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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: Spécifications pour les plans d'échantillonnage simples indexés d'après le niveau de qualité acceptable (NQA) pour le 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.

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.

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 3951-1 was prepared by Technical Committee ISO/TC 69, *Applications of statistical methods*, Subcommittee SC 5, *Acceptance sampling*.

This first edition of ISO 3951-1 cancels and replaces ISO 3951:1989, of which it constitutes a technical revision. The most significant differences between ISO 3951-1:2003 and ISO 3951:1989 are as follows.

— The acronym AQL now stands for Acceptance Quality Limit rather than Acceptable Quality Level, in order to reflect more accurately its function.

— The coverage of this part of ISO 3951 is constrained to a single, normally distributed variable with a single class of nonconformity. This part of ISO 3951 includes the case of combined control of double specification limits, but procedures for separate or complex control of double specification limits are deferred to ISO 3951-2. More general procedures that can be used for multiple characteristics and/or multiple AQLs are also given in ISO 3951-2.

— The plans have been modified so that their operating characteristic curves more closely match those of the plans in ISO 2859-1. The sample sizes for both the "s" method and the "σ" method are constant along rows of the master tables.

— All acceptability constants (see Annexes B, C, G and I) have been revised and tabulated to three decimal places for an extended range of AQLs corresponding to ISO 2859-1:1999.

— All tabulated values of operating characteristics have been recalculated and related directly to reduced inspection as well as to normal and tightened inspection.

— The annex containing the general statistical theory has been removed. It is planned ultimately to reintroduce this within a guidance document to sampling procedures for inspection by variables.

— Tables that are required for implementing the procedures have been relocated into annexes.

— The annex dealing with the "R" method has been eliminated, now that the availability of calculators with a standard deviation function key is so widespread. Data for acceptance sampling by variables is often substantially more expensive to acquire than data for sampling by attributes, and the "s" method makes more efficient use of this data.

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ISO 3951 currently 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*

The following parts are under preparation:

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

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

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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 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:

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) if consistently good quality is 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 this part of ISO 3951 that measurement error is negligible. For information on allowing for measurement error, see Reference [17] in the Bibliography.

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

Inspection by variables for percent nonconforming items, as described in the present document, 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.

Fourteen 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 risks, together with tables showing these risks for normal, tightened and reduced inspection as well as for the "s" and "σ" methods. 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.

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

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Table 1 — Summary table

Inspection type	Single specification limit						Double specification limits with combined control					
	"s" method			"σ" method			"s" method			"σ" method		
	Clauses or subclauses	**Tables**	**Charts**	**Clauses or subclauses**	**Tables**	**Charts**	**Clauses or subclauses**	**Tables**	**Charts**	**Clauses or subclauses**	**Tables**	**Charts**
Normal inspection	15.1, 15.2, 15.3 and 20.1	A.1, A.2, B.1, B to R	B to R	16.1, 16.2 and 20.1	A.1, A.2, C.1, B to R *	B to R *	15.1, 15.4 and 20.1	A.1, A.2, D.1, F (for n = 3), G (for n = 3 or 4), B to R*	*s*-D to *s*-R, B to R *	16.1, 16.3 and 20.1	A.1,A.2, C.1, E, B to R *	B to R *
Switching between normal and tightened inspection	20.2, 20.3	B.1, B.2	B to R	20.2, 20.3	C.1, C.2	B to R *	20.2, 20.3	D.1, D.2	*s*-D to *s*-R, B to R *	20.2, 20.3	C.1, C.2, E	B to R *
Switching between normal and reduced inspection	20.4, 20.5	B.1, B.3	B to R	20.4, 20.5	C.1, C.3	B to R *	20.4, 20.5	D.1, D.3	*s*-D to *s*-R, B to R *	20.4, 20.5	E	B to R *
Switching between tightened and dis-continued inspection	21	B.2	B to R	21	C.2	B to R *	21	D.2	*s*-D to *s*-R, B to R *	21	E	B to R *
Switching between the "s" and "σ" methods	22	Annex K		22	Annex K		22	Annex K		22	Annex K	
* But see 8.4.												

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

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

1 Scope

This part of ISO 3951 specifies an acceptance sampling system of single sampling plans for inspection by variables, in which 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 primarily designed for application 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 the measurement error is negligible, i.e. with a standard deviation no more than 10 % of the process standard deviation;

d) 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;

e) where a contract or standard defines an upper specification limit U, a lower specification limit L, 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) $x \geqslant L$ (i.e. the lower specification limit is not violated);

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

   3) $x \geqslant L$ and $x \leqslant U$ (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.

If 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 product outside the two specification limits. This is referred to as combined control.

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