BRITISH STANDARD

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Sampling procedures for inspection by variables —

Part 4: Sequential sampling plans indexed by acceptance quality limit (AQL) for inspection by variables (known standard deviation)

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ISO 3951-5

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Sampling procedures for inspection by variables —

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

Règles d'échantillonnage pour les contrôles par mesures —

Partie 5: Plans d'échantillonnage séquentiels indexés d'après la limite d'acceptation de qualité (LAQ) pour l'inspection par variables (écart-type connu)

Reference number
ISO 3951-5:2006(E)

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

This edition cancels and replaces Annex A of ISO 8423:1991, which has been technically revised to greatly improve its compatibility with the sampling systems in ISO 3951-1.

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

The following parts are under preparation:

— *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*

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Introduction

In contemporary production processes, quality is often expected to reach such high levels that the number of nonconforming items is reported in parts per million. Under such circumstances, popular acceptance sampling plans by attributes, such as those presented in ISO 2859-1, require prohibitively large sample sizes. When it is possible to apply acceptance sampling plans by variables, such as those presented in ISO 3951-1, the sample sizes are much smaller. However, especially in the case of acceptance of a product of extremely high quality, those sample sizes are still too large. Therefore, there is a need to apply standardized statistical procedures that require the smallest possible sample sizes. Sequential sampling plans are the only statistical procedures that satisfy that need. It has been mathematically proved that among all possible sampling plans having similar statistical properties, the sequential sampling plan has the smallest average sample size. Therefore, there is a strong need to present sequential sampling plans which are statistically equivalent to the commonly used acceptance sampling plans from ISO 3951-1, but which require significantly smaller average sample sizes.

The principal advantage of sequential sampling plans is the reduction in the average sample size. The *average sample number* is the average of all the sample sizes that may occur under a sampling plan for a given lot or process quality level. The use of sequential sampling plans leads to a smaller average sample number than single sampling plans having the equivalent operating characteristic. For the sequential sampling plans in this part of ISO 3951, a curtailment rule has been introduced involving an upper limit of 1,5 n_0 on the actual number of items to be inspected, where n_0 is the sample size of the corresponding single sampling plan.

Other factors that should be taken into account are as follows:

a) Complexity

The rules of a sequential sampling plan are more easily misunderstood by inspectors than the simple rules for a single sampling plan.

b) Variability in the amount of inspection

As the actual number of items inspected for a particular lot is not known in advance, the use of sequential sampling plans brings about various organizational difficulties. For example, scheduling of inspection operations may be difficult.

c) Ease of drawing sample items

If drawing sample items is at different times rather difficult, the reduction in the average sample size by sequential sampling plans may be cancelled out by the increased sampling cost.

d) Duration of test

If the test of a single item is of long duration and a number of items can be tested simultaneously, sequential sampling plans are much more time-consuming than the corresponding single sampling plans.

e) Variability of quality within the lot

If the lot consists of two or more sublots from different sources and if there is likely to be any substantial difference between the qualities of the sublots, drawing of a random sample under a sequential sampling plan is more awkward than under the corresponding single sampling plan.

The balance between the advantage of a smaller average sample number of the sequential sampling plan and the above disadvantages leads to the conclusion that sequential sampling plans are suitable only when inspection of individual items is costly in comparison with inspection overheads.

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The choice between single and sequential sampling plans should be made before the inspection of a lot is started. During inspection of a lot, it is not permitted to switch from one type of plan to another, because the operating characteristics of the plan may be drastically changed if the actual inspection results influence the choice of acceptability criteria.

Although a sequential sampling plan is on average much more economical than the corresponding single sampling plan, it may occur, during inspection of a particular lot, that acceptance and non-acceptance comes at a very late stage because the cumulative leeway (the statistic used for the determination of lot acceptability) remains between the acceptance value and the rejection value for a long time. With the graphical method, this corresponds to the random progress of the step-wise linear curve remaining in the indecision zone.

In order to alleviate this disadvantage, the sample size curtailment value is set before the inspection of a lot is started, and inspection terminates if the cumulative sample size reaches the curtailment value, n_t, without determination of lot acceptability. The acceptance and non-acceptance of the lot is then determined using the curtailment acceptance and rejection values.

For sequential sampling plans in common use, curtailment usually represents a deviation from their intended usage, leading to a distortion of their operating characteristics. In this part of ISO 3951, however, the operating characteristics of the sequential sampling plans have been determined with curtailment taken into account, so curtailment is an integral component of the provided plans.

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Sampling procedures for inspection by variables —

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

1 Scope

This part of ISO 3951 specifies a system of sequential sampling plans (schemes) for lot-by-lot inspection by variables. The schemes are indexed in terms of a preferred series of acceptance quality limit (AQL) values, ranging from 0,01 to 10, which are defined in terms of percent nonconforming items.

The schemes of ISO 3951 are intended to induce a supplier through the economic and psychological pressure of lot non-acceptance to maintain a process average at least as good as the specified AQL value, while at the same time providing an upper limit for the risk to the consumer of accepting the occasional poor lot.

The schemes are designed to be applied to a continuing series of lots, that is, a series long enough to allow the switching rules (Clause 6) to be applied. These switching rules provide:

— 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;

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

This part of ISO 3951 is 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, apply this part of ISO 3951 to each one separately;

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 uncertainty of the measurement system is negligible with respect to the production 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) or a distribution which may be mathematically transformed to a normal distribution;

e) where the standard deviation of the quality characteristic, x, is known;

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

f) 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:

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

2) $x \geqslant L$ (i.e. the single lower specification limit is not violated);

3) $L \leqslant x \leqslant U$ (i.e. the upper and lower double specification limits are not violated).

In this part of ISO 3951, it is assumed that, where double specification limits apply, conformance to both specification limits is either equally important to the integrity of the product or is considered separately for both specification limits. In the first case, it is appropriate to apply a single AQL to the combined percentage of product outside the two specification limits. This is referred to as a combined AQL requirement. In the second case, separate AQLs apply to nonconformity beyond each of the limits, and this is referred to as a separate AQL requirement.

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. As such, it is not applicable for judging the acceptability of isolated lots or short series of lots. Refer to ISO 2859-2 for applicable sampling plans in this case.

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 2859-1:1999, *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 3534-1, ISO 3534-2, ISO 2859-1, and ISO 3951-1 and the following apply.

3.1
inspection by variables
inspection by measuring the magnitude(s) of the characteristic(s) of an item

[ISO 3534-2]

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

[ISO 3534-2]

3.3
acceptance sampling
sampling after which decisions are made to accept or not to accept a lot, or other grouping of product, material or service, based on sample results

[ISO 3534-2]

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

[ISO 3534-2]

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

3.6
acceptance quality limit
AQL
⟨acceptance sampling⟩ worst tolerable quality level

[ISO 3534-2]

NOTE 1 This concept only applies when a sampling scheme with rules for switching and for discontinuation, such as in ISO 2859-1, ISO 3951-1 or this part of ISO 3951 is used.

