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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

Règles d'échantillonnage pour les contrôles par mesures —

Partie 2: Spécification générale pour les plans d'échantillonnage simples indexés d'après une limite de qualité acceptable (LQA) pour le contrôle lot par lot de caractéristiques-qualité indépendantes

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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. www.iso.org/directives

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

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

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: http://www.iso.org/iso/home/standards_development/resources-for-technical-work/foreword.htm

This second edition cancels and replaces the first edition (ISO 3951-2:2006), 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)*

This corrected version of ISO 3951-2:2013 incorporates the following corrections:

— Clause 1, letter f), points 2) and 3): "$x \geq U$" has been replaced with "$x \leq U$";

— Clause 4, process mean (6th line): "process mean" has been replaced with "unknown process mean";

— Clause 11, Note 1: reference to “ISO 16269-4” has been replaced with a reference to “ISO 5479”;

— Clause 11, Note 2: reference to “Clause 2 of ISO 5725-2” has been replaced with a reference to “ISO 2854”;

— 16.3.2.5, under “Information needed”, last line: “(from Table G.1 as it is normal inspection)” has been replaced with “(from Table D.1, with 2,5 % AQL)”, and the value “0,115 4” has been replaced with “0,064 66”;

— 16.3.2.5, last line before the Note: “which is less than the acceptability constant p^*. The lot is therefore accepted.” has been replaced with “which is greater than the acceptability constant p^*. The lot is therefore not accepted.”;

— 18.2, second paragraph: “$\bar{x}_U$ $[=U-ks]$” has been replaced with “$\bar{x}_U$ $[=U-k\sigma]$”;

— 18.2, Example, second paragraph, fourth line: “, it is seen that for an AQL of 1,0 %,” has been replaced with “, it is seen that for an AQL of 0,65 %,”;

— 18.3, Example: the sample size has been corrected to be “19” instead of “20” (several occurrences) and the value 488 Ω for the resistance has been deleted; under “Further information needed” and “Alternative further information needed”, the values have been corrected accordingly;

— 20.2, paragraph below Table 4: reference to “Table G.1” has been replaced with a reference to “Table E.1”;

— O.2: the acceptability constant k has been corrected from “1,962” to “1,963” and the example has been recalculated;

— P.4, last line before Figure P.1: “As $\bar{x} = 12{,}990 > 12{,}975$,” has been replaced with “As $\bar{x} = 12{,}980 > 12{,}975$,”;

— Bibliography: ISO 2854 and ISO 5479 have been added.

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 of a technical nature, aimed at users who are already familiar with sampling by variables or who have complicated requirements. (A more introductory treatment is given in ISO 3951-1.)

The objectives of the methods laid down in this part of ISO 3951 are to ensure that lots of an 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) 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 either implicitly or explicitly 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 complementary to ISO 2859-1. When specified by the responsible authority, both this part of ISO 3951 and ISO 2859-1 may be referenced in a product specification, contract, inspection instructions, or other documents, and the provisions set forth therein govern. The responsible authority shall be designated in one of the above documents.

Caution — The procedures in this part of ISO 3951 are not suitable for application to lots that have been screened previously 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 double specification limits with combined, separate, or complex control;

— univariate or multivariate cases;

— three inspection severities, namely normal inspection, tightened inspection, or reduced inspection.

Table 1 is intended to facilitate the use of this part of ISO 3951 by directing the user to the paragraphs and tables concerning any situation with which he may be confronted. Table 1 only deals with Clauses 15, 16, 17, 18, 19, 23, 24, and 25; in every case, it is necessary first of all to have read all the preceding clauses.

