TECHNICAL SPECIFICATION

ISO/TS 14253-4

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Geometrical product specifications (GPS) — Inspection by measurement of workpieces and measuring equipment —

Part 4:
Background on functional limits and specification limits in decision rules

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

Partie 4: Informations de base sur les limites fonctionnelles et les limites de spécification dans les règles de décision

Reference number
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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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of 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 in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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/TS 14253-4 was prepared by Technical Committee ISO/TC 213, *Dimensional and geometrical product specifications and verification*.

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 specifications*

— *Part 2: Guidance for the estimation of uncertainty in GPS measurement, in calibration of measuring equipment and in product verification*

— *Part 3: Guidelines for achieving agreements on measurement uncertainty statements*

— *Part 4: Background on functional limits and specification limits in decision rules* [Technical Specification]

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 3, 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 decision rules given in ISO 14253-1, which apply unless otherwise specified, are designed to ensure that workpieces and measuring equipment are within the specification and that disputes over whether workpieces and measuring equipment are within the specification can be avoided.

In order for the decision rules to work as designed, it is important to first give proof of conformance. In other words, the user/buyer of the product in question should always require the manufacturer/supplier/seller of the product to provide proof of conformance with the product.

If subsequent incoming inspection proves nonconformance, uncertainty budgets can be examined according to ISO 14253-3 for mutual assurance of their validity. If it is concluded that both uncertainty budgets are valid, the only conclusion is that one or the other or both measurement results are unrepresentative for the measurement process in question.

If, for some reason, the user of the product does not want the supplier to provide the first proof, but instead relies on incoming inspection, the user should reduce the functional limits by the measurement uncertainty of the incoming inspection to arrive at the contractual specification limits that are communicated to, and negotiated and agreed with, the supplier.

A separate problem is that of the reseller, who purchases product from a manufacturer and resells it to the user. The decision rules given in ISO 14253-1 will function correctly if the reseller requires the manufacturer of the product to provide proof of conformance and subsequently provides that proof to the user. If the reseller for some reason decides to prove conformance to the user independently, there will be cases where neither conformance nor nonconformance can be proven, so the reseller can neither return nor resell the product based on the original specification. Consequently, this approach is not recommended.

The decision rules in ISO 14253-1 are also based on a number of assumptions. When these assumptions are not true, these decision rules may not be economically optimal. This part of ISO 14253 outlines these assumptions and discusses why they are the theoretically ideal assumptions.

For workpieces, only the creator of the specification (the designer) can be expected to know whether the assumptions are true. Therefore, any deviations from the ISO 14253-1 decision rules can only be initiated and documented by the specification owner.

For measuring equipment, a specification may be based on a standard, written unilaterally by the manufacturer or purchaser of the equipment or written in cooperation between the manufacturer and the purchaser of the equipment. If the specification is based on an ISO standard, and the standard does not indicate other decision rules, the rules of ISO 14253-1 apply. In other cases, the decision rules can only be documented by the specification author(s).

It must be recognized that the decision rules, whether they are given implicitly or explicitly, are part of the specification.

It must further be recognized that the issues involved in choosing the optimal set of decision rules are complicated and that it is unrealistic to expect that simple rules can suit every circumstance. Parties should ensure access to competent technical resources before deviating from the ISO 14253-1 decision rules.

In this case, the specification owner must explicitly recognize that decision rules other than those defined in ISO 14253-1 apply, and that documentation of this policy needs to be prepared and be made available to trading partners (customers and/or suppliers) and be referenced in the technical product documentation.

Geometrical product specifications (GPS) — Inspection by measurement of workpieces and measuring equipment —

Part 4: Background on functional limits and specification limits in decision rules

1 Scope

This part of ISO 14253 outlines the main assumptions behind the theoretically ideal decision rules established in ISO 14253-1. It discusses why these rules have to be the default rules and what considerations should be taken into account before applying different decision rules.

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

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

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

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 14253-1:1998, *Geometrical Product Specifications (GPS) — Inspection by measurement of workpieces and measuring equipment — Part 1: Decision rules for proving conformance or non-conformance with specifications*

3 Definitions

3.1
reverse engineering
design process that consists in analysing the shape, dimensions and function of a finished part or prototype and using this information to produce a similar product

3.2
product functional level
how well the product functions overall

3.3
product attribute functional level
how well the product functions with regard to a particular attribute

NOTE The overall product functional level depends on the product attribute functional levels for all the product attributes.

3.4
workpiece functional level
how well a product made up of the workpiece in question and a set of acceptable workpieces functions overall

3.5
workpiece characteristic functional level
how well a product made up of the workpiece in question and a set of acceptable workpieces functions with regard to the attributes influenced by the characteristic in question

NOTE The overall workpiece functional level depends on the workpiece characteristic functional levels for all the workpiece characteristics.

3.6
functional level of metrological characteristic
how well a measuring equipment with the metrological characteristic in question and a set of acceptable metrological characteristics functions with regard to the attributes influenced by the characteristic in question

3.7
functional deterioration curve
graphical representation of the relationship between the product (attribute) functional level and the value of a geometrical characteristic, a combination of geometrical characteristics or a metrological characteristic

NOTE In general, the translation from product attribute functional level to derived functional limits for geometrical characteristics or metrological characteristics is not perfect. Correlation uncertainty (see ISO/TS 17450-2) quantifies this imperfection.