NOTE 2 Although individual lots with quality as bad as the acceptance quality limit may be accepted with fairly high probability, the designation of an acceptance quality limit does not suggest that this is a desirable quality level. Sampling schemes found in International Standards such as ISO 2859-1, ISO 3951-1 or this part of ISO 3951, with their rules for switching and for discontinuation of sampling inspection, are designed to encourage suppliers to have process averages consistently better than the AQL. Otherwise, there is a high risk that the inspection severity will be switched to tightened inspection under which the criteria for lot acceptance become more demanding. Once on tightened inspection, unless action is taken to improve the process, it is very likely that the rule requiring discontinuation of sampling inspection pending such improvement will be invoked.

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

3.8
nonconformity
non-fulfilment of a requirement

[ISO 3534-2]

3.9
nonconforming unit
unit with one or more nonconformities

[ISO 3534-2]

3.10
"σ" method acceptance sampling plan
sigma method
acceptance sampling plan by variables using the presumed value of the process standard deviation

NOTE Adapted from ISO 3534-2.

3.11
specification limit
limiting value stated for a characteristic

[ISO 3534-2]

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3.12
lower specification limit
L
specification limit (3.11) that defines the lower limiting value

[ISO 3534-2]

3.13
upper specification limit
U
specification limit (3.11) that defines the upper limiting value

[ISO 3534-2]

3.14
combined AQL requirement
requirement when both upper and lower limits are specified for the quality characteristic and an AQL is given which applies to the combined percent nonconforming beyond the two limits

NOTE The use of a combined AQL requirement implies that nonconformities beyond either specification limit are believed to be of equal, or at least roughly equal, importance to the lack of integrity of the product.

3.15
separate AQL requirement
requirement when both upper and lower limits are specified for the quality characteristic and separate AQLs are given which apply to each limit

NOTE The use of separate AQL requirements implies that nonconformities beyond either specification limit are either believed to be of different importance to the lack of integrity of the product or it is desired to control them separately.

3.16
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 the combined control of double specification limits under all inspection severities (i.e. normal, tightened and reduced) when the process variability is known

NOTE 1 The MPSD depends on whether the double specification limits are under combined, separate or complex control, but does not depend on the inspection severity.

NOTE 2 Adapted from ISO 3534-2.

3.17
switching rule
instruction within an acceptance sampling scheme for changing from one acceptance sampling plan to another of greater or lesser severity of sampling based on demonstrated quality history

NOTE Normal, tightened or reduced inspection, or discontinuation of inspection, are examples of “severity of sampling”.

[ISO 3534-2]

3.18
measurement
set of operations having the object of determining a value of a quantity

[ISO 3534-2]

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3.19
leeway
quantity derived from a measured value of an item

NOTE In the case of a single lower specification limit and in the case of double specification limits, the leeway is obtained by subtracting the numerical value of the lower specification limit from the measured value. In the case of an upper specification limit, the leeway is obtained by subtracting the measured value from the numerical value of the upper specification limit.

3.20
cumulative leeway
value calculated by summing the leeways obtained from the start of the inspection up to, and including, that of the item last inspected

3.21
cumulative sample size
total number of inspected items, counting from the start of the inspection up to, and including, the item last inspected

3.22
acceptance value for sequential sampling
value derived from the specified parameters of the sampling plan and the cumulative sample size

NOTE Whether the lot may yet be accepted is determined by comparing the cumulative leeway with the acceptance value.

3.23
rejection value for sequential sampling
value derived from the specified parameters of the sampling plan and the cumulative sample size

NOTE Whether the lot may yet be considered unacceptable is determined by comparing the cumulative leeway with the rejection value.

3.24
responsible authority
concept used to maintain the neutrality of this part of ISO 3951 (primarily for specification purposes), irrespective of whether it is being invoked or applied by the first, second or third party

NOTE The responsible authority may be:

a) the quality department within a supplier's organization (first party);

b) the purchaser or procurement organization (second party);

c) an independent verification or certification authority (third party).

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4 Symbols

The symbols used are as follows:

A acceptance value for sequential sampling

A_t acceptance value corresponding to the curtailed value of the cumulative sample size

f_σ factor given in Tables B.1 and B.2, that relates the maximum process standard deviation to the difference between U and L

g multiplier of the cumulative sample size that is used to determine the acceptance values and the rejection values (slope of the acceptance and rejection lines)

h_A constant that is used to determine the acceptance values (intercept of the acceptance line)

h_R constant that is used to determine the rejection values (intercept of the rejection line)

L lower specification limit (as a suffix or a superscript to a variable, denotes its value at L)

N lot size (number of items in a lot)

n sample size (number of items in a sample)

n_{cum} cumulative sample size

n_0 sample size of the corresponding single sampling plan

n_t curtailment value of the cumulative sample size ($n_t = 1{,}5\ n_0$)

P_a probability of acceptance

R rejection value for sequential sampling

U upper specification limit (as a suffix or a superscript to a variable, denotes its value at U)

x measured value of the quality characteristic for the measured item of the sample

y leeway, defined as

$y = U - x$ for a single upper specification limit

$y = x - L$ for a single lower specification limit

$y = x - L$ for double specification limits

Y cumulative leeway obtained by adding the leeways up to, and including, the item last inspected

μ process mean

σ standard deviation of a process that is under statistical control

σ_{max} maximum process standard deviation

NOTE σ^2, the square of the process standard deviation, is known as the process variance.

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5 Acceptance quality limit (AQL)

5.1 Principle

The AQL is the quality level that is the worst tolerable process average when a continuing series of lots is submitted for acceptance sampling. Although individual lots with quality as bad as the acceptance quality limit may be accepted with fairly high probability, the designation of an acceptance quality limit does not suggest that this is a desirable quality level. The sampling schemes found in this part of ISO 3951, with their rules for switching and for discontinuation of sampling inspection, are designed to encourage suppliers to have process averages consistently better than the AQL. Otherwise, there is a high risk that the inspection severity will be switched to tightened inspection, under which the criteria for lot acceptance become more demanding. Once on tightened inspection, unless action is taken to improve the process, it is very likely that the rule requiring discontinuation of sampling inspection will be invoked pending such improvement.

5.2 Use

The AQL, together with the sample-size code letter, is used to index the sampling plans in this part of ISO 3951.

5.3 Specifying AQLs

The AQL to be used will be designated in the product specification, contract or by the responsible authority. Where both upper and lower specification limits are given, this part of ISO 3951 addresses two cases:

— combined AQL requirement (this is known as “combined control of double specification limits”); and

— separate AQL requirements (this is known as “separate control of double specification limits”).

