BRITISH STANDARD

BS EN ISO
14253-1:1999

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

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

The European Standard EN ISO 14253-1:1998 has the status of a British Standard

ICS 17.040.10

National foreword

This British Standard is the English language version of EN ISO 14253-1:1998. It is identical with ISO 14253-1:1998.

The UK participation in its preparation was entrusted by Technical Committee TDE/4, Engineering drawing, metrology, precision measurement and all related documentation, to Subcommittee TDE/4/-/4, Engineers precision measuring equipment including limits and fits, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Cross-references

Attention is drawn to the fact that CEN and CENELEC Standards normally include an annex which lists normative references to international publications with their corresponding European publications. The British Standards which implement these international or European publications may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN ISO title page, page 2, the ISO title page, pages ii to iv, pages 1 to 13 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

This British Standard, having been prepared under the direction of the Engineering Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 May 1999

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Contents

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EUROPEAN STANDARD

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EN ISO 14253-1

November 1998

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Descriptors: See ISO document

English version

Geometrical Product Specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 1: Decision rules for proving conformance or non-conformance with specifications

(ISO 14253-1:1998)

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 (ISO 14253-1:1998)

Geometrische Produktspezifikation (GPS) — Prüfung von Werkstücken und Meßgeräten durch Messen — Teil 1: Entscheidungsregeln für die Feststellungen von Übereinstimmung oder Nichtübereinstimmung mit Spezifikationen (ISO 14253-1:1998)

This European Standard was approved by CEN on 8 November 1998.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Foreword

The text of the International Standard ISO 14253-1:1998 has been prepared by Technical Committee ISO/TC 213 "Dimensional and geometrical product specifications and verification" in collaboration with Technical Committee CEN/TC 290 "Dimensional and geometrical product specification and verification", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 1999, and conflicting national standards shall be withdrawn at the latest by May 1999.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Endorsement notice

The text of the International Standard ISO 14253-1:1998 was approved by CEN as a European Standard without any modification.

NOTE Normative references to International Standards are listed in Annex ZA (normative).

INTERNATIONAL STANDARD

ISO 14253-1

First edition
1998-11-15

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 number
ISO 14253-1:1998(E)

Contents

Descriptors: Geometrical product specifications, workpieces, dimensional measurements, measuring instruments, verification.

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.*

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

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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.

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**]

NOTE 1 The tolerance is a quantity without sign.
NOTE 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

NOTE 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.

NOTE 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

NOTE 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.

NOTE 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.

NOTE 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

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

NOTE 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

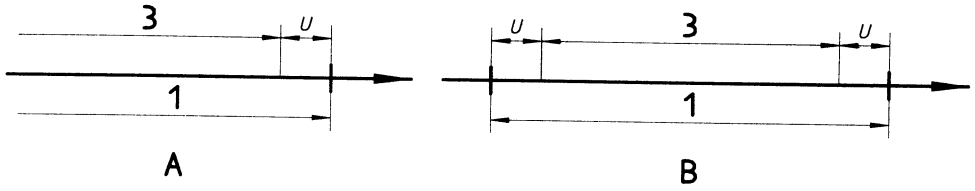
[ISO 8402:1994, **2.9**]

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

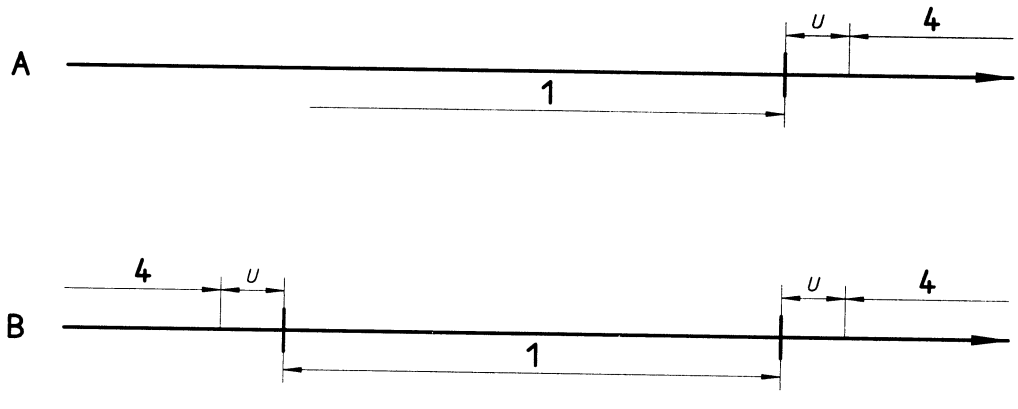
[ISO 8402:1994, **2.10**]