4 Relationship between functional limits and specification limits

4.1 General

The management policy for determining specification limits (the specification limit operator) determines the relationship between the functional limits and the specification limits that are specified on the drawing.

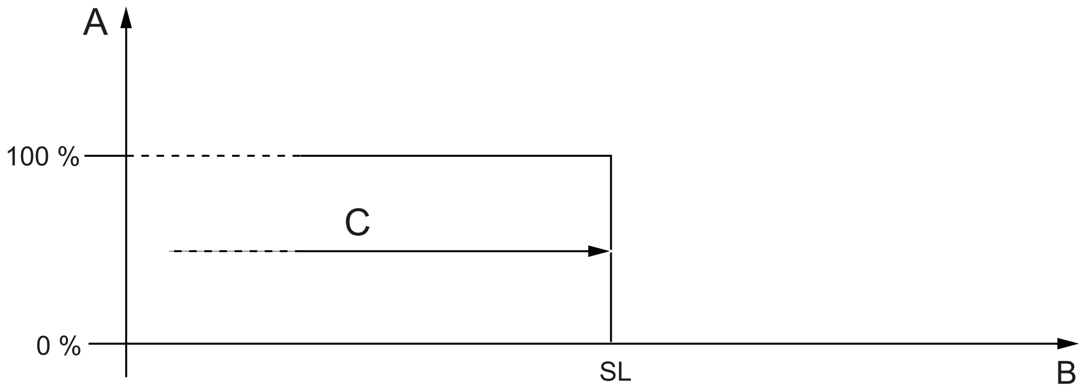
In many cases, several workpieces and several features and characteristics of those features on each workpiece contribute to a given function.

Choosing the right characteristics of the right features for the specification is crucial for ensuring that the specification is functionally relevant. It is the responsibility of the specification creator to select the functionally relevant characteristics for the specification.

Most functions depend on a one-sided specification limit. For example, the ability of a shaft to fit into a given hole depends on its diameter not being too large. There is no lower limit on the range of diameters that can fit into the hole. The lower limit of the specification for the diameter of such a shaft serves an entirely different function, e.g. that the shaft may not fit too loosely, the interface may not leak, or the shaft may not be too weak.

4.2 The one-sided case

The theoretically ideal assumption that is used for defining fundamental rules in GPS, including the decision rules defined in ISO 14253-1, is that the specification limits are equal to the functional limits and that the function of the workpiece is 100 % when the specification limit is not exceeded and 0 % when it is exceeded (see Figure 1).



Key

A workpiece characteristic functional level

B characteristic value

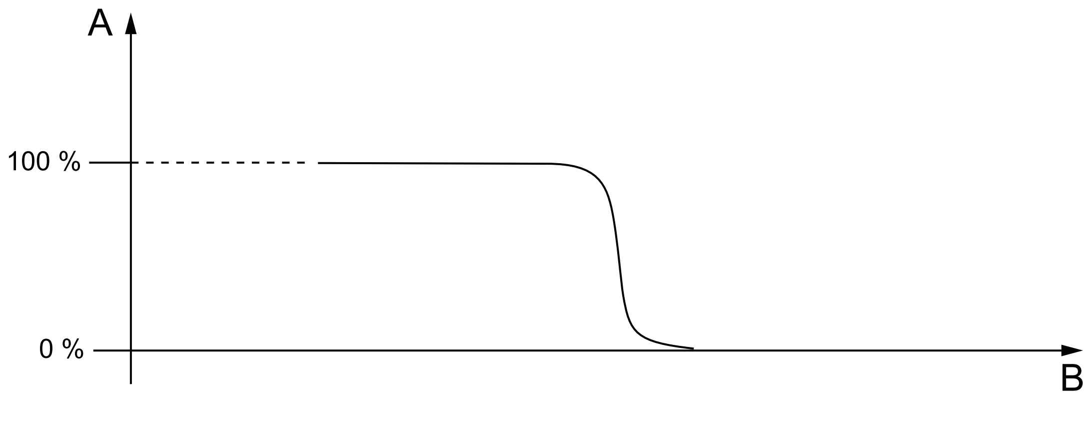
C workpiece conforms

SL specification limit

NOTE For an upper specification limit, the workpiece function is 100 % (full functionality) when the specified characteristic value is below the specification limit (SL) and 0 % when the specified characteristic value is above the specification limit (SL). The situation is similar, but reversed, for a lower specification limit.

Figure 1 — One-sided case with specification limit equal to functional limit

The workpiece functional level deterioration curve generally has a different shape from that shown in Figure 1 (see Figure 2). This functional level curve may represent the diameter of a shaft whose function it is to fit into a hole. As the diameter becomes too large, the functional level deteriorates rapidly because the shaft no longer fits into the hole.