5.4 Preferred AQLs

The sixteen AQLs given in this part of ISO 3951, ranging in value from 0,01 % to 10 % nonconforming, are described as preferred AQLs. If, for any product or service, an AQL is designated other than a preferred AQL, then this part of ISO 3951 is not applicable.

5.5 Caution

From the above definition of the AQL, it follows that the desired protection can only be assured when a continuing series of lots is provided for inspection.

5.6 Limitation

The designation of an AQL shall not imply that the supplier has the right to supply knowingly any nonconforming product.

6 Switching rules for normal, tightened and reduced inspection

6.1 General

Switching rules discourage the producer from operating at a quality level that is worse than the AQL. This part of ISO 3951 prescribes a switch to tightened inspection when inspection results indicate that the AQL is being exceeded. It further prescribes a discontinuation of sampling inspection altogether if tightened inspection fails to stimulate the producer into rapidly improving his production process.

Tightened inspection and the discontinuation rule are integral, and therefore obligatory, procedures of this part of ISO 3951, if the protection implied by the AQL is to be maintained.

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This part of ISO 3951 also provides the possibility of switching to reduced inspection when inspection results indicate that the quality level is stable and reliable at a level better than the AQL. This practice is, however, optional (at the discretion of the responsible authority).

When it has been necessary to discontinue sampling inspection, inspection shall not be resumed until action has been taken by the producer to improve the quality of the submitted product.

Details of the operation of the switching rules and the discontinuation rule are given in 6.2 and 6.3.

6.2 Standard switching rules

6.2.1 Normal inspection

Normal inspection is used at the start of inspection (unless otherwise designated) and shall continue to be used during the course of inspection until tightened inspection becomes necessary or reduced inspection is allowed.

6.2.2 Tightened inspection instituted

Tightened inspection shall be instituted when two lots on original normal inspection are not accepted within any five or fewer successive lots.

6.2.3 Tightened inspection relaxed

Tightened inspection shall be relaxed when five successive lots on original inspection have been accepted on tightened inspection; then normal inspection shall be reinstated.

6.2.4 Reduced inspection instituted

Reduced inspection may be instituted after ten successive lots have been accepted under normal inspection, provided that

a) the cumulative sample size for each lot does not exceed $0{,}5n_t$;

b) production is in statistical control;

c) reduced inspection is considered desirable by the responsible authority.

6.2.5 Reduced inspection ceased and normal inspection reinstated

Reduced inspection shall cease and normal inspection be reinstated if any of the following occur on original inspection:

a) a lot is not accepted;

b) production becomes irregular or delayed;

c) reduced inspection is no longer considered desirable by the responsible authority.

6.3 Discontinuation and resumption of inspection

If the cumulative number of lots not accepted in a sequence of consecutive lots on original tightened inspection reaches 5, the acceptance procedures of this part of ISO 3951 shall be discontinued.

Inspection under the provisions of this part of ISO 3951 shall not be resumed until action has been taken by the supplier to improve the quality of the submitted product or service. Tightened inspection shall then be used as if 6.2.2 had been invoked.

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7 Planning

The choice of the most suitable variables plan, if one exists, requires experience, judgement and some knowledge both of statistics and the product to be inspected. Clauses 8 and 9 are intended to help those responsible for specifying sampling plans in making this choice. They suggest the considerations that should be borne in mind when deciding whether a variables plan would be suitable, and the choices to be made when selecting an appropriate standard plan.

8 Choice between variables and attributes

The first question to consider is whether it is desirable to inspect by variables rather than by attributes. The following points should be taken into account.

a) In terms of economics, it is necessary to compare the total cost of the relatively simple inspection of a larger number of items by means of an attributes scheme with the generally more elaborate procedure required by a variables scheme, which is usually more time-consuming and costly per item.

b) In terms of the knowledge gained, the advantage lies with inspection by variables, as the information obtained indicates more precisely how good the product is. Earlier warning will therefore be given if the quality is slipping.

c) An attributes scheme can be more readily understood and accepted; for example, it may at first be difficult to accept that, when inspecting by variables, a lot can be rejected on measurements taken of a sample that does not contain any nonconforming items.

d) Inspection by variables is particularly appropriate in conjunction with the use of control charts for variables.

e) Variables sampling has a substantial advantage when the inspection process is expensive, for example in the case of destructive testing.

f) A variables scheme becomes relatively more complicated to operate as the number of measurements to be taken on each item increases.

g) The use of this part of ISO 3951 is only applicable when there is a reason to believe that the distribution of measurements of the quality characteristic is normal. In case of doubt, the responsible authority should be consulted.

NOTE 1 ISO 5479 gives detailed procedures for tests for departure from normality.

NOTE 2 Departure from normality is also dealt with in Clause 2 of ISO 2854:1976, which provides examples of graphical methods which can be used to verify that the distribution of the data is sufficiently normal to justify the use of sampling by variables.

9 Choice of inspection level and AQL

The choice of inspection level and AQL is governed by a number of factors, but is mainly a balance between the total cost of inspection and the consequences of nonconforming items passing into service. For a standard sampling plan, the inspection level in conjunction with the size of the lots and AQL determines the expected size of the sample to be taken, and governs the severity of the inspection. The OC curves of equivalent single sampling plans given in ISO 3951-1 (see Annex M of ISO 3951-1:2005) should be used for the evaluation of involved risks.

The normal practice is to use general inspection level II, unless special circumstances indicate that another level is more appropriate.

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10 Preliminary operations

Before starting inspection by variables:

a) check that production is considered to be continuing and that the distribution of the quality characteristic can be considered to be normal;

NOTE If lots have been screened for nonconforming items prior to acceptance sampling, then the distribution will have been truncated and this part of ISO 3951 will not be applicable.

b) check that the inspection level to be used has been designated. If none has been given, inspection level II shall be used;

c) check, for a quality characteristic with double specification limits, that nonconformities beyond each limit are of equal importance. If this is the case, apply the procedure for the combined control of double specification limits;

d) check that an AQL (or AQLs, in the case of separate control of double specification limits) has been designated, and that the designated value (or each of the designated values) belongs to the set of preferred AQLs for use with this International Standard. If it is not, then the tables are not applicable;

e) determine the value of the standard deviation σ (see ISO 3951-1:2005, Annex J).

11 Sampling plans

11.1 Inspection level

The inspection level designates the relative amount of inspection. Three general inspection levels, I, II and III, are given in Table 3 for general use. Unless otherwise specified, level II shall be used. Level I may be used when less discrimination is needed or level III when greater discrimination is required. Four additional special levels, S-1 to S-4 are also given in Table 3 and may be used where relatively small sample sizes are necessary and larger sampling risks can be tolerated.

The inspection level required for any particular application shall be specified by the responsible authority. This allows the authority to require greater discrimination for some purposes and less for others.

At each inspection level, the switching rules shall operate to require normal, tightened and reduced inspection. The choice of inspection level is quite separate from these three severities of inspection. Thus, the inspection level that has been specified shall be kept unchanged when switching between normal, tightened and reduced inspection.

