SLOVENSKI STANDARD
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Postopki vzorčenja za kontrolo po številskih spremenljivkah - 1. del: Specifikacija enojnih vzorčnih načrtov, razvrščenih po prevzemni meji kakovosti (AQL), za kontrolo zaporednih partij za posamezno karakteristiko kakovosti in posamezno AQL

Sampling procedures for inspection by variables - Part 1: Specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection for a single quality characteristic and a single AQL

Règles d'échantillonnage pour les contrôles par mesures - Partie 1: Spécification pour les plans d'échantillonnage simples indexés par un niveau de qualité acceptable (NQA) pour un contrôle lot par lot pour une caractéristique de qualité unique et un NQA unique

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INTERNATIONAL STANDARD

ISO 3951-1

Second edition
2013-09-01

Sampling procedures for inspection by variables —

Part 1: Specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection for a single quality characteristic and a single AQL

Règles d'échantillonnage pour les contrôles par mesures —
Partie 1: Spécification pour les plans d'échantillonnage simples indexés par un niveau de qualité acceptable (NQA) pour un contrôle lot par lot pour une caractéristique de qualité unique et un NQA unique

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 69, *Application of statistical methods,* SC 5, *Acceptance sampling.*

This second edition cancels and replaces the first edition (ISO 3951-1:2006), of which it constitutes a minor revision with the following changes:

— procedures have been introduced to accommodate measurement uncertainty;

— many of the sampling plans have been adjusted to improve the match between their operating characteristic curves and the operating characteristic curves of the corresponding plans for single sampling by attributes in ISO 2859-1.

ISO 3951 consists of the following parts, under the general title *Sampling procedures for inspection by variables*:

— *Part 1: Specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection for a single quality characteristic and a single AQL*

— *Part 2: General specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection of independent quality characteristics*

— *Part 3: Double sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

— *Part 4: Procedures for assessment of declared quality levels*

— *Part 5: Sequential sampling plans indexed by acceptance quality limit (AQL) for inspection by variables (known standard deviation)*

Introduction

This part of ISO 3951 specifies an acceptance sampling system of single sampling plans for inspection by variables. It is indexed in terms of the acceptance quality limit (AQL) and is designed for users who have simple requirements. (A more comprehensive and technical treatment is given in ISO 3951-2.) This part of ISO 3951 is complementary to ISO 2859-1.

The objectives of the methods laid down in this part of ISO 3951 are to ensure that lots of acceptable quality have a high probability of acceptance and that the probability of not accepting inferior lots is as high as practicable. This is achieved by means of the switching rules, which provide the following:

a) an automatic protection to the consumer (by means of a switch to tightened inspection or discontinuation of sampling inspection) should a deterioration in quality be detected;

b) an incentive (at the discretion of the responsible authority) to reduce inspection costs (by means of a switch to a smaller sample size) should consistently good quality be achieved.

In this part of ISO 3951, the acceptability of a lot is implicitly determined from an estimate of the percentage of nonconforming items in the process, based on a random sample of items from the lot.

This part of ISO 3951 is intended for application to a continuing series of lots of discrete products all supplied by one producer using one production process. If there are different producers or production processes, this part of ISO 3951 is applied to each one separately.

This part of ISO 3951 is intended for application to a single quality characteristic that is measurable on a continuous scale. For two or more such quality characteristics, see ISO 3951-2.

It is assumed in the body of this part of ISO 3951 that measurement error is negligible (see ISO 10576-1:2003). For information on allowing for measurement error, see Annex O, which was derived from Reference [20] in the Bibliography.

For double specification limits, this part of ISO 3951 treats combined control. For other types of control, refer to ISO 3951-2.

CAUTION — The procedures in this part of ISO 3951 **are not suitable for application to lots that have been screened for nonconforming items.**

Inspection by variables for percent nonconforming items, as described in this part of ISO 3951, includes several possible modes, the combination of which leads to a presentation that may appear quite complex to the user:

— unknown standard deviation, or originally unknown then estimated with fair precision, or known since the start of inspection;

— a single specification limit, or combined control of double specification limits;

— normal inspection, tightened inspection, or reduced inspection.

Table 1 is intended to facilitate the use this part of ISO 3951 by directing the user to the paragraphs and tables concerning any situation with which he may be confronted. The table only deals with Clauses 15, 16, 20, 21, and 22; in every case, it is necessary, first of all, to have read the other clauses.