Key

A workpiece characteristic functional level

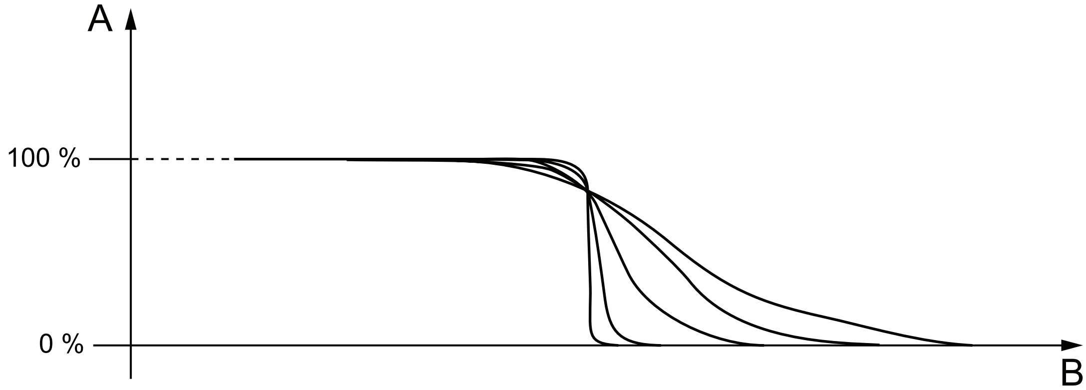
B characteristic value

NOTE 1 The abore is an example of an upper functional limit where the workpiece function deteriorates gradually as the specified characteristic value is increased beyond the range where it is 100 %. The situation is similar, but reversed, for a lower specification limit.

NOTE 2 The “tail” can either represent the situation where a press fit still allows assembly with a perfect counterpart, or the situation where variation in the counterpart still allows assembly, as the function of fit is dependent on the difference between the two sizes rather than on the one size only.

Figure 2 — One-sided case with deteriorating functional level of workpiece

The functional level deterioration curve has different shapes and deteriorate at different rates for different functions (see Figure 3).



Key

A workpiece characteristic functional level

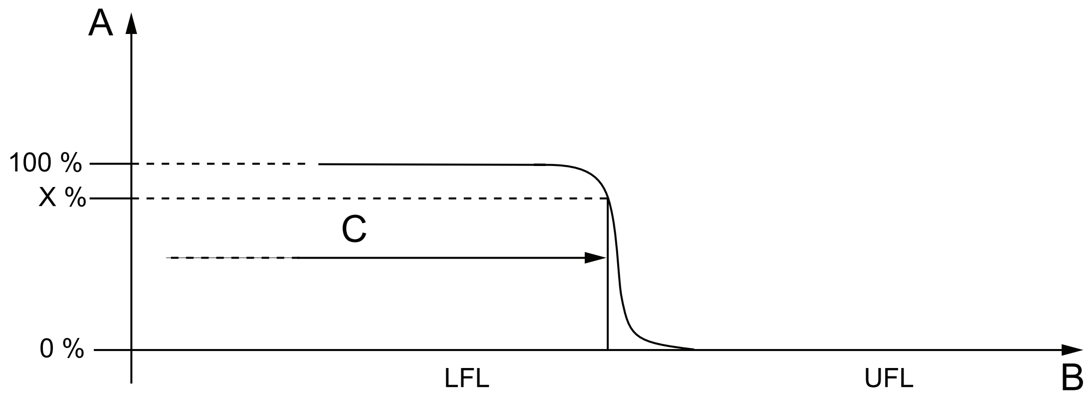
B characteristic value

NOTE For different functions, the workpiece function degrades gradually at different rates as the specified characteristic value is increased beyond the range where it is 100 %.

Figure 3 — One-sided case with different deteriorating functional levels of workpiece

In the cases shown in Figures 2 and 3, it is necessary to define a minimum acceptable functional level before functional limits can be considered meaningful (see Figure 4).

An example of this situation is the vibration of a turbine shaft. Vibration is caused by imbalances in the turbine due to, for example, straightness deviations in the axis of the turbine shaft, roundness deviations of the turbine shaft and variation in the weight of the fan blades. As the vibration level increases, the noise increases and the life of the turbine decreases. The design criteria for the turbine include a requirement for minimum life. It is impossible to manufacture a turbine with no vibration and the manufacturing cost generally goes up as tolerances are reduced to limit vibration, so the design is based on an acceptable level of vibration that leads to an acceptable life span. This acceptable level of vibration defines the X % workpiece functional level in Figure 4. Specifications for the workpieces that make up the turbine can be derived from this minimum acceptable functional level.