In the designation of inspection levels S-1 to S-4, care shall be exercised to avoid AQLs inconsistent with these inspection levels. For instance, it will be seen that the code letters under S-3 go no further than H for which the lowest AQL is 1,0 %, so it is of no use specifying S-3 if the AQL is 0,65 % or less.

The amount of information about the quality of a lot gained from examining samples drawn from the lot depends upon the absolute size of the samples, not upon the relative size of the sample to the lot size, provided the sample is small relative to the lot that is examined.

In spite of this, there are three reasons for varying the sample size with the lot size:

a) when the loss due to a wrong decision is high, it is more important to make the correct decision;

b) with a large lot, a sample size can be afforded that would be uneconomic for a small lot;

c) truly random sampling is relatively more difficult if the sample is too small a proportion of the lot.

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11.2 Sample size code letters

Sample sizes are designated by sample size code letters. Table 3 shall be used to find the applicable code letter for the particular lot size and the prescribed inspection level.

NOTE For economy of space in the tables or to avoid unnecessary repetition in the text, the abbreviated term "code letter" is sometimes used.

11.3 Obtaining a sampling plan

The AQL and the sample size code letter shall be used to obtain the sampling plan from Tables A.1, A.2 or A.3. For a specified AQL and a given lot size, the same combination of AQL and sample size code letter shall be used to obtain the sampling plan from the table for normal, tightened and reduced inspection.

When no sampling plan is available for a given combination of AQL and sample size code letter, arrows in the tables direct the user to a different code letter. The sampling plan to be used is given by the new sample size code letter, not by the original letter. If this procedure leads to different curtailment values for different classes of nonconforming items, the sample size code letter corresponding to the largest curtailment value derived may be used for all classes of nonconforming items, when designated or approved by the responsible authority.

For some combinations of AQL and sample size code letter, the entry in the table is a star (*) indicating that the decision cannot be made before the cumulative sample size reaches the sample size of the corresponding single sampling plan. In such a case, the sequential sampling plan does not have any advantage over the single sampling plan, and the user is advised to use the simpler single sampling plan of ISO 3951-1 in place of the more complicated sequential sampling plan.

11.4 Operation of a sequential sampling plan

11.4.1 Specification of the plan

Before operation of a sequential sampling plan, the inspector shall record on the sampling document the specified values of the parameters, h_A, h_R and g, and the curtailment value, n_t.

11.4.2 Drawing a sample item

As a rule, the individual sample items shall be drawn at random from the lot and inspected one by one in the order in which they were drawn. If, for convenience, successive items are drawn, the order in which each sample item is inspected shall be at random.

11.4.3 Leeway and cumulative leeway

Following the inspection of each item, record the inspection result x against the current value, n_{cum}, of the cumulative sample size.

Calculate the leeway, y, for that item as

$y = x - L$ in the case of combined control of double specification limits or a single lower specification limit;

$y = U - x$ in the case of a single upper specification limit.

Record the cumulative leeway, Y, as the sum of the leeways found so far in the sample from the lot.

11.4.4 Choice between numerical and graphical methods

This part of ISO 3951 provides two methods of operating a sequential sampling plan: a numerical method and a graphical method, either of which may be chosen.

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The numerical method uses an acceptability table for operating, and has the advantage of being accurate, thereby avoiding disputes relating to marginal decisions about acceptance or non-acceptance. An acceptability table can also be used as an inspection record sheet, after inscribing the inspection results.

The graphical method uses an acceptability chart for operating, and has the advantage of displaying the increase in the information on the lot quality as additional items are inspected, information being represented by the piecewise linear curve within the indecision zone, until the line reaches, or crosses, one of the boundaries of that zone. On the other hand, the method is less accurate, due to the inaccuracy inherent in plotting points and in drawing lines.

In case of double specification limits, acceptability charts for sequential sampling plans from this part of ISO 3951 may not be easy to use because of their limited readability (see, for example, Figures 2 and 3). Therefore, in such a case it is recommended to use both methods simultaneously.

The numerical method is the standard method so far as acceptance or non-acceptance is concerned. When the numerical method is applied, it is recommended that the calculation and preparation of an acceptability table be done using appropriate software.

11.4.5 Numerical method for a single specification limit

11.4.5.1 Acceptance and rejection values

When the numerical method is used, the following calculations shall be carried out and an acceptability table shall be prepared.

For each value, n_{cum} of the cumulative sample size, that is less than the curtailment value of the sample size, the acceptance value, A, is given by the following equation;

$$A = g\sigma n_{\text{cum}} + h_{\text{A}}\sigma. \tag{1}$$

For each value of n_{cum}, the rejection value, R, is given by the following equation;

$$R = g\sigma n_{\text{cum}} - h_{\text{R}}\sigma. \tag{2}$$

The acceptance value A_{t} corresponding to the curtailment sample size n_{t} is determined as

$$A_{\text{t}} = g\sigma n_{\text{t}}. \tag{3}$$

The values, A and R, given by Equations (1) and (2), shall be recorded with one decimal place more than the inspection results.

11.4.5.2 Determination of acceptability

Inscribe the leeway and the cumulative leeway into the acceptability table prepared in accordance with 11.4.5.1, after the inspection of each item.

Compare the cumulative leeway, Y, with the corresponding acceptance value, A, and rejection value, R.

a) If the cumulative leeway, Y, is greater than or equal to the acceptance value, A, for the cumulative sample size, n_{cum}, the lot shall be considered acceptable and the inspection shall be terminated.

b) If the cumulative leeway, Y, is less than or equal to the rejection value, R, for the cumulative sample size, n_{cum}, the lot shall be considered not acceptable and the inspection shall be terminated.

c) If neither a) nor b) is satisfied, another item shall be sampled and inspected.

When the cumulative sample size reaches the curtailment value, n_{t}, the lot shall be considered acceptable if $Y \geqslant A_{\text{t}}$, otherwise the lot shall be considered not acceptable.

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11.4.6 Graphical method for a single specification limit

11.4.6.1 Acceptance chart

When the graphical method is used, an acceptability chart shall be prepared in accordance with the following procedures. Prepare a graph with the cumulative sample, n_{cum}, as the horizontal axis, and the cumulative leeway, Y, as the vertical axis. Draw two straight lines with the same slope, $g\sigma$, corresponding to the acceptance and rejection values, A and R, given by Equations (1) and (2). The lower line with the intercept of $-h_R$ is designated the *rejection line,* and the upper line with the intercept of h_A is designated the *acceptance line.* Add a vertical line, the *curtailment line,* at $n_{cum} = n_t$.