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

Figure 2 — Non-conformance zone

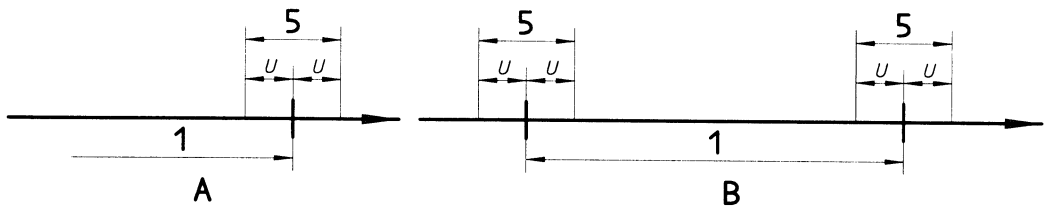
3.23
uncertainty range

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

NOTE 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 $2 \times U$.

NOTE 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).

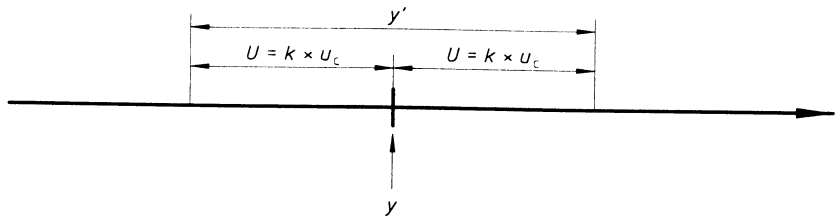


Figure 4 — Result of a measurement, y, and result of measurement, complete statement, y'

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;

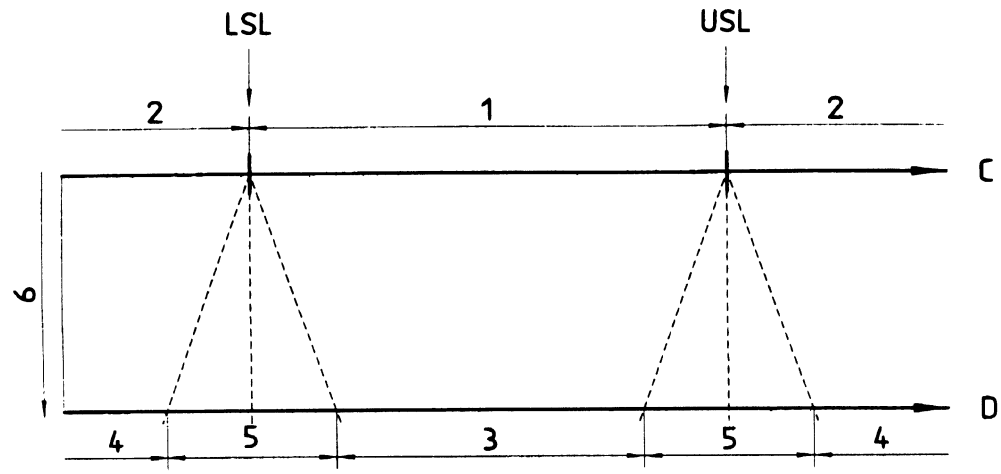
— either LSL or USL for a one-sided specification.

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.



