INTERNATIONAL STANDARD

ISO 14253-1

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Geometrical Product Specifications (GPS) — Inspection by measurement of workpieces and measuring equipment —

Part 1:
Decision rules for proving conformance or non-conformance with specifications

Spécification géométrique des produits (GPS) — Vérification par la mesure des pièces et des équipements de mesure —

Partie 1: Règles de décision pour prouver la conformité ou la non-conformité à la spécification

Reference numbe
ISO 14253-1:1998(E)

Contents

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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.

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.

International Standard ISO 14253-1 was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification.*

This part of ISO 14253 cancels and replaces clause 4 of ISO/R 1938:1971 which concerns indicating measurement instruments and uncertainty of measurement. The rules given in ISO/R 1938:1971 is no longer sufficient and do not correspond to the GUM method, which is now the uncertainty of measurement method in the field of GPS.

ISO 14253 consists of the following parts, under the general title *Geometrical product specifications (GPS) — Inspection by measurement of workpieces and measuring equipment*:

— *Part 1: Decision rules for proving conformance or non-conformance with specification*

— *Part 2: Guide to the estimation of uncertainty in measurement in calibration of measuring equipment and product verification*

— *Part 3: Procedures for evaluating the integrity of uncertainty of measurement values*

Annexes A and B of this part of ISO 14253 are for information only.

Introduction

This part of ISO 14253 is a geometrical product specifications (GPS) standard and is to be regarded as a global GPS standard (see ISO/TR 14638). It influences the chain links 4, 5 and 6 of all chains of general GPS standards.

For more detailed information on the relation of this part of ISO 14253 to other standards and the GPS matrix model see annex A.

The estimated uncertainty of measurement is to be taken into account when providing evidence for conformance or non-conformance with specification.

The problem arises when a measurement result falls close to the upper or lower specification limit. In this case it is not possible to prove conformance or non-conformance with specifications, since the measurement result plus or minus the expanded uncertainty of measurement includes one of the specification limits.

Therefore a supplier/customer agreement should be foreseen in order to solve the problems which could arise. This part of ISO 14253 explains how to handle specification, uncertainty of measurement and establishes decision rules for proving conformance or non-conformance with specification.

Geometrical Product Specifications (GPS) — Inspection by measurement of workpieces and measuring equipment —

Part 1:
Decision rules for proving conformance or non-conformance with specifications

1 Scope

This part of ISO 14253 establishes the rules for determining when the characteristics of a specific workpiece or measuring equipment are in conformance or non-conformance with a given tolerance (for a workpiece) or limits of maximum permissible errors (for a measuring equipment), taking into account the uncertainty of measurement.

It also gives rules on how to deal with cases where a clear decision (conformance or non-conformance with specification) cannot be taken, i.e. when the measurement result falls within the uncertainty range (see 3.23) that exists around the specification limits.

This part of ISO 14253 applies to specifications defined in general GPS standards (see ISO/TR 14638), i.e. standards prepared by ISO/TC 213, including

— workpiece specifications (usually given as tolerance limits), and

— measuring equipment specifications (usually given as maximum permissible errors).

It may also apply to specifications other than those defined in connection with general GPS standards.

This part of ISO 14253 does not apply to inspection using limit gauges. Inspection with limit gauges is covered by ISO/R 1938.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 14253. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 14253 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of valid International Standards.

ISO 3534-2:1993, *Statistics — Vocabulary and symbols — Part 2: Statistical quality control.*

ISO 8402:1994, *Quality management and quality assurance — Vocabulary.*

Guide to the expression of uncertainty in measurement (GUM), 1st edition, 1995.

International vocabulary of basic and general terms in metrology (VIM). BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, 2nd edition, 1993.

3 Definitions

For the purposes of this part of ISO 14253, the definitions given in ISO 3534-2, ISO 8402, VIM, GUM and the following apply.

3.1
tolerance
T
difference between the upper and lower tolerance limits

[ISO 3534-2:1993, 1.4.4]

NOTES

1 The tolerance is a quantity without sign.

2 A tolerance may be two-sided or one-sided (maximum permissible value on one side; the other limit value is zero) but the tolerance zone does not necessarily include the nominal value.

3.2
tolerance zone
tolerance interval
variate values of the characteristic between and including the tolerance limits

[ISO 3534-2:1993, 1.4.5]

3.3
tolerance limits
limiting values
specified values of the characteristic giving upper and/or lower bounds of the permissible value

[ISO 3534-2:1993, 1.4.3]

3.4
maximum permissible errors (of a measuring equipment)
MPE
extreme values of an error permitted by specifications, regulations, etc. for a given measuring equipment

[VIM:1993, 5.21]

3.5
specification
tolerance on a workpiece characteristic or the maximum permissible errors, MPE, of measuring equipment characteristic

NOTE — A specification should refer to or include drawings, patterns or other relevant documents and indicate the means and the criteria whereby conformity can be checked.

