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Sampling procedures for inspection by variables

Part 4: Procedures for assessment of declared quality levels

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National foreword

This British Standard is the UK implementation of ISO 3951-4:2011.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Sampling procedures for inspection by variables —

Part 4: Procedures for assessment of declared quality levels

Règles d'échantillonnage pour les contrôles par mesures —

Partie 4: Procédures pour l'évaluation des niveaux déclarés de qualité

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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 3951-4 was prepared by Technical Committee ISO/TC 69, *Application of statistical methods*, Subcommittee SC 5, *Acceptance sampling*.

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)*

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Introduction

The procedures in this part of ISO 3951 differ in their scope from the procedures in ISO 3951 Parts 1, 2, 3 and 5. The acceptance sampling procedures that are specified in ISO 3951 Parts 1, 2, 3 and 5 are intended to be used in bilateral agreements between two parties. Those acceptance sampling procedures are intended to be used as simple, pragmatic rules for releasing product after inspection of only a limited sample of a consignment, and therefore the procedures do not make reference (either explicitly or implicitly) to any formally declared quality level.

Under acceptance sampling, there is no sharp borderline between quality levels that should be considered acceptable and qualities that should be rejected by the procedure. For the procedures in ISO 3951 Parts 1, 2, 3 and 5, the two parties agree upon some limiting quality level (AQL) which is the worst tolerable process average when a continuing series of lots is submitted. The switching rules and the sampling schemes in those four standards are designed to encourage the suppliers to have process averages consistently better than the AQL selected. In order to keep sample sizes moderate, the protection against accepting individual lots of inferior quality may be less than that provided by sampling plans targeted for sentencing individual lots.

Procedures in ISO 3951 Parts 1, 2, 3 and 5 are well suited for acceptance sampling purposes, but they should not be used in reviews, audits, etc. to verify a quality that has been declared for some entity. The main reason is that the procedures have been indexed in terms of quality levels that are relevant solely for the pragmatic purposes of acceptance sampling, and the various risks have been balanced accordingly.

The procedures in this part of ISO 3951 have been developed as a response to the growing need for sampling procedures suitable for formal, systematic inspections such as reviews or audits. When performing such a formal inspection, it is necessary for the authority to consider the risk of reaching an incorrect conclusion, and to take this risk into account in planning and executing the review/audit/testing, etc.

This part of ISO 3951 provides guidance and rules to assist the user in taking this risk into account in an informed manner.

The rules in this part of ISO 3951 have been devised such that there is only a small, limited risk of contradicting the declared quality level when in fact the actual level conforms to the declared level.

If it were also desired that there should be a similarly small risk of not contradicting the declared quality level when in fact the actual quality level does not conform to the declared quality level, then it would be necessary to investigate a rather large sample. Therefore, in order to obtain the benefit of a moderate sample size, the procedures in this part of ISO 3951 have been devised in such a way that they allow a somewhat higher risk of failing to contradict the declared quality level when in fact the actual quality level does not conform to the declared quality level.

The wording of the result of the assessment should reflect this unbalance between the risks of reaching incorrect conclusions.

When the sample result contradicts the declared quality level, *there is strong evidence of nonconformance to the declared quality level.*

When the sample result does not contradict the declared quality level, this should be understood as “we have not, in this limited sample, found strong evidence of nonconformance to the declared quality level”.

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Sampling procedures for inspection by variables —

Part 4:
Procedures for assessment of declared quality levels

1 Scope

This part of ISO 3951 establishes sampling plans and procedures by variables that can be used to assess whether the quality level of an entity (lot, process, etc.) conforms to a declared value. The sampling plans have been devised so that their operating characteristic curves match those of the corresponding attributes plans in ISO 2859-4 as closely as possible, so that the choice between using sampling by attributes and sampling by variables is not influenced by attempts to increase the chance of accepting an incorrectly declared quality level. In this part of ISO 3951, there is a risk of between 1,4 % and 8,2 % of contradicting a correct declared quality level. The risk is 10 % of failing to contradict an incorrect declared quality level which is related to the limiting quality ratio (see Clause 4). Sampling plans are provided corresponding to three levels of discriminatory ability, and for the cases of unknown and known process standard deviation.

In contrast to the procedures in the other parts of ISO 3951, the procedures in this part of ISO 3951 are not applicable to acceptance assessment of lots. Generally, the balancing of the risks of reaching incorrect conclusions in assessment procedures will differ from the balancing in the procedures for acceptance sampling.