Key

A workpiece characteristic functional level

B characteristic value

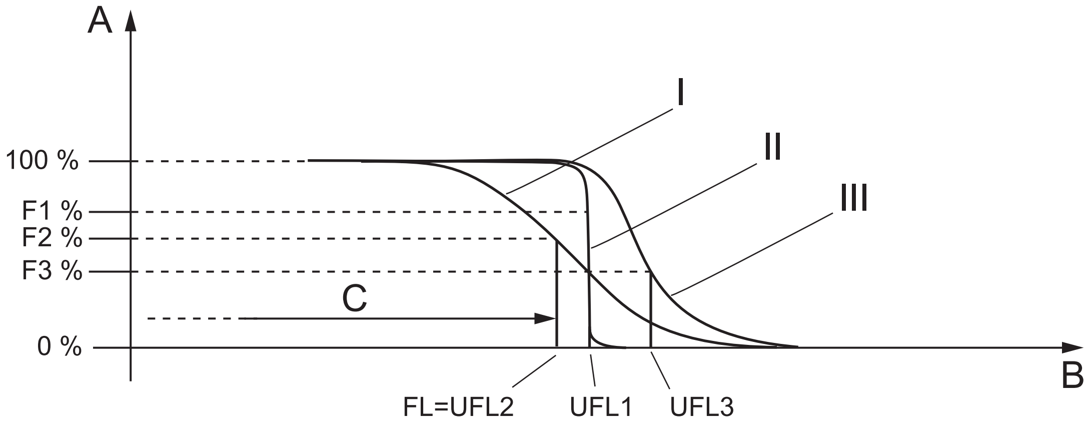
C workpiece conforms

LFL lower functional limit

UFL upper functional limit

NOTE A minimum functional level of X % is determined and the functional limit is determined as the point where the function degrades beyond this value.

Figure 4 — One-sided case with defined minimum acceptable functional level



Key

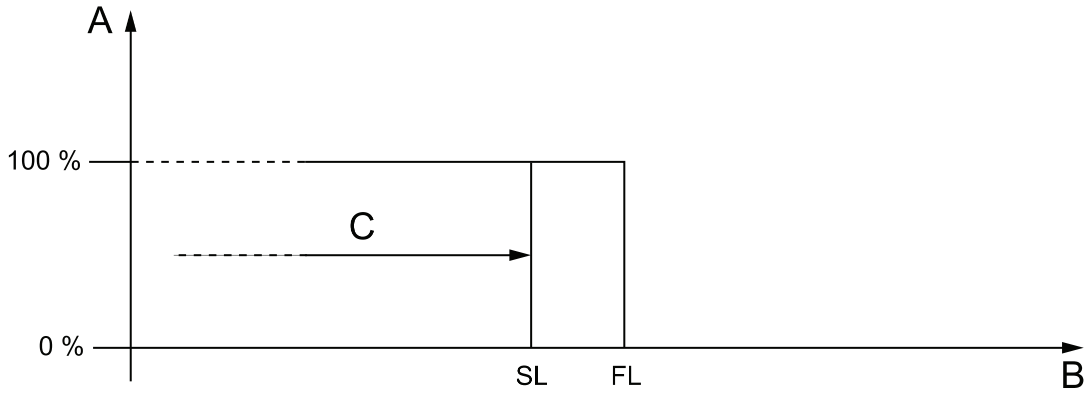
A workpiece characteristic functional level
B characteristic value
C workpiece conforms
I function 1
II function 2
III function 3
FL functional limit
UFL upper functional limit

Figure 5 — A characteristic value determines the functional level for three functions

Figure 5 shows the situation where one characteristic value determines the functional level for three functions. Each function has a minimum acceptable functional level F1, F2 or F3. These minimum acceptable functional levels each determine an upper functional limit for the characteristic value UFL1, UFL2 or UFL3. The functional limit (FL) is the most restrictive of these upper functional limits, in this case UFL2.

Once the functional limit (FL) is determined as in Figure 4 or Figure 5, the specification limit (SL) may, optionally, be placed before the functional limit as in Figure 6. In principle, it could also be placed after the functional limit, but it is hard to find a case where it would be meaningful to do this on purpose.

In many cases, companies have a (written or unwritten) management policy that dictates the relationship between specification limits and functional limits.



Key

A workpiece characteristic functional level

B characteristic value

C workpiece conforms

FL functional limit

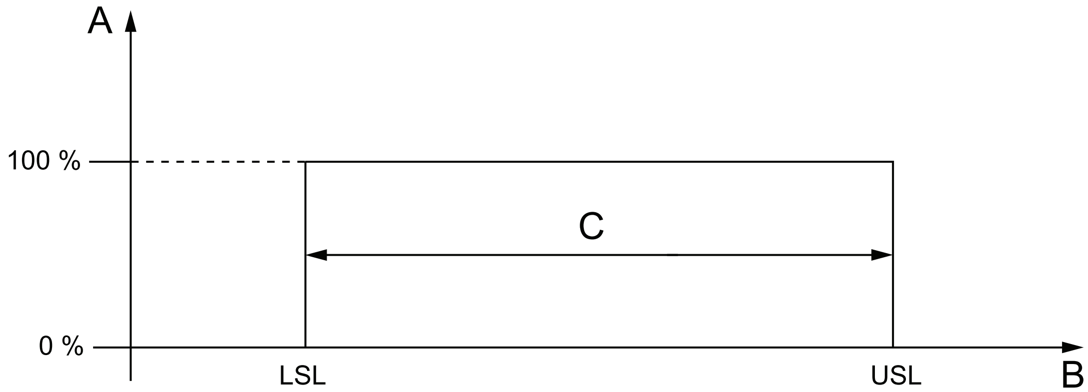
SL specification limit

NOTE For an upper functional limit (UFL), the workpiece function is 100 % (full functionality) when the specified characteristic value is below the functional limit (FL) and 0 % when the specified characteristic value is above the functional limit (FL). However, the specification limit (SL) is placed before the functional limit. The situation is similar, but reversed, for a lower specification limit.