Table 1 — Summary table

	Single specification limit				Double specification limits with combined control			
	s-method		σ-method		*s*-method		σ-method	
	Clauses or sub-clauses	Tables/ Annexes	Clauses or sub-clauses	Tables/ Annexes	Clauses or sub-clauses	Tables	Clauses or sub-clauses	Tables/ Annexes
Normal inspection	16.1, 16.2, 16.3, 17.1, 17.2, 20 24.1	A.1, B.1	18.1, 18.2, 19, 20, 24.1	A.1, G.3	16.1, 16.3, 17.1,17.2, 20, 24.1 Annex L	A.1, D.1, Annex F (for $n = 3$), G.1	18.1, 18.3, 19, 20, 24.1	A.1, C.1, E.1
Switching between normal and tightened inspection	24.2, 24.3	B.1, B.2	24.2, 24.3	C.1, C.2	24.2, 24.3	D.1, D.2 F.1, F.2	24.2, 24.3	E.1 G.1, G.2
Switching between normal and reduced inspection	24.4, 24.5	B.1, B.3 J.1	24.4, 24.5	C.1, J.1	24.4, 24.5	D.1, D.3 F.1, F.3 J.1	24.4, 24.5	E.1 G.1, G.3 J.1
Switching between tightened and discontinued inspection	22, 25	B.2	25	C.2	22, 25	D.2 F.2	25	E.1 G.2
Switching between the *s*-method and σ-method	26	I.1	26	K.2, I.1	26 L.2.1 L.3, L.4, L.5	I.1	26 L.2.2	K.2, I.1
Normal inspection	16.1, 17.1, 17.2, 20, 24.1, Annex L	A.1, D.1, Annex F (for $n = 3$), G.1	18.1, 18.2, 18.3, 19, 20, 24.1	Annex A, C.1, E.1	16.1, 16.3.4, 17.1, 17.2, 20, 24.1, Annex L	A.1, D.1, Annex F (for $n = 3$), G.1	18.1, 18.3, 19, 20, 24.1	A.1, C.1, E.1
Switching between normal and tightened inspection	24.2, 24.3	D.1, D.2, F.1, F.2	24.2, 24.3	E.1, E.2, G.2	24.2, 24.3	D.1, D.2, F.1, F.2	24.2, 24.3	E.1, E.2, G.3

	Single specification limit				Double specification limits with combined control			
	s-method		*σ*-method		*s*-method		*σ*-method	
	Clauses or sub-clauses	Tables/ Annexes	Clauses or sub-clauses	Tables/ Annexes	Clauses or sub-clauses	Tables	Clauses or sub-clauses	Tables/ Annexes
Switching between normal and reduced inspection	24.4, 24.5	D.1, D.3 F.1, F.3 J.1	24.4, 24.5	E.1, E.3, G.2, J.1	24.4, 24.5	D.1, D.3 F.1, F.3 J.1	24.4, 24.5	E.1, E.3, G.3, J.1
Switching between tightened and discontinued inspection	22, 25	D.2 F.2	25	E.2 G.2	22, 25	D.2 F.2	25	E.2 G.3
Switching between the *s*-method and *σ*-method	26 L.2.1 L.3, L.4, L.5	I.1	26 L.2.2	I.1, K.2	26 L.2.1 L.3, L.4, L.5	I.1	26 L.2.2	I.1, K.2

16 annexes are provided. Annexes A to J provide the tables needed to support the procedures. Annex K indicates how the sample standard deviation, *s*, and the presumed known value of the process standard deviation, *σ*, should be determined. Annex L provides formulae for the estimation of the process fraction nonconforming, together with a highly accurate approximation for use when the process standard deviation is unknown. Annex M provides formulae for the consumer's risk qualities, together with tables showing these quality levels for normal, tightened, and reduced inspection under the *s*-method and *σ*-method. Annex N provides similar information for the producer's risks. Annex O gives the general formula for the operating characteristic of the *σ*-method. Annex P provides procedures for accommodating measurement uncertainty.

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

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. If there are different producers or production processes, this part of ISO 3951 shall be applied to each one separately;

b) where the **quality characteristics** of the items of product are **measurable on a continuous scale**;

c) where the measurement error is negligible (i.e. with a standard deviation no more than 10 % of the corresponding process standard deviation). However, procedures are also provided in Clause 9 and Annex P for accommodating measurement error when it has a non-negligible standard deviation;

d) where production is stable (under statistical control) and the quality characteristics are distributed, at least to a close approximation, according to **normal distributions**;

e) where, in the case of multiple quality characteristics, the characteristics are independent, or almost independent, of one another;

f) where a contract or standard defines **a lower specification limit**, L, **an upper specification limit**, U, **or both** on each of the quality characteristics. If there is only one quality characteristic, an item is qualified as conforming 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).