3.6
specification zone
specification interval
variate values of the workpiece characteristic and the measuring equipment characteristic between and including the specification limits

3.7
specification limits
tolerance limits of a workpiece characteristic or maximum permissible errors of a measuring equipment characteristic

3.8
upper specification limit
USL
specified value giving either:

— the upper boundaries of the permissible value of the tolerance limits of a workpiece characteristic; or

— the upper boundaries of the permissible value of the permissible errors of a measuring equipment characteristic

3.9
lower specification limit
LSL
specified value giving either:

— the lower boundaries of the permissible value of the tolerance limits of a workpiece characteristic; or

— the lower boundaries of the permissible value of the permissible errors of a measuring equipment characteristic

3.10
measurand
Y
particular quantity subject to measurement

[VIM:1993, 2.6]

3.11
result of measurement
y
value attributed to a measurand, obtained by measurement

NOTES

1 When a result is given, it should be made clear whether it refers to:

— the indication,

— the uncorrected result,

— the corrected result,

and whether several results are averaged.

2 A complete statement of the result of a measurement, y', includes information about the uncertainty of measurement.

[VIM:1993, 3.1]

3.12
nominal value
designated value of a characteristic in a given design specification or drawing

3.13
uncertainty of measurement
parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand

NOTES

1 The parameter may be, for example, a standard deviation (or a given multiple of it), or the half-width of an interval having a stated level of confidence.

2 Uncertainty of measurement comprises, in general, many components. Some of these components may be evaluated from the statistical distribution of the results of series of measurements and can be characterized by experimental standard deviations. The other components, which can also be characterized by standard deviations, are evaluated from assumed probability distributions based on experience or other information.

3 It is understood that the result of the measurement is the best estimate of the value of the measurand, and that all components of uncertainty including those arising from systematic effects, such as components associated with corrections and reference standards, contribute to the dispersion.

[VIM:1993, 3.9 and GUM:1995, B.2.18]

3.14
standard uncertainty (of a measurement)
u
uncertainty of the result of a measurement expressed as a standard deviation

[GUM:1995, 2.3.1]

3.15
combined standard uncertainty (of a measurement)
u_c
standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities, equal to the positive square root sum of terms, the terms being variances or covariances of these other quantities weighted according to how the measurement result varies with changes in these quantities

[GUM:1995, 2.3.4]

3.16
expanded uncertainty (of a measurement)
U
quantity defining an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurand

NOTES

1 The fraction may be viewed as the coverage probability or the level of confidence of the interval.

2 To associate a specific level of confidence with the interval defined by the expanded uncertainty requires explicit or implicit assumptions regarding the probability distribution characterized by the measurement result and its combined standard uncertainty. The level of confidence that may be attributed to this interval can be known only to the extent to which such assumptions may be justified.

[GUM:1995, 2.3.5]

3.17
coverage factor
k
numerical factor used as a multiplier of the combined standard uncertainty in order to obtain an expanded uncertainty

NOTE — A coverage factor, k, is typically in the range of 2 to 3.

[GUM:1995, 2.3.6]

3.18
result of measurement, complete statement
y'
result of measurement including the expanded uncertainty, U

NOTE — The complete statement is expressed by the equation given in clause 4.

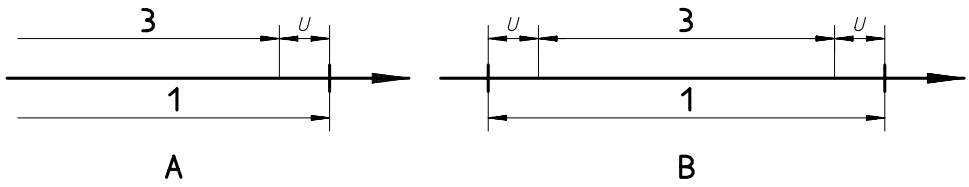
3.19
conformance
conformity
fulfilment of specified requirements

[ISO 8402:1994, 2.9]

3.20
conformance zone
specification zone reduced by the expanded uncertainty of measurement, U

See figure 1.

NOTE — The specification is reduced by the expanded uncertainty of measurement at the upper and/or lower specification limits.



Key
A One-sided specification
B Two-sided specification
1 Specification zone
3 Conformance zone

Figure 1 — Conformance zone

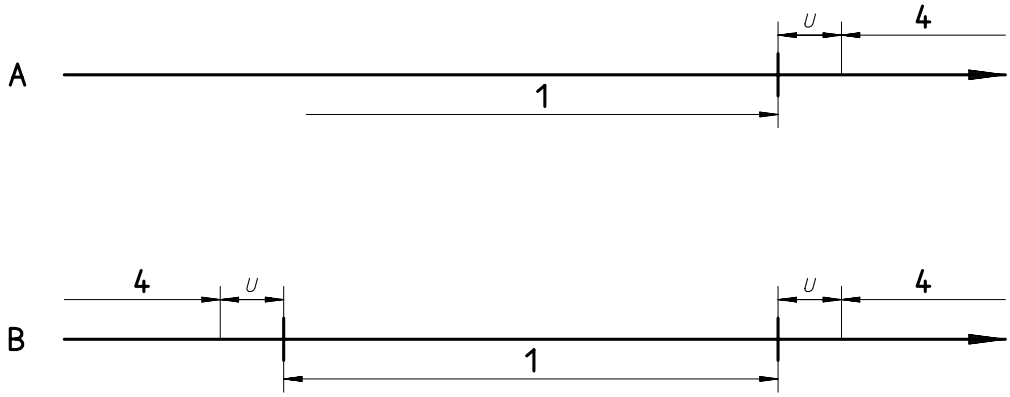
3.21
non-conformance
non-conformity
non-fulfilment of a specified requirement

[ISO 8402:1994, 2.10]

3.22
non-conformance zone
zone(s) outside the specification zone extended by the expanded uncertainty of measurement, U

See figure 2.