Figure 6 — One-sided case with specification limit placed before the functional limit

4.3 The two-sided case

In some cases, the characteristic value has to be within an interval for the workpiece function to be acceptable. In such a case, the workpiece function may be 100 % when the characteristic value is between the specification limits and 0 % when it is outside those limits (see Figure 7).



Key

A workpiece characteristic functional level

B characteristic value

C workpiece conforms

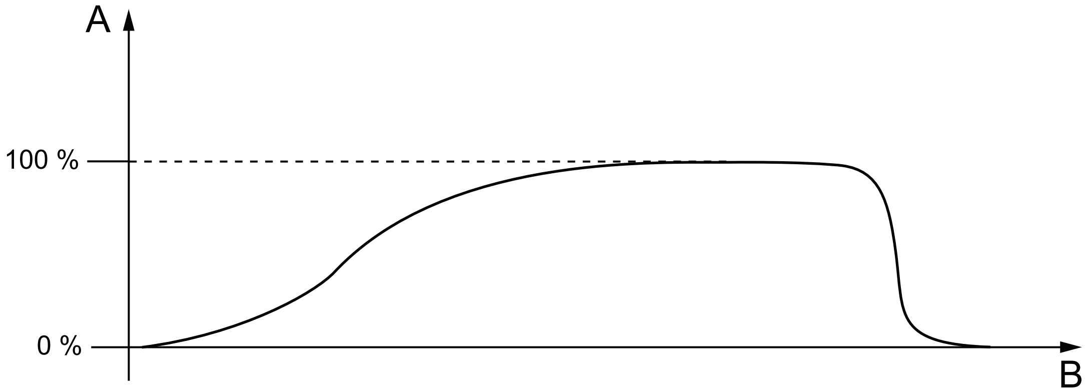
LSL lower specification limit

USL upper specification limit

NOTE The workpiece function is 100 % (full functionality) when the specified characteristic value is between the lower specification limit (LSL) and the upper specification limit (USL) and 0 % when the specified characteristic value is outside this interval.

Figure 7 — Two-sided case with specification limits equal to functional limits

The workpiece functional level deterioration curve generally has a different shape from that shown in Figure 7 (see Figure 8). In general, the shape of the curve is different at the two ends.



Key

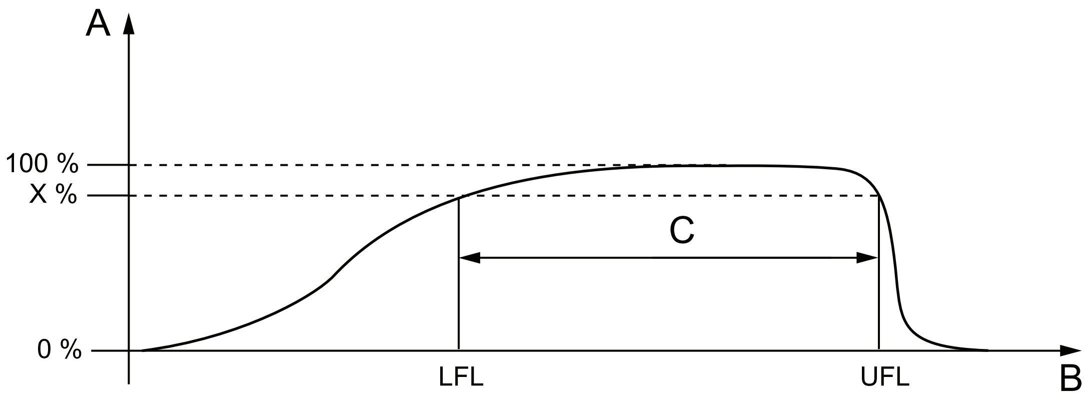
A workpiece characteristic functional level

B characteristic value

NOTE The workpiece function degrades gradually as the specified characteristic value falls beyond the range where it is 100 %. The rate of degradation is different at the two ends of the range.

Figure 8 — Two-sided case with deteriorating functional levels of workpiece

In the case shown in Figure 8, it is necessary to define a minimum acceptable function level before functional limits can be considered meaningful (see Figure 9).



Key

A workpiece characteristic functional level

B characteristic value

C workpiece conforms

LFL lower functional limit

UFL upper functional limit

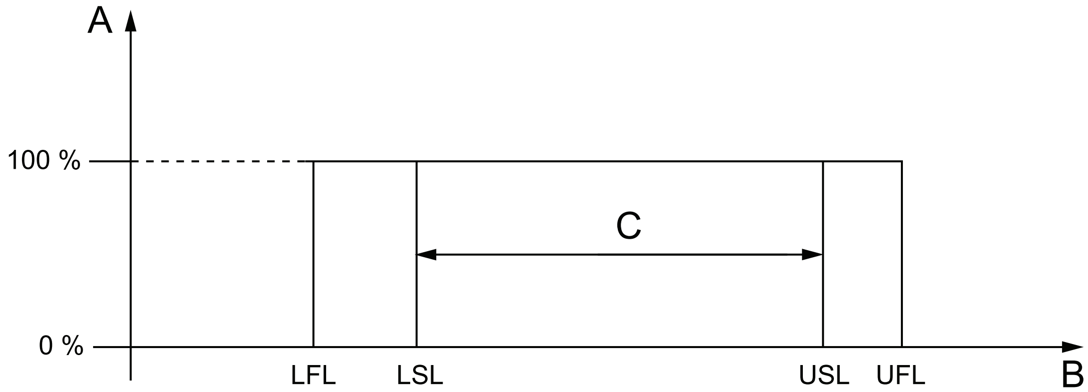
NOTE A minimum function level of X % is determined and the functional limits are determined as the points where the function degrades beyond this value.