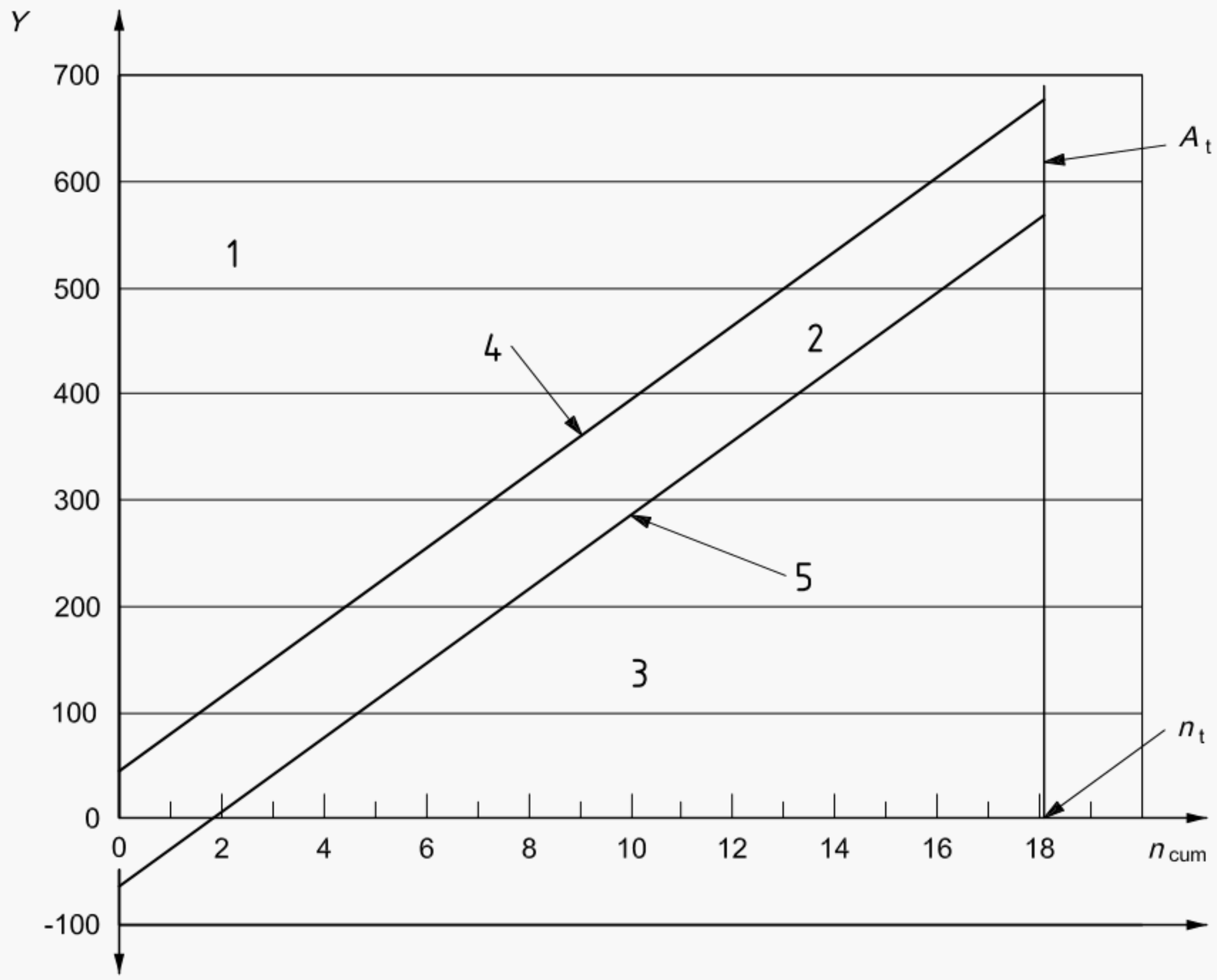
The lines define three zones on the chart.

— The *acceptance zone* is the zone above (and including) the acceptance line together with that part of the curtailment line that is above and includes the point (n_t, A_t).

— The *rejection zone* is the zone below (and including) the rejection line together with that part of the curtailment line that is below the point (n_t, A_t).

— The *indecision zone* is the strip between acceptance and rejection lines that is to the left of the curtailment line.

An example of the prepared graph is given as Figure 1.



Key

1 acceptance zone
2 indecision zone
3 rejection zone
4 acceptance line
5 rejection line

Figure 1 — Acceptability chart for the sequential sampling plan for a single specification limit

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11.4.6.2 Determination of acceptability

When the graphical method is used, the following procedures shall be followed.

Plot the point (n_{cum}, Y) on the acceptability chart prepared in accordance with 11.4.6.1, after the inspection of each item.

a) If the point lies in the acceptance zone, the lot shall be considered acceptable and the inspection shall be terminated.

b) If the point lies in the rejection zone, the lot shall be considered not acceptable and the inspection shall be terminated.

c) If the point lies in the indecision zone, another item shall be sampled and inspected.

The successive points on the acceptability chart shall be connected by a step curve to show up any trend in the inspection results.

CAUTION — If the point is close to the acceptance or rejection lines, the numerical method shall be used to make the decision.

11.4.7 Numerical method for combined control of double specification limits

11.4.7.1 Maximum values of process standard deviation

In the case of the combined control of double specification limits, sequential sampling is only applicable if the process standard deviation σ is sufficiently small in relation to the specification interval ($U - L$). The limiting value of the process standard deviation is given by the MPSD, σ_{max}.

$$\sigma_{\text{max}} = (U - L) f_{\sigma}$$

where f_{σ} depends only on the value of AQL, and can be found in Table B.1.

If, in the case of the combined control of double specification limits, σ exceeds MPSD, the lot shall immediately be judged not acceptable without a sample being drawn.

11.4.7.2 Acceptance and rejection values

When the numerical method is used, the following calculations shall be carried out and an acceptability table shall be prepared.

For each value, n_{cum} of the cumulative sample size, that is less than the curtailment value of the sample size, a pair of acceptance values and a pair of rejection values, are determined.

The upper acceptance value, A_U, is found as

$$A_U = (U - L - g\sigma) n_{\text{cum}} - h_{\text{A}}\sigma \tag{4}$$

The lower acceptance value, A_L, is found as

$$A_L = g\sigma n_{\text{cum}} + h_{\text{A}}\sigma \tag{5}$$

The upper rejection value, R_U, is found as

$$R_U = (U - L - g\sigma) n_{\text{cum}} + h_{\text{R}}\sigma \tag{6}$$

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The lower rejection value, R_L, is found as

$$R_L = g\sigma n_{\text{cum}} - h_{\text{R}}\sigma \tag{7}$$

Whenever the value of A_U is less than corresponding value of A_L, the cumulative sample size is too small to allow acceptance of the lot.

The acceptance values $A_{\text{t},U}$ and $A_{\text{t},L}$ corresponding to the curtailment sample size are determined as

$$A_{\text{t},U} = \left(U - L - g\sigma\right) n_{\text{t}} \tag{8}$$

and

$$A_{\text{t},L} = g\sigma n_{\text{t}} \tag{9}$$

The acceptance and rejection values shall be recorded with one decimal place more than the inspection results.