Table 1 — Summary table

Inspection	Single specification limit						Double specification limits with combined control					
	s–method			*σ*–method			*s*–method			*σ*–method		
	Clauses or sub-clauses	Tables/ Annexes	Charts	Clauses or sub-clauses	Tables/ Annexes	Charts	Clauses or sub-clauses	Tables/ Annexes	Charts	Clauses or sub-clauses	Tables/ Annexes	Charts
Normal inspection	16.1, 16.2, 16.3, 21.1	A.1, B.1, B to R	B to R	17.1, 17.2, 21.1	A.1, C.1, B to R[a]	B to R[a]	16.1, 16.4, 21.1	A.1, D.1, E.1 (for $n = 3$), G.1 (for $n = 3$ or 4), B to R[a]	*s*-D to *s*-R, B to R[a]	17.1, 17.3 and 21.1	A.1, C.1, E.1, B to R[a]	B to R[a]
Switching between normal and tightened inspection	21.2, 21.3	B.1, B.2	B to R	21.2, 21.3	C.1, C.2	B to R[a]	21.2, 21.3	D.1, D.2	*s*-D to *s*-R, B to R[a]	21.2, 21.3	C.1, C.2, E.1	B to R[a]
Switching between normal and reduced inspection	21.4, 21.5	B.1, B.3	B to R	21.4, 21.5	C.1, C.3, I	B to R[a]	21.4, 21.5	D.1, D.3, G.1 (for $n = 3$ or 4)	*s*-D to *s*-R, B to R[a]	21.4, 21.5	C.1, C.3, E.1	B to R[a]
Switching between tightened and dis- contin- ued inspec- tion	22	B.2	B to R	22	C.2	B to R[a]	22	D.2	*s*-D to *s*-R, B to R[a]	22	E.1	B to R[a]
Switching between the *s*-method and *σ*-method	23	Annex J		23	Annex J		23	Annex J		23	Annex E, Annex J	

[a] But see 8.4.

Fifteen annexes are provided. Annexes A to I provide the tables needed to support the procedures. Annex J indicates how the sample standard deviation, *s*, and the presumed known value of the process standard deviation, *σ*, should be determined. Annex K provides the statistical theory underlying the calculation of the consumer's risk qualities, together with tables showing these quality levels for normal, tightened, and reduced inspection as well as for the *s*–method and *σ*–method. Annex L provides similar information for the producer's risks. Annex M gives the general formula for the operating characteristic of the *σ*–method. Annex N provides the statistical theory underlying the estimation of the process fraction nonconforming under the *s*–method for sample sizes 3 and 4, which, for technical reasons, are treated differently from the other sample sizes in this part of ISO 3951. Annex O provides procedures for accommodating measurement uncertainty.

Sampling procedures for inspection by variables —

Part 1: Specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection for a single quality characteristic and a single AQL

1 Scope

This part of ISO 3951 is primarily designed for use under the following conditions:

a) where the inspection procedure is to be applied to a continuing series of lots of discrete products all supplied by one producer using one production process;

b) where only a single quality characteristic, x, of these products is taken into consideration, which must be measurable on a continuous scale;

c) where production is stable (under statistical control) and the quality characteristic, x, is distributed according to a normal distribution or a close approximation to the normal distribution;

d) where a contract or standard defines a lower specification limit, L, an upper specification limit, U, or both; an item is qualified as conforming if and only if its measured quality characteristic, x, satisfies the appropriate one of the following inequalities:

   1) $x \geq L$ (i.e. the lower specification limit is not violated);

   2) $x \leq U$ (i.e. the upper specification limit is not violated);

   3) $x \geq L$ and $x \leq U$ (i.e. neither the lower nor the upper specification limit is violated).

Inequalities 1) and 2) are called cases with a single specification limit and 3), a case with double specification limits.

Where double specification limits apply, it is assumed in this part of ISO 3951 that conformance to both specification limits is equally important to the integrity of the product. In such cases, it is appropriate to apply a single AQL to the combined percentage of a product outside the two specification limits. This is referred to as combined control.

2 Normative references

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

ISO 2859-1, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 2859-2, *Sampling procedures for inspection by attributes — Part 2: Sampling plans indexed by limiting quality (LQ) for isolated lot inspection*

ISO 3534-1, *Statistics — Vocabulary and symbols — Part 1: General statistical terms and terms used in probability*

ISO 3534-2, *Statistics — Vocabulary and symbols — Part 2: Applied statistics*

ISO 3951-2, *Sampling procedures for inspection by variables — Part 2: General specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection of independent quality characteristics*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2859-1, ISO 3534-1, and ISO 3534-2 and the following apply.

3.1
inspection by variables
inspection by measuring the magnitude of a characteristic of an item

[SOURCE: ISO 3534-2]

3.2
sampling inspection
inspection of selected items in the group under consideration

[SOURCE: ISO 3534-2]

3.3
acceptance sampling inspection
acceptance sampling
sampling inspection (3.2) to determine whether or not to accept a lot or other amount of product, material, or service

[SOURCE: ISO 3534-2]

3.4
acceptance sampling inspection by variables
acceptance sampling inspection (3.3) in which the acceptability of the process is determined statistically from measurements on specified quality characteristics of each item in a sample from a lot

3.5
process fraction nonconforming
rate at which nonconforming items are generated by a process

Note 1 to entry: It is expressed as a proportion.

3.6
acceptance quality limit
AQL
worst tolerable *process fraction nonconforming* (3.5) when a continuing series of lots is submitted for *acceptance sampling* (3.3)

Note 1 to entry: See Clause 5.

3.7
quality level
quality expressed as a rate of occurrence of nonconforming units

3.8
limiting quality
LQ
quality level (3.7), when a lot is considered in isolation, which, for the purposes of *acceptance sampling inspection* (3.3), is limited to a low probability of acceptance

[SOURCE: ISO 3534-2]

Note 1 to entry: See 14.1.