Figure 9 — Two-sided case with defined minimum acceptable functional levels

A characteristic value may determine the functional level for several functions. In this situation, as in the one-sided case, the overall functional limits are determined by the most restrictive amongst the upper functional limits and lower functional limits.

Once the functional limits are determined as in Figure 9, the specification limits may, optionally, be placed inside the functional limit as in Figure 10. In principle, they could also be placed beyond the functional limits, but it is hard to find a case where it would be meaningful to do this on purpose.

As for the case described in Figure 6, companies may have a (written or unwritten) management policy that dictates that specification limits have a different relationship to the functional limits (see Figure 10). The specification limits are not necessarily placed at the same distance from the functional limits.



Key

A workpiece characteristic functional level

B characteristic value

C workpiece conforms

LFL lower functional limit

UFL upper functional limit

LSL lower specification limit

USL upper specification limit

NOTE The workpiece function is 100 % (full functionality) when the specified characteristic value is between the lower functional limit (LFL) and the upper functional limit (UFL) and 0 % when the specified characteristic value is outside this interval. However, the lower specification limit (LSL) and the upper specification limit (USL) are placed inside the functional limits.

Figure 10 — Two-sided case with specification limits placed inside the functional limits

The above discussion covers the situation where one characteristic value governs one workpiece function. The common situation where one function is impeded if a characteristic value is too large and another function is impeded if it is too small is not addressed in Figures 7 to 10. Rather, these should be considered two separate incidents of the situation addressed in Figures 1 to 6 (one for the upper limit and one for the lower limit). In particular, this means that the minimum acceptable function level may be different for the two limits.

In other cases, two different characteristic values related to some aspect of a workpiece feature are used to control two different functions. For example, the minimum circumscribed diameter may be the characteristic specified for the upper limit of the size of a shaft and the smallest two-point diameter may be the characteristic specified for the lower limit of the size of the shaft. In this case, the specification does not define an interval for one characteristic value, but rather an upper limit for one characteristic value and a lower limit for another characteristic value. They also control two different functions: the upper limit on the minimum circumscribed diameter controls the shaft's ability to fit into a hole of a certain size; the lower limit on the smallest two-point diameter controls another workpiece function, e.g. strength, leakage, longevity or noise. These should also be considered two separate incidents of the situation addressed in Figures 1 to 6.

If knowledge about the shape of the functional level curve is available and a conscious management policy is applied to the placement of the specification limits relative to the functional limits, it may be technically and economically advantageous to apply decision rules different from those defined in ISO 14253-1.

In this case, the company shall explicitly recognize that it is using decision rules other than those defined in ISO 14253-1. The company shall document this policy, make it available to trading partners (customers and/or suppliers) and reference it in part drawings and/or specifications.

5 How functional limits are determined

5.1 Ideal situation

The ideal situation is that where the functional limits are determined based on an exhaustive investigation done by experiments or theory, or a combination of both, so that the functional limits are known exactly.

5.2 Use of earlier models

The functional limits may be determined by taking functioning workpieces of a previous version and assuming that, since they function satisfactorily, their specifications equal the functional limits. Alternatively, these specifications may be incrementally increased or decreased so as to obtain new estimated functional limits that are perceived to more optimally define the functional limits.

In general, this leads to estimated functional limits that are within the true functional limits, since there is always feedback, often immediate, in case workpieces that are in specification do not function, but there is little or no feedback to indicate that workpieces that are outside the specifications can function satisfactorily.

5.3 Reverse engineering

The functional limits may be determined by reverse engineering, which is a process of discovering the technological principles of a device/object or system through analysis of its structure, function and operation. It often involves taking something (e.g. a mechanical device, an electronic component, a software program) apart and analysing its workings in detail, usually with the intention of constructing a new device or program that does the same thing without actually copying anything from the original.

In general, reverse engineering is limited by the absence of available knowledge regarding which characteristics of the workpiece to specify. For example, the workpiece's function may depend on the ratio between the Rz and Rk values of the surface of a certain feature, but the engineer may choose to characterize the surface using only Ra. In this case, there is likely to be significant correlation uncertainty compared to the specification for the original design. This tends to lead to specification limits that are outside the functional limits for the workpiece. In the above example, all workpieces with a proper ratio between Rz and Rk may have an Ra value of less than 3 µm, but not all workpieces with an Ra value of less than 3 µm may have the proper ratio between Rz and Rk and thus be functional.

Another limitation in reverse engineering is the uncertainty of the measurements made on the workpieces. This means that even if the correct characteristics for the workpiece are chosen, the values measured may be too high, too low or have more spread than the true values for the workpiece.