Key

C Design/specification phase
D Verification phase
1 Specification zone (in specification)
2 Out of specification
3 Conformance zone
4 Non-conformance zone
5 Uncertainty range
6 Increasing measurement uncertainty, U

Figure 5 — Uncertainty of measurement: the uncertainty range reduces the conformance and non-conformance zones

A given specification (LSL and/or USL) is invariable and is defined by the drawing indication and the respective chain of standards (see ISO/TR 14638) or by the detailed description of the characteristic of the measurement equipment (e.g. in a standard) and the indicated value of the maximum permissible error (MPE).

Uncertainty of measurement (the expanded uncertainty of measurement) is variable and is controlled by several uncertainty components in the measuring process (see ISO/TR 14253-2).

Consequently, the sizes of the conformance and the non-conformance zones are variable and depend on the estimated uncertainty of measurement, U.

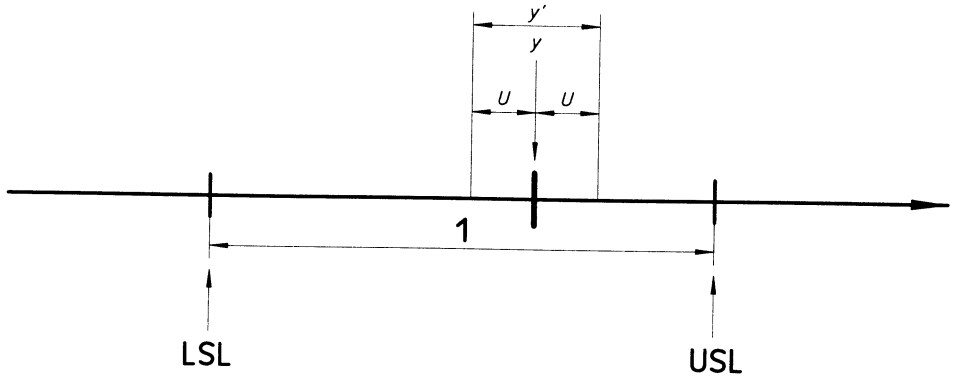
5.2 Rule for proving conformance with specifications

Conformance with a specification (specified tolerance or MPE) is proved when the result of measurement, complete statement, y', falls within the tolerance zone of a workpiece characteristic or within the maximum permissible error of a measuring equipment characteristic (see Figure 6).

$$\text{LSL} < y - U \quad \text{and} \quad y + U < \text{USL}$$

The same conformance can be proved similarly when the result of measurement, y, falls within the tolerance zone of a workpiece characteristic or within the maximum permissible error of a measuring equipment characteristic reduced on either side by the expanded uncertainty, U, i.e. the conformance zone (see Figure 7).