Note 2 to entry: In this part of ISO 3951: 10 %.

3.9
nonconformity
non-fulfilment of a requirement

3.10
nonconforming unit
unit with one or more nonconformities

[SOURCE: ISO 3534-2]

3.11
***s*–method acceptance sampling plan**
acceptance sampling (3.3) plan by variables using the sample standard deviation

[SOURCE: ISO 3534-2]

Note 1 to entry: See Clause 16.

3.12
***σ*–method acceptance sampling plan**
acceptance sampling (3.3) plan by variables using the presumed value of the process standard deviation

[SOURCE: ISO 3534-2]

Note 1 to entry: See Clause 17.

3.13
specification limit
conformance boundary specified for a characteristic

[SOURCE: ISO 3534-2]

3.14
lower specification limit
L
specification limit (3.13) that defines the lower conformance boundary

[SOURCE: ISO 3534-2]

3.15
upper specification limit
U
specification limit (3.13) that defines the upper conformance boundary

[SOURCE: ISO 3534-2]

3.16
combined control
requirement when both upper and lower limits are specified for the quality characteristic and an *AQL* (3.6) that applies to the combined percent nonconforming beyond the two limits is given

Note 1 to entry: See 5.3.

Note 2 to entry: The use of combined control implies that nonconformity beyond either *specification limit* (3.13) is believed to be of equal, or at least roughly equal, importance to the lack of integrity of the product.

3.17
acceptability constant
k
constant depending on the specified value of the *acceptance quality limit* (3.6) and the sample size, used in the criteria for accepting the lot in an *acceptance sampling* (3.3) plan by variables

[SOURCE: ISO 3534-2]

Note 1 to entry: See 16.2 and 17.2.

3.18
quality statistic
Q
function of the *specification limit* (3.13), the sample mean, and the sample or process standard deviation used in assessing the acceptability of a lot

[SOURCE: ISO 3534-2]

Note 1 to entry: For the case of a single *specification limit* (3.13), the lot may be sentenced on the result of comparing *Q* with the *acceptability constant* (3.17)*k*.

Note 2 to entry: See 16.2 and 17.2.

3.19
lower quality statistic
Q_L
function of the *lower specification limit* (3.14), the sample mean, and the sample or process standard deviation

Note 1 to entry: For a single *lower specification limit* (3.14), the lot is sentenced on the result of comparing Q_L with the *acceptability constant* (3.17)*k*.

[SOURCE: ISO 3534-2]

Note 2 to entry: See Clause 4, 16.2, and 17.2.

3.20
upper quality statistic
Q_U
function of the *upper specification limit* (3.15), the sample mean, and the sample or process standard deviation

Note 1 to entry: For a single *upper specification limit* (3.15), the lot is sentenced on the result of comparing Q_U with the *acceptability constant* (3.17)*k*.

[SOURCE: ISO 3534-2]

Note 2 to entry: See Clause 4, 16.2, and 17.2.

3.21
maximum sample standard deviation
MSSD
s_{max}
largest sample standard deviation for a given sample size code letter, inspection severity, and *acceptance quality limit* (3.6) for which it is possible to satisfy the acceptance criteria for the combined control of double *specification limits* (3.13) when the process variability is unknown

Note 1 to entry: See 16.4.

3.22
maximum process standard deviation
MPSD
σ_{max}
largest process standard deviation for a given sample size code letter and *acceptance quality limit* (3.6) for which it is possible to satisfy the acceptance criterion for double specification limits with a combined *AQL* (3.6) requirement under tightened inspection with known process variability

[SOURCE: ISO 3534-2]

Note 1 to entry: See 17.3.

3.23
switching rule
instruction within an *acceptance sampling* (3.3) scheme for changing from one *acceptance sampling* (3.3) plan to another of greater or lesser severity based on demonstrated quality history

[SOURCE: ISO 3534-2]

Note 1 to entry: Normal, tightened, or reduced inspection or discontinuation of inspection are examples of 'severity'.

Note 2 to entry: See Clause 21.

3.24
measurement
set of operations to determine the value of some quantity

[SOURCE: ISO 3534-2]

4 Symbols

The symbols used are as follows:

c_U factor for determining the upper control limit for the sample standard deviation (See Annex H.)

f_s factor that relates the maximum sample standard deviation to the difference between U and L (See Annex D)

f_σ factor that relates the maximum process standard deviation under tightened inspection to the difference between U and L (See Annex E)

k Form k acceptability constant for use with a single quality characteristic and a single specification limit (See Annex B for the s–method or Annex C for the σ–method)

L lower specification limit (As a subscript to a variable, it denotes its value at L.)

m process mean

N lot size (number of items in a lot)

n sample size (number of items in a sample)

$\hat{p}$ estimate of the process fraction nonconforming

$\hat{p}_L$ estimate of the process fraction nonconforming below the lower specification limit

$\hat{p}_U$ estimate of the process fraction nonconforming above the upper specification limit