A third limitation in reverse engineering is that the population of workpieces chosen for reverse engineering may not represent the full variation amongst functional workpieces. Especially in the case where the workpieces are produced using highly capable manufacturing processes, the workpiece population may only utilize a fraction or the functional range. This tends to lead to specification limits that are (often significantly) inside the functional limits for the workpiece.

5.4 Trial and error

This process consists in selecting a possible answer, applying it to the problem and, if it is not successful, selecting (or generating) another possibility, which is subsequently tried. The process ends when a possibility yields a solution.

In some versions of trial and error, the option that is a priori viewed as the most likely should be tried first, followed by the next most likely, and so on until a solution is found, or until all the options are exhausted. In other versions, options are simply tried at random.

The trial and error approach suffers from the same weaknesses as the reverse engineering approach and any other approach that is not based on a fundamental understanding of the functional requirements: it is limited by the characteristics chosen to characterize the workpiece.

5.5 Method based on a set of working examples

This method is quite similar to reverse engineering (see 5.3) of existing designs. In this case, a number of working samples are analysed.

6 Specification limits and how specification limits are determined relative to functional limits

6.1 General

In order for a specification to fulfill its role as a contract, both the creator and the recipient of the specification shall treat all specification limits as if they were absolute functional limits, unless otherwise specified. Consequently, a user cannot reject a product that is in specification because it does not function as expected and a supplier cannot demand that a product that is out of specification be accepted, even if it functions as expected.

In other words, function shall not be considered for contractual purposes. Only the specification shall be considered.

6.2 Ideal situation

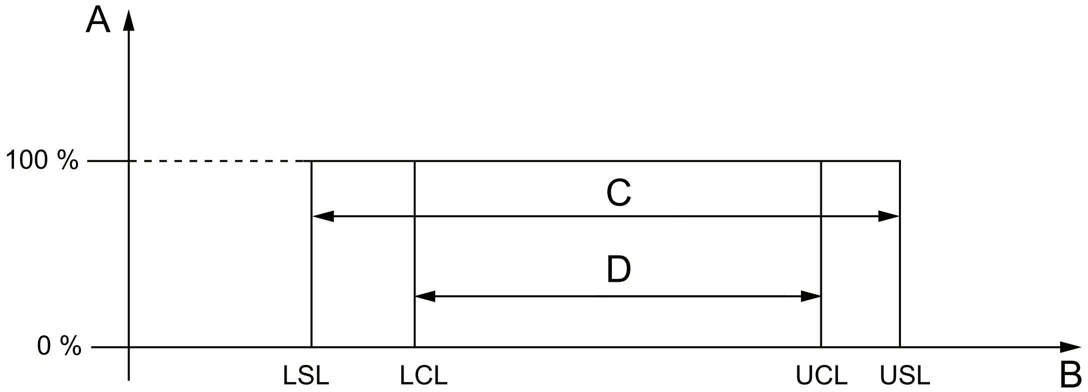
The ideal situation is that where specification limits are identical to functional limits.

In order for a specification to fulfill its role as a contract, both the creator and the recipient of the specification shall treat all specification limits as if they were identical to the functional limits, unless otherwise specified.

6.3 Specification reduced by assumed measurement uncertainty

The determined functional limits may be reduced by an assumed measurement uncertainty. This may be done to simplify the decision rule (accept when measured values are within the specification limits and reject when they are outside the specification limits). In order for this approach to work, it is necessary to stipulate the measurement method and conditions. If these change, the specification limits shall be changed as well to ensure continued functionality. In cases where this approach is used without documenting the functional limits and/or the original assumed measurement uncertainty, any change in measurement method or conditions holds the risk that the assumed measurement uncertainty might not be sufficient to apply the simplified decision rule.

A variation of this approach is to maintain documented specification limits that are equal to the functional limits yet define separate contractual limits that reduce the specification limits by the assumed measurement uncertainty of the buyer of the workpieces or equipment. The purpose of this approach is to allow the buyer to rely on incoming inspection instead of the seller's proof of conformance and still be able to reject all potentially nonconforming items. As this approach provides the seller of the workpieces or equipment with more restrictive contractual limits than the ideal situation, this approach shall be expected to increase the price of the items.



Key

A workpiece characteristic functional level

B characteristic value

C workpiece conforms

D workpiece contractually acceptable

LSL lower specification limit

USL upper specification limit

LCL lower contractual limit

UFL upper contractual limit

Figure 11 — Two-sided case with contractual limits placed within the specification limits

6.4 Specification reduced by an arbitrary amount

The functional limits are reduced by a certain amount to account for measurement uncertainty (as in 6.3), the designer's confidence in the determined functional limits, the confidence in the manufacturer, etc. to arrive at the specification limits. The reduction is generally not based on a defined policy and may differ amongst designers within a company and from one design to another for one designer.

If, as is most commonly the case, the functional limits and the amount of the reduction are not documented, the same limitations apply as for 6.3.

7 Shape of assumed functional deterioration curve

7.1 Ideal situation

The ideal situation is that of a functional deterioration curve for the workpiece where the functional level is 100 % within the specification limits and 0 % outside the specification limits.

7.2 Gradual deterioration

The functional level of the workpiece diminishes gradually as the functional limits are exceeded. This is probably true for most functions with the exception of fit.