   If there are two or more, say m, quality characteristics, then, designating the lower and upper limits for the i^{th} quality characteristic by L_i and U_i respectively, an item of product is qualified as nonconforming if one or more of its m measured quality characteristics, x_i, fails to satisfy the appropriate one of the following inequalities:

   4) $x_i \geq L_i$;

   5) $x_i \leq U_i$;

   6) $x_i \geq L_i$ and $x_i \leq U_i$.

Inequalities 1), 2), 4), and 5) are called cases with a **single specification limit** while 3) and 6) are called cases with **double specification limits**. For double specification limits, a further distinction is made between combined control, separate control, and complex control. If there is only one quality characteristic, then

— combined control is where a single AQL applies to nonconformity beyond both limits,

— separate control is where separate AQLs apply to nonconformity beyond each of the limits, and

— complex control is where one AQL applies to nonconformity beyond the limit that is of greater seriousness and a larger AQL applies to the total nonconformity beyond both limits.

If there are two or more quality characteristics, this generalizes as follows:

— combined control is where nonconformity beyond both limits on a variable belongs to the same class, to which a single AQL applies;

— separate control is where nonconformity beyond the two limits on a variable belongs to separate classes, to each of which a single AQL applies;

— complex control is where nonconformity beyond the limit that is of greater seriousness belongs to one class to which a single AQL applies, and the total nonconformity beyond both limits belongs to another class to which a larger AQL applies.

Note that, in the case of two or more quality characteristics, nonconformity on more than one quality characteristic may belong to the same class.

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 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 3951-1:2005, *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*

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 items

3.8
consumer's risk quality
CRQ
quality level (3.7) of a process which, in the acceptance sampling plan, corresponds to a specified consumer's risk

Note 1 to entry: In this part of ISO 3951, the *quality level* (3.7) is the process fraction nonconforming.

Note 2 to entry: In this part of ISO 3951, the consumer's risk quality corresponds to a consumer's risk of 10 %.

3.9
producer's risk
PR
probability of non-acceptance when the quality level has a value stated by the plan as acceptable

Note 1 to entry: Quality level relates to the *process fraction nonconforming* (3.5) and acceptable relates to the *acceptance quality limit* (3.6).

3.10
nonconformity
non-fulfilment of a requirement

Note 1 to entry: Nonconformity will generally be classified by its degree of seriousness such as the following:

Class A. Nonconformity of a type considered to be of the highest concern for the product or service. Such types of nonconformity will typically be assigned very small AQL values;

Class B. Nonconformity of a type considered to have the next lower degree of concern; this is typically assigned a larger AQL value than that in class A and smaller than that in class C if a third class exists and so on.

The number of classes and the assignment into a class should be appropriate to the quality requirements of the specific situation.

3.11
nonconforming unit
unit with one or more nonconformities

[SOURCE: ISO 3534-2]

3.12
***s*-method acceptance sampling plan**
acceptance sampling (3.3) plan by variables using the sample standard deviation(s)

[SOURCE: ISO 3534-2]

Note 1 to entry: See Clause 15.

3.13
***σ*-method acceptance sampling plan**
acceptance sampling (3.3) plan by variables using the presumed value(s) of the process standard deviation(s)

[SOURCE: ISO 3534-2]

Note 1 to entry: See Clause 16.

3.14
specification limit
conformance boundary specified for a characteristic

[SOURCE: ISO 3534-2]

3.15
lower specification limit
L
specification limit (3.14) that defines the lower conformance boundary

[SOURCE: ISO 3534-2]

3.16
upper specification limit
U
specification limit (3.14) that defines the upper conformance boundary

[SOURCE: ISO 3534-2]

3.17
combined control
requirement when nonconformance beyond both the *lower specification limit* (3.15) and the *upper specification limit* (3.16) of a quality characteristic belongs to the same class, to which a single *AQL* (3.6) applies

Note 1 to entry: See 5.3, 16.3.2, 18.3.

Note 2 to entry: The use of a combined *acceptance quality limit* (3.6) requirement implies that nonconformance beyond either *specification limit* (3.14) is believed to be of equal, or at least roughly equal, importance to the lack of integrity of the product.

3.18
separate control
requirement when nonconformance beyond the *lower specification limit* (3.15) and the *upper specification limit* (3.16) of a quality characteristic belong to different classes, to which separate *acceptance quality limits* (3.6) are applied

Note 1 to entry: See 5.3, 16.3.3, 17.2.