11.4.7.3 Determination of acceptability

Inscribe the leeway and the cumulative leeway into the acceptability table prepared in accordance with 11.4.7.2, after the inspection of each item.

Compare the cumulative leeway Y with the corresponding upper and lower acceptance values, A_U and A_L, and the corresponding upper and lower rejection values R_U and R_L.

a) If, for the cumulative sample size, n_{cum}, the cumulative leeway, Y, is greater than or equal to the lower acceptance value, A_L and less than or equal to the upper acceptance value, A_U, the lot shall be considered acceptable and the inspection shall be terminated.

b) If, for the cumulative sample size, n_{cum}, the cumulative leeway, Y, is either less than or equal to the lower rejection value, R_L, or greater or equal to the upper rejection value, R_U, the lot shall be considered not acceptable and the inspection shall be terminated.

c) If neither a) nor b) is satisfied, another item shall be sampled and inspected.

When the cumulative sample size reaches the curtailment value, n_{t}, the lot shall be considered acceptable if $A_{\text{t},L} \leqslant Y \leqslant A_{\text{t},U}$, otherwise the lot shall be considered not acceptable.

11.4.8 Graphical method for combined control of double specification limits

11.4.8.1 Acceptance chart

When the graphical method is used, an acceptability chart shall be prepared in accordance with the following procedures. Prepare a graph with the cumulative sample, n_{cum}, as the horizontal axis, and the cumulative leeway, Y, as the vertical axis. Draw two straight lines with the same slope, U-L-$g\sigma$, corresponding to the upper acceptance and rejection values, A_U and R_U, given by Equations (4) and (6), and two straight lines with the same slope, $g\sigma$, corresponding to the lower acceptance and rejection values, A_L and R_L, given by Equations (5) and (7). Add a vertical line, the *curtailment line,* at $n_{\text{cum}} = n_{\text{t}}$.

The uppermost line with the slope U-L-$g\sigma$ and intercept $h_{\text{R}}\sigma$ is called the upper rejection line. The upper acceptance line has the slope U-L-$g\sigma$ and intercept $-h_{\text{A}}\sigma$. The lowermost line with the slope $g\sigma$ and intercept $-h_{\text{R}}\sigma$ is called the lower rejection line. The lower acceptance line has the slope $g\sigma$ and the intercept $h_{\text{A}}\sigma$.

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The lines define the following zones on the chart.

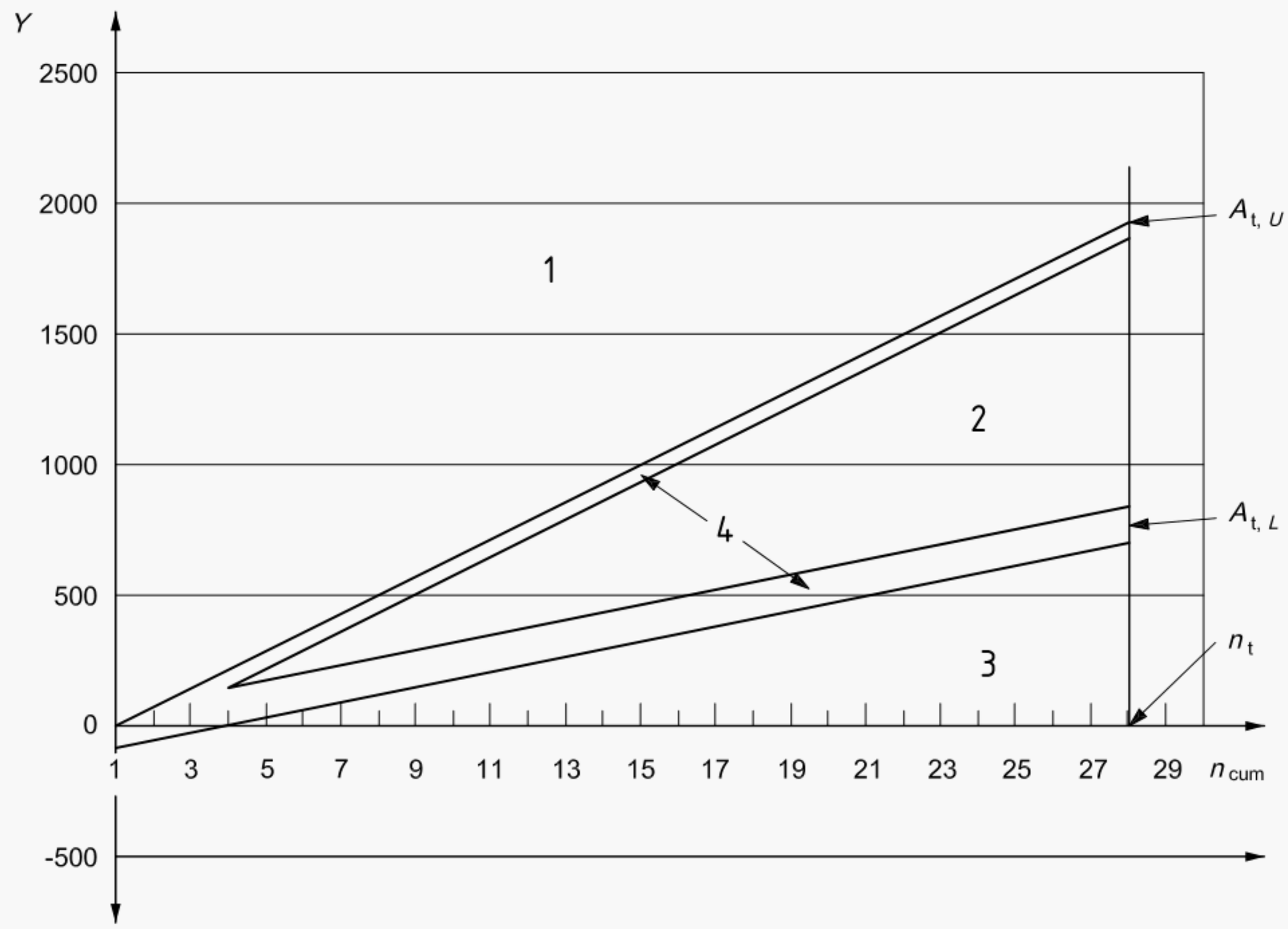
— The *acceptance zone* is the triangular sector on the chart which is bounded above by the upper acceptance line, below by the lower acceptance line and to the right by the curtailment line. The acceptance zone includes the two acceptance lines; moreover that part of the curtailment line which is between (and including) the points (n_t, $A_{t,U}$) and (n_t, $A_{t,L}$) belongs to the acceptance zone.