The deterioration in functional level may be so gradual that the change in functional level within the range of the measurement uncertainty is negligible.

8 Determining specification limits

8.1 Ideal situation

It is recognized, as discussed in Clause 4, that one workpiece or metrological characteristic may influence several product attributes. Ideally, specification limits are determined by decisions made for the issues covered in Clauses 5, 6 and 7 with regard to the functional level of all product attributes. These decisions may or may not be conscious, based on a defined policy or technically meaningful.

8.2 Batch parts made by desired process

This is referred to as Production Part Approval Process (PPAP) which consists of a set of advanced product quality planning tools used by major industry customers to approve a supplier's processes for production parts. In essence, the PPAP supplier manufactures a set of workpieces based on a preliminary specification. These workpiece are subsequently measured and tested. If the workpieces are within the specification and all the workpieces function, the manufacturing process and process parameters are locked down and future production from that supplier shall not only meet the specification, it shall also be produced using the approved manufacturing process and parameters.

In essence, PPAP turns the specification into a black box that is disconnected from the functional limits for the workpiece, i.e. we do not know why it works, but it does, and we do not know how far we are from the functional limits, but this is not important.

PPAP may lead to severe and unnecessary limitations on manufacturing and thus to unnecessarily expensive workpieces.

The advantage of PPAP is that it can be applied without access to engineering resources knowledgeable about the functional requirements of the workpieces.

9 Alternative basis for decision rules

9.1 General

ISO 14253-1 deals with the concept that uncertainty shall be considered in product acceptance and rejection decisions and that strict decision rules need to be applied. The standard specifies that the supplier of a product is to use stringent acceptance in order to sell the product. The customer of the product, using his or her own measurement uncertainty, similarly uses a 100 % guard band in stringent rejection. The default rule uses a strict interpretation of uncertainty.

No information is supplied regarding the decision outcome if the supplier's or the customer's measurement result lies in their zones of ambiguity (uncertainty range).

The absence of a decision outcome for measurement results that lie in the uncertainty range is particularly troublesome for customers who become resellers of the product.

Contractual specification limits can be documented either in the contract, or by producing a contract drawing that is different from the functional drawing, or by combining the contractual drawing and the functional drawing by appropriate means.

9.2 Alternative decision rules

An alternative decision rule shall

a) have a well-documented method of determining the location of the conformance, non-conformance, and any uncertainty range,

b) make sure that each zone of a decision rule corresponds to a documented decision that is implemented if the result of measurement lies in that zone; while this is automatic for the conformance and non-conformance zones by definition, any uncertainty range shall have its corresponding decision outcome documented.

If the measuring process is specified and agreed amongst the parties, it shall also

c) state the procedure for addressing repeated measurements of the same characteristic on the same workpiece or instrument,

d) state the procedure for allowing data rejection with cause, that is, rejection of “outliers”.

9.3 Choice of alternative decision rules

The choice of an alternative decision rule is ultimately a business decision. It includes such factors as:

a) the cost of rejecting an in-specification product;

b) the cost of accepting an out-of-specification product;

c) the uncertainty associated with the measurement process;

d) the distribution of the product's characteristic under consideration;

e) the cost of making measurements.

It shall be recognized that the Expected Cost of an Error (ECE) is equal to the probability of making the error times the cost of making the error.

Once an alternative decision rule is formulated, the responsibility for its application shall be unambiguously defined, in particular which party (customer or supplier) shall apply a particular rule.

Disregarding measurement uncertainty in decisions is never recommended. However, in some cases it may be necessary to consider measurement uncertainty differently when formulating alternative decision rules. Future parts of the ISO 14253 series are planned to deal with such cases.

Annex A
(informative)

Relation to the GPS matrix model

A.1 General

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

A.2 Information about this part of ISO 14253 and its use

This part of ISO 14253 outlines the main assumptions behind the theoretically ideal decision rules established in ISO 14253-1. It discusses why these rules have to be the default rules and what considerations should be taken into account before applying different decision rules.

A.3 Position in the GPS matrix model

This part of ISO 14253 is a global geometrical product specifications (GPS) standard (see ISO/TR 14638). It influences the chain links 3, 4, 5 and 6 of all chains of general GPS standards, as graphically illustrated in Figure A.1.

Fundamental GPS standards

Global GPS standards

General GPS standards						
Chain link number	**1**	**2**	**3**	**4**	**5**	**6**
Size			X	X	X	X
Distance			X	X	X	X
Radius			X	X	X	X
Angle			X	X	X	X
Form of line independent of datum			X	X	X	X
Form of line dependent on datum			X	X	X	X
Form of surface independent of datum			X	X	X	X
Form of surface dependent on datum			X	X	X	X
Orientation			X	X	X	X
Location			X	X	X	X
Circular run-out			X	X	X	X
Total run-out			X	X	X	X
Datums			X	X	X	X
Roughness profile			X	X	X	X
Waviness profile			X	X	X	X
Primary profile			X	X	X	X
Surface imperfections			X	X	X	X
Edges			X	X	X	X

Figure A.1 — Position in the GPS matrix model

A.4 Related standards

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

Bibliography

[1] ISO/TR 14638, *Geometrical product specifications (GPS) — Masterplan*

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

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