.2.1) either missing, incompletely defined or unordered, or all three

NOTE 1 An incomplete specification operator is ambiguous and therefore introduces **specification uncertainty** (3.4.3).

NOTE 2 In order to establish the corresponding **perfect verification operator** (3.3.10), when an incomplete specification operator is given, it is necessary to choose a **complete specification operator** (3.3.4) by adding operations or parts of operations missing in the incomplete specification operator. See also **method uncertainty** (3.4.5).

EXAMPLE The specification of the step dimension 30 ± 0,1, which does not specify the association to be used.

3.3.6
default specification operator
ordered set of **default specification operation(s)** (3.2.2) only, in the default order

NOTE 1 The default specification operator can be

— an ISO default specification operator specified by ISO standards, or

— a national default specification operator specified by national standards, or

— a company default specification operator specified by company standards/documents, or

— a drawing default specification operator indicated on the drawing according to one of the above (see annex B).

NOTE 2 A default specification operator can be either a **complete specification operator** (3.3.4) or an **incomplete specification operator** (3.3.5).

EXAMPLE In accordance with ISO standards, the specification of *Ra* 1,5 indicates

— partition from the skin model of a non-ideal surface,

— partition of non-ideal lines from this non-ideal surface in multiples places,

— extraction using the evaluation length given in ISO 4288,

— filtration using a Gaussian filter with a cut-off wavelength determined by the rules in ISO 4288 and that the corresponding stylus tip radius and sample spacing are to be used, and

— evaluation of *Ra* value as defined in ISO 4287 and ISO 4288 (16 % rule).

Since each of these operations is a default specification operation and they are to be used in the default order, the **specification operator** (3.3.3) is a default specification operator.

3.3.7
special specification operator
specification operator (3.3.3) including one or more **special specification operation(s)** (3.2.3)

NOTE 1 The special specification operator is defined by a **GPS specification** (3.5.3).

NOTE 2 A special specification operator may be a **complete specification operator** (3.3.4) or an **incomplete specification operator** (3.3.5).

EXAMPLE 1 The specification for a shaft of ∅ 30 ± 0,1 Ⓔ is a special specification operator, because one of the **specification operation(s)** (3.2.1), the association of the minimum circumscribed cylinder, is not a **default specification operation** (3.2.2).

EXAMPLE 2 The specification of *Ra* 1,5 using a 2,5 mm filter for a surface is a special specification operator, because one of the **specification operations** (3.2.1), the cut-off length used in the filtration, is not a **default specification operation** (3.2.2).