— The *upper rejection zone* is the zone above (and including) the upper rejection line together with that part of the curtailment line that is above the point (n_t, $A_{t,U}$).

— The *lower rejection zone* is the zone below (and including) the lower rejection line together with that part of the curtailment line that is below the point (n_t, $A_{t,L}$).

— The *indecision zone* is the V-shaped strip between the acceptance and rejection zones that is to the left of the curtailment line.

An example of the prepared graph is given as Figure 2.



Key

1 upper rejection zone
2 acceptance zone
3 lower rejection zone
4 indecision zone

Figure 2 — Acceptance chart for the sequential sampling plan for combined control of double specification limits

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11.4.8.2 Determination of acceptability

When the graphical method is used, the following procedures shall be followed.

Plot the point (n_{cum}, Y) on the acceptability chart, prepared in accordance with 11.4.8.1, after the inspection of each item.

a) If the point lies in the acceptance zone, the lot shall be considered acceptable and the inspection shall be terminated.

b) If the point lies in either of the rejection zones, the lot shall be considered not acceptable and the inspection shall be terminated.

c) If the point lies in either of the indecision zones, another item shall be sampled and inspected.

The successive points on the acceptability chart shall be connected by a step curve to show up any trend in the inspection results.

CAUTION — If the point is close to the acceptance or rejection lines, the numerical method shall be used to make the decision.

11.4.9 Numerical method for separate control of double specification limits

11.4.9.1 Maximum values of process standard deviation

In the case of the separate control of double specification limits, sequential sampling is only applicable if the process standard deviation σ is sufficiently small in relation to the length of the specification interval. The limiting value of the process standard deviation is given by the MPSD, σ_{max}:

$$\sigma_{\text{max}} = (U - L) f_{\sigma}$$

where f_{σ} depends only on the values of the AQL specified for the upper and lower limit, and can be found in Table B.2.

If, in the case of the separate control of double specification limits, σ exceeds MPSD, the lot shall immediately be judged not acceptable without a sample being drawn.

11.4.9.2 Acceptance and rejection values

When the numerical method is used, the following calculations shall be carried out and an acceptability table shall be prepared.

For each value, n_{cum}, of the cumulative sample size, that is less than the curtailment value of the sample size, a pair of acceptance values and a pair of rejection values are determined.

The acceptance value, A_U, for the upper specification limit is found as

$$A_U = (U - L - g_U \sigma) n_{\text{cum}} - h_{\text{A},U} \sigma \tag{10}$$

The acceptance value, A_L, for the lower specification limit is found as

$$A_L = g_L \sigma n_{\text{cum}} + h_{\text{A},L} \sigma \tag{11}$$

The rejection value, R_U, for the upper specification limit is found as

$$R_U = (U - L - g_U \sigma) n_{\text{cum}} + h_{\text{R},U} \sigma \tag{12}$$

The rejection value, R_L, for the lower specification limit is found as

$$R_L = g \sigma n_{\text{cum}} - h_{\text{R},L} \sigma \tag{13}$$

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The acceptance values $A_{t,U}$ and $A_{t,L}$ corresponding to the curtailment sample size are determined as

$$A_{t,U} = \left(U - L - g_U \sigma\right) n_t \tag{14}$$

and

$$A_{t,U} = g_L \sigma n_t \tag{15}$$

The acceptance and rejection values shall be recorded with one decimal place more than the inspection results.

11.4.9.3 Determination of acceptability

Inscribe the leeway and the cumulative leeway into the acceptability table prepared in accordance with 11.4.9.2, after the inspection of each item.

The acceptability criteria in 11.4.9.3.1 and 11.4.9.3.2 shall be applied to determine the acceptability for each specification limit separately. The lot shall be considered acceptable and inspection shall terminate if the lot has been considered acceptable with respect to both limits according to 11.4.9.3.1 a) and 11.4.9.3.2 a).

11.4.9.3.1 Determination of acceptability for the upper specification limit

Compare the cumulative leeway, Y, with the corresponding acceptance value, A_U, and rejection value, R_U.

a) If the cumulative leeway, Y, is less than or equal to the acceptance value, A_U, for the cumulative sample size, n_{cum}, the lot shall be considered acceptable with respect to the upper specification limit and the inspection with respect to that limit shall be terminated.

b) If the cumulative leeway, Y, is greater than or equal to the rejection value, R_U, for the cumulative sample size, n_{cum}, the lot shall be considered not acceptable and the inspection with respect to both limits shall be terminated.

c) If neither a) nor b) is satisfied, another item shall be sampled and inspected with respect to the upper specification limit.

When the cumulative sample size reaches the curtailment value, n_t, the lot shall be considered not acceptable if $Y \leqslant A_{t,U}$ and inspection shall terminate.

When the cumulative sample size reaches the curtailment value n_t and $Y \leqslant A_{t,U}$, the lot shall be considered acceptable with respect to the upper limit. If the lot has already been considered acceptable with respect to the lower limit, or if $Y \geqslant A_{t,L}$, the lot shall be considered acceptable and inspection shall terminate, otherwise the lot shall be considered not acceptable, and inspection shall terminate.

11.4.9.3.2 Determination of acceptability for the lower specification limit

Compare the cumulative leeway, Y, with the corresponding acceptance value, A_L, and rejection value, R_L.

a) If the cumulative leeway, Y, is greater than or equal to the acceptance value, A_L, for the cumulative sample size, n_{cum}, the lot shall be considered acceptable with respect to the lower specification limit and the inspection with respect to that limit shall be terminated.

b) If the cumulative leeway, Y, is less than or equal to the rejection value, R_L, for the cumulative sample size, n_{cum}, the lot shall be considered not acceptable and the inspection with respect to both limits shall be terminated.

c) If neither a) nor b) is satisfied, another item shall be sampled and inspected with respect to the lower specification limit.

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When the cumulative sample size reaches the curtailment value, n_t, the lot shall be considered not acceptable if $Y \geqslant A_{t,L}$ and inspection shall terminate.

When the cumulative sample size reaches the curtailment value n_t and $Y \geqslant A_{t,L}$, the lot shall be considered acceptable with respect to the lower limit. If the lot has already been considered acceptable with respect to the upper limit, or if $Y \leqslant A_{t,U}$, the lot shall be considered acceptable and inspection shall terminate, otherwise the lot shall be considered not acceptable, and inspection shall terminate.

11.4.10 Graphical method for separate control of double specification limits

11.4.10.1 Acceptance chart

When the graphical method is used, an acceptability chart shall be prepared in accordance with the following procedures. Prepare a graph with the cumulative sample n_{cum} as the horizontal axis, and the cumulative leeway, Y, as the vertical axis. Draw two straight lines with the same slope, $U\text{-}L\text{-}g_U\sigma$, corresponding to the upper acceptance and rejection values, A_U and R_U, given by Equations (10) and (12), and two straight lines with the same slope, $g_L\sigma$, corresponding to the lower acceptance and rejection values, A_L and R_L, given by Equations (11) and (13). Add a vertical line, the *curtailment line*, at $n_{cum} = n_t$.