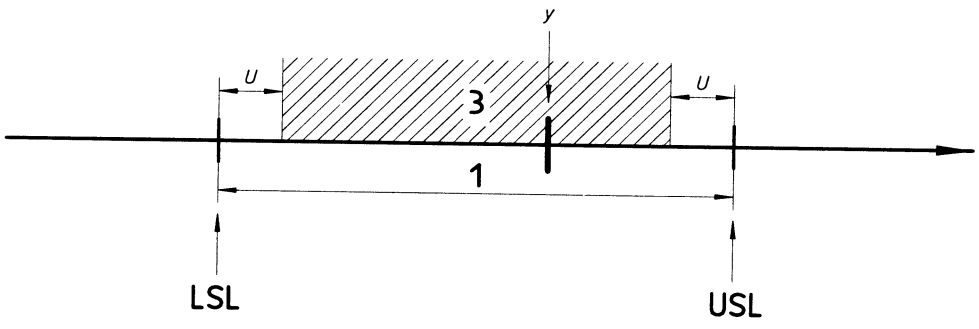
$$\text{LSL} + U < y < \text{USL} - U$$



Key

1 Specification zone

Figure 6 — Conformance with specification is proved



Key

1 Specification zone

3 Conformance zone

Figure 7 — Conformance with specification is proved

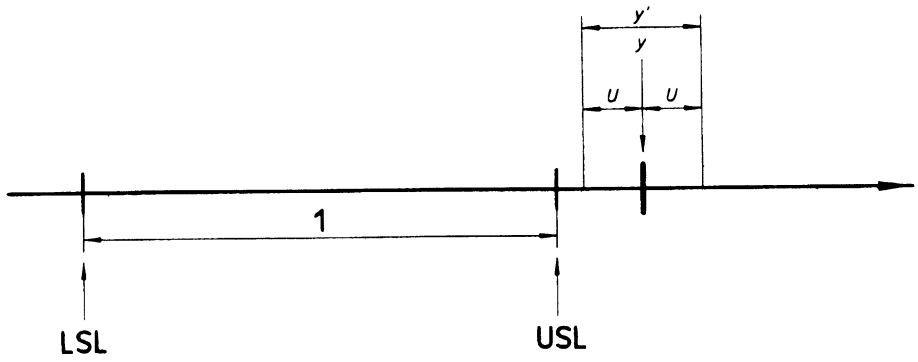
The size of the conformance zone is directly linked to the given specification (LSL and USL) and the actual expanded uncertainty, U.

Consequently, workpieces or measuring equipment can be accepted if conformance with the specification is proved by applying the above rule.

5.3 Rule for proving non-conformance with specifications

Non-conformance with a specification (specified tolerance or MPE) is proved when the result of measurement, complete statement, y', falls outside the tolerance zone of a workpiece characteristic or outside the maximum permissible error of a measuring equipment characteristic (see Figure 8).

$y + U < \text{LSL}$ and $\text{USL} < y - U$

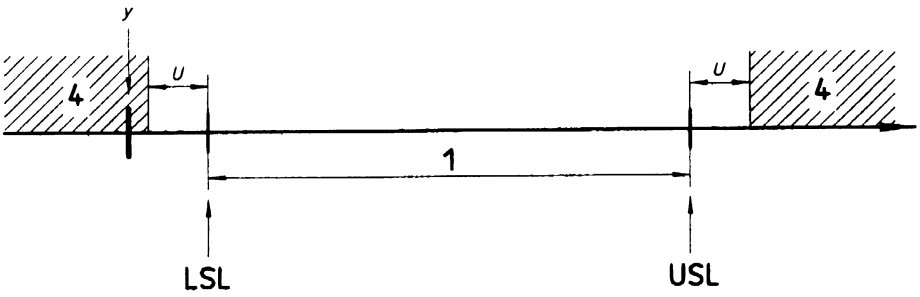


Key
1 Specification zone

Figure 8 — Non-conformance with specification is proved (USL < $y - U$)

The same non-conformance can be proved similarly when the result of measurement, y, falls outside the tolerance zone of a workpiece characteristic or outside the maximum permissible error of a measuring equipment characteristic increased on either side by the expanded uncertainty, U, i.e. the non-conformance zone (see Figure 9).

$y < \text{LSL} - U$ or $\text{USL} + U < y$



Key
1 Specification zone
4 Non-conformance zone

Figure 9 — Non-conformance with specification is proved (y < LSL – U)

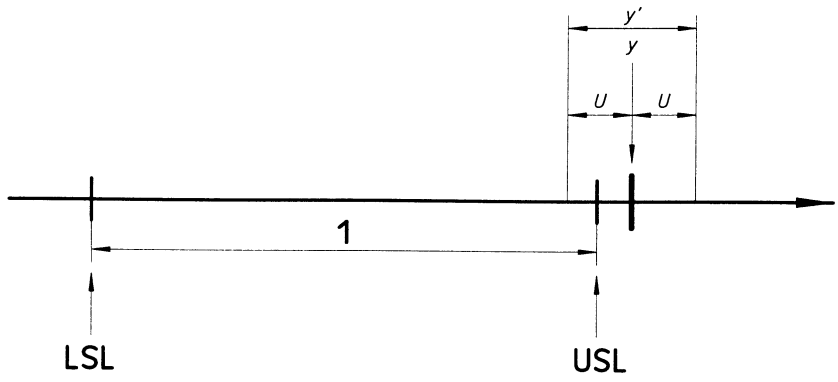
The non-conformance zone is directly linked to the given specification (LSL and USL) and the actual expanded uncertainty, U.