NOTE — The specification is extended by the expanded uncertainty of measurement at the upper and/or lower specification limit.



Key
A One-sided specification
B Two-sided specification
1 Specification zone
4 Non-conformance zone

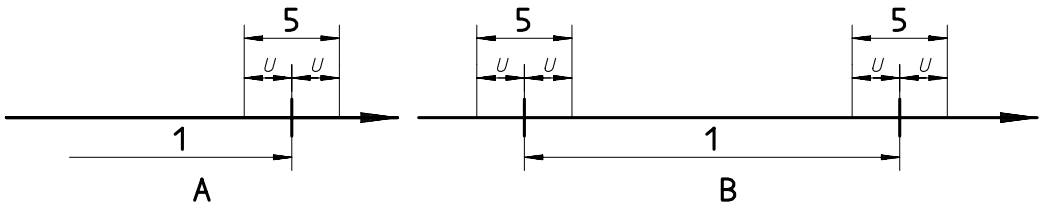
3.23
uncertainty range
range(s) close to the specification limit(s) where neither conformance nor non-conformance can be proved taking into account the uncertainty of measurement

See figure 3.

NOTES

1 The uncertainty range(s) is(are) located around the specification limit (one-sided specification) or specification limits (two-sided specification) and has the width of $2 \times U$.

2 The uncertainty of measurement on the upper and lower side of the result of measurement may be of different magnitudes.



Key
A One-sided specification
B Two-sided specification
1 Specification zone
5 Uncertainty range

Figure 3 — Uncertainty range

4 General

For the purposes of this part of ISO 14253, uncertainty of measurement is estimated and evaluated according to GUM, consequently, uncertainty of measurement is expressed as the expanded uncertainty, U (see ISO/TR 14253-2):

$$U = k \times u_c$$

with a default coverage factor being $k = 2$.

NOTE — If required, a different coverage factor can be assigned by agreement between customer and supplier (see clause 6).

The result of measurement, complete statement, is expressed as:

$$y' = y \pm U$$

In figure 4, a result of measurement, complete statement, y', is illustrated as a symmetrical interval of expanded uncertainty of measurement, U, around a result of measurement, y.

It is recommended that the customer and supplier agree on the estimated uncertainty value(s).

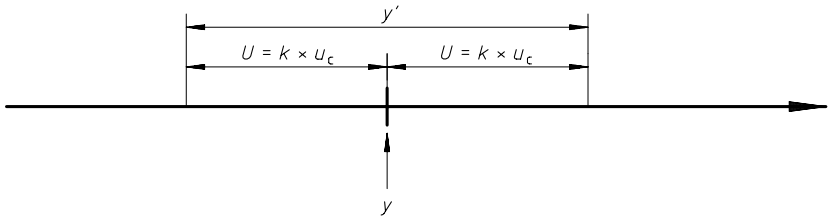


Figure 4 — Result of a measurement, y, and result of measurement, complete statement, y'

5 Proving conformance and non-conformance with specifications

5.1 General

The following rules are default rules for proving conformance and non-conformance with specifications, i.e. rules which are in force when no other rules are agreed upon between supplier and customer.

Other rules may be agreed upon between supplier and customer, in which case they shall be made as special agreements and be included in the documentation (see clause 6).

It is recommended that the following rules always be applied for the most important specifications controlling the function of the workpiece or the measuring equipment. Other less restrictive rules may be used, by special agreement between the parties, for less important requirements.

In the design or specification phase, e.g. on an engineering drawing, the terms "in specification" and "out of specification" (see 1 and 2 in figure 5, line C) designate the areas separated by the sharp borderlines

— LSL and USL for a two-sided specification;

— either LSL or USL for a one-sided specification.

NOTE — For simplification, the text and figures in this clause only illustrate a two-sided specification.

In the production or verification phase, the meaning of the terms "in specification" and "out of specification" are complicated by the ever-existing uncertainty of measurement. The sharp borderlines (from the design phase) are transformed into uncertainty ranges. Consequently, the conformance and non-conformance zones are reduced by the estimated uncertainty of measurement by means of the uncertainty range (see D in figure 5).

The specifications for a workpiece or a measuring equipment are given under the assumption that they are respected, so that no workpieces or measuring equipment are out of specification.

In practice, in the verification phase, the estimated uncertainty of measurement shall be taken into account to demonstrate or prove the conformance or non-conformance with a given specification.