This part of ISO 3951 may be used for various forms of quality inspection in situations where objective evidence of conformity to some declared quality level is to be provided by means of inspection of a sample. The procedures are applicable to entities such as lots, process output, etc. that allow random samples of individual items to be taken from the entity.

The sampling plans provided in this part of ISO 3951 are applicable, but not limited, to inspection of a variety of products such as

— end items,

— components and raw materials,

— operations,

— materials in process,

— supplies in storage,

— maintenance operations,

— data or records, and

— administrative procedures.

The procedures are intended to be used when the quality characteristics are measurable variables that are independent and normally distributed, and where the quantity of interest is the fraction of items that are nonconforming.

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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 2859-4:2002, *Sampling procedures for inspection by attributes — Part 4: Procedures for assessment of declared quality levels*

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: 2006, *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*

ISO 9000, *Quality management systems — Fundamentals and vocabulary*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this part of ISO 3951, the terms and definitions given in ISO 3534-1, ISO 3534-2, ISO 3951-2 and ISO 9000 and the following apply.

3.1.1
quality ratio
ratio of the actual to the declared quality level of the entity under investigation

3.1.2
limiting quality ratio
LQR
value of the quality ratio that is limited to a small risk (10 % in this part of ISO 3951) of failing to contradict an incorrect declared quality level

3.2 Symbols and abbreviated terms

The symbols and abbreviated terms used in this part of ISO 3951 are as follows:

$B_v(.)$ Distribution function of the symmetric beta distribution with both parameters equal to v

$B(v,v)$ Beta function with both arguments equal to v, i.e. $B(v,v)=\Gamma(v)\Gamma(v)/\Gamma(v)$ where $\Gamma(v)$ is the gamma function (see below)

D Declared quality level (as a symbol)

DQL Declared Quality Level (as an acronym)

k_s Form k acceptability constant under the "s" method, used when the sample standard deviation is unknown

k_σ Form k acceptability constant under the "σ" method, used when the process standard deviation is presumed to be known

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L	Lower specification limit (as a subscript, denotes the value at L)
LQR	Limiting Quality Ratio (as an acronym)
m	Number of quality characteristics, all assumed to be independent and normally distributed
n_s	Sample size under the "s" method
n_σ	Sample size under the "σ" method
OC	Operating Characteristic
p	Process fraction nonconforming in the entity
$\hat{p}$	Estimate of the fraction nonconforming in the entity
$\hat{p}_c$	Estimate of the combined fraction nonconforming at both specification limits, i.e. $\hat{p}_c = \hat{p}_L + \hat{p}_U$
p^*	Form p^* acceptability constant (for both the "s" and "σ" methods)
Q	Quality statistic (see 7.2.2 and 7.3.2)
s	Sample standard deviation
U	Upper specification limit (as a subscript, denotes the value at U)
$\bar{x}$	Sample mean
$\Phi(.)$	Standard normal distribution function
$\Gamma(v)$	Gamma function, defined by $\Gamma(v) = \int_0^\infty t^{v-1}\exp(-t)\mathrm{d}t$ for $v > 0$
σ	Process standard deviation

4 Principles

In any assessment procedure based on sampling, there will be an inherent uncertainty due to possible sampling fluctuations. The procedures in this part of ISO 3951 have been conceived so as to lead to contradiction of the declared quality level only when there is sufficient evidence to support a conclusion that the actual quality is poorer than the declared quality level.

The plans have been devised in such a way that their operating characteristic curves match those of the corresponding attributes plans ISO 2859-4 as closely as possible. Details of the matching method are given in Annex A. The attributes plans of ISO 2859-4 were selected such that when the actual quality level is equal to or better than the declared quality level, the risk is less than 5 % of contradicting the declared value. It follows that when the actual quality level is worse than the declared quality level, there is a risk that the procedures will fail to contradict an incorrect declared quality level. Owing to the fact that the match between corresponding OC curves in ISO 2859-4 and ISO 3951-4 is imperfect, the corresponding risk in this part of ISO 3951 varies around 5 %.

This risk depends on the value of the quality ratio, i.e. the ratio between the actual and the declared quality level. The limiting quality ratio, LQR, is introduced to denote the highest quality ratio considered tolerable. When the actual quality level is LQR times the declared quality level, the procedures in this part of ISO 3951 have a risk of 10 % of failing to contradict the declared quality level (corresponding to a 90 % probability of contradicting the incorrect declared quality level).

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