Consequently, workpieces or measuring equipment can be rejected if non-conformance with specification is proved applying the above given rule.

5.4 Uncertainty range

Neither conformance nor non-conformance with a specification can be proved when the result of measurement, complete statement, y', includes one of the specification limits LSL or USL (see Figure 10): tolerance limits of a workpiece or the maximum permissible error of a measuring equipment.

$y - U < \text{LSL} < y + U$ or $y - U < \text{USL} < y + U$

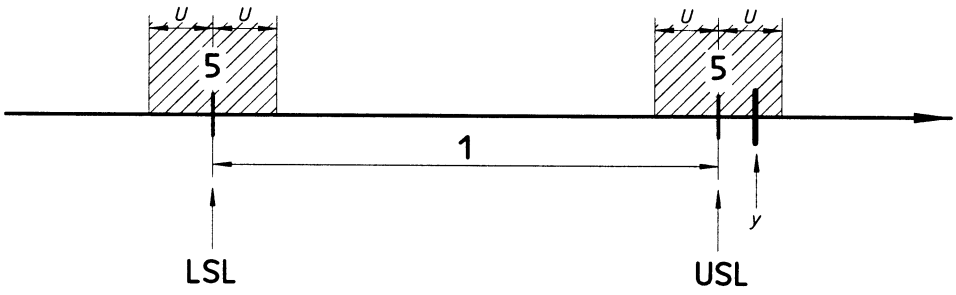


Key
1 Specification zone

Figure 10 — Neither conformance nor non-conformance with specification can be proved
($y - U <$ USL $< y + U$)

The same situation occurs when the result of measurement, y, falls within one of the uncertainty ranges (see Figure 11).

LSL $- U < y <$ LSL $+ U$ or USL $- U < y <$ USL $+ U$



Key
1 Specification zone
5 Uncertainty range

Figure 11 — Neither conformance nor non-conformance with specification can be proved
(USL $- U <$ USL $< y <$ USL $+ U$)

The uncertainty range is directly linked to the actual expanded uncertainty, U.

Consequently, workpieces or measuring equipment cannot automatically be accepted or rejected.

6 Application in a supplier/customer relationship

6.1 General

The rules given this part of ISO 14253 apply if no previous agreement has been made between the supplier and the customer.

The principle behind the rules is the following: the uncertainty of measurement always counts against the party who is providing the proof of conformance or non-conformance and therefore making the measurement.

NOTE 1 Improving the uncertainty of measurement benefits the party who is providing the proof.
NOTE 2 The above principle applies regardless of whether the party providing the proof performs the measurements in-house or contracts a third-party laboratory to perform the measurements.

6.2 Supplier proving conformance

The supplier shall prove conformance in accordance with **5.2** using his estimated uncertainty of measurement.

NOTE It is customary that the supplier provides proof of conformance with specifications for all work pieces or measuring equipment delivered.

6.3 Customer proving non-conformance

The customer shall prove non-conformance in accordance with **5.3** using his estimated uncertainty of measurement.

NOTE A reseller is first customer and then supplier of the same workpieces or measuring equipment. A reseller may be in the situation where he cannot prove conformance of workpieces or measuring equipment to his customer and at the same time cannot prove non-conformance of the same workpieces or measuring equipment to his supplier. This situation only occurs, when the resellers uncertainty of measurement is larger than that of his supplier. To avoid this situation a reseller should use the proof provided to him by his supplier to prove conformance to his customer.

Annex A (informative)
Relation to the GPS matrix model

For full details about the GPS matrix model see ISO/TR 14638.

A.1 Information about this part of ISO 14253 and its use

This part of ISO 14253 provides rules for:

— proving conformance with GPS specification for workpieces and measuring equipment taking into account the estimated uncertainty of measurement;

— proving non-conformance with GPS specification for workpieces and measuring equipment taking into account the estimated uncertainty of measurement;

— how to deal with the situations where neither conformance nor non-conformance with GPS specification can be proven.

In this part of ISO 14253 the uncertainty of measurement is estimated and expressed as expanded uncertainty and the uncertainty of measurement is estimated according to GUM and ISO/TR 14253-2.

A.2 Position in the GPS matrix model

This part of ISO 14253 is a Global GPS standard, which influences the chain links 4, 5 and 6 of all chains of standards in the *General GPS matrix*, as graphically illustrated in Figure A.1.

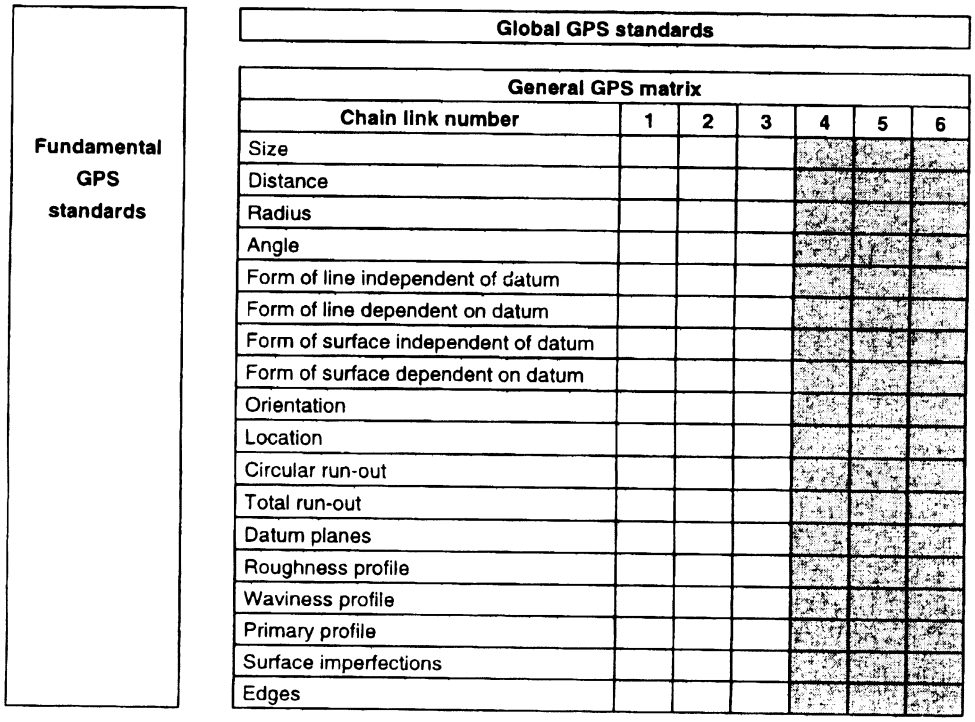


Figure A.1

A.3 Related standards

The related International Standards are those of the chains of standards indicated in Figure A.1.

Annex B (informative)
Bibliography

[1] ISO/R 1938:1971, *System of limits and fits — Part 1: Inspection of plain workpieces.*

[2] ISO/TR 14253-2:—, *Geometrical Product Specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 2: Guide to the estimation of uncertainty of measurement in calibration of measuring equipment and product verification*[1)].

[3] ISO/TR 14638:1995, *Geometrical product specifications (GPS) — Masterplan.*

Annex ZA (normative)
Normative references to international publications with their relevant European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

Publication	Year	Title	EN	Year
ISO 8402	1994	*Quality management and quality assurance — Vocabulary*	EN ISO 8402	1995

[1)] To be published.

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