The uppermost line with the slope $U\text{-}L\text{-}g_U\sigma$ and intercept $h_{R,U}\sigma$ is called the upper rejection line. The upper acceptance line has the slope $U\text{-}L\text{-}g_U\sigma$ and intercept $-h_{A,U}\sigma$. The lowermost line with the slope $g_L\sigma$ and intercept $-h_{R,L}\sigma$ is called the lower rejection line. The lower acceptance line has the slope $g_L\sigma$ and intercept $h_{A,L}\tilde{\sigma}$.

The lines define the following zones on the chart.

— The *acceptance zone for the upper specification limit* is the zone below (and including) the acceptance line for the upper specification limit together with that part of the curtailment line that is below and includes the point (n_t, $A_{t,U}$).

— The *rejection zone for the upper specification limit* is the zone above (and including) the rejection line for the upper specification limit together with that part of the curtailment line that is above the point (n_t, $A_{t,U}$).

— The *indecision zone for the upper specification limit* is the strip between acceptance and rejection lines for the upper specification limit that is to the left of the curtailment line.

— The *acceptance zone for the lower specification limit* is the zone above (and including) the acceptance line for the lower specification limit together with that part of the curtailment line that is above and includes the point (n_t, $A_{t,L}$).

— The *rejection zone for the lower specification limit* is the zone below (and including) the rejection line for the lower specification limit together with that part of the curtailment line that is below the point (n_t, $A_{t,L}$).

— The *indecision zone for the lower specification limit* is the strip between acceptance and rejection lines for the lower specification limit that is to the left of the curtailment line.

An example of the prepared graph is given as Figure 3.

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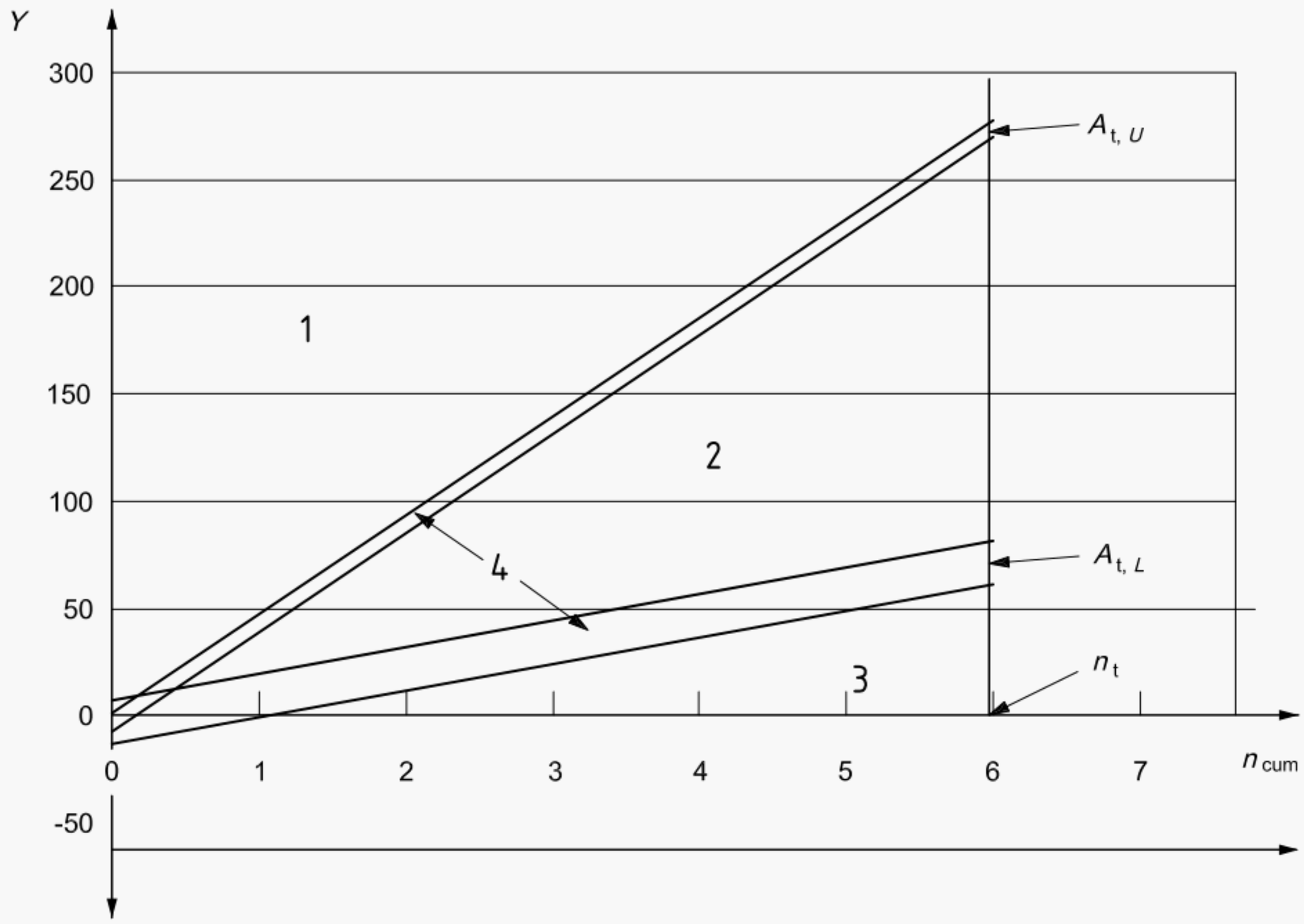

Key

1 rejection zone for the upper specification limit

2 acceptance zone

3 rejection zone for the lower specification limit

4 indecision zones

Figure 3 — Acceptance chart for the sequential sampling plan for separate control of double specification limits

CAUTION — If the point is close to the acceptance or rejection lines, the numerical method shall be used to make the decision.

11.4.10.2 Determination of acceptability

11.4.10.2.1 General

When the graphical method is used, the following procedures shall be followed.

Plot the point (n_{cum}, Y) on the acceptability chart prepared in accordance with 11.4.10.1, after the inspection of each item.

The acceptability criteria in 11.4.10.2.2 and 11.4.10.2.3 shall be applied to determine the acceptability for each specification limit separately. The lot shall be considered acceptable and inspection shall terminate if the lot has been considered acceptable with respect to both limits according to 11.4.10.2.2 a) and 11.4.10.2.3 a).

The successive points on the acceptability chart shall be connected by a step curve to show up any trend in the inspection results.

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11.4.10.2.2 Determination of acceptability for the upper specification limit

a) If the point lies in the acceptance zone for the upper specification limit, the lot shall be considered acceptable with respect to the upper specification limit and inspection with respect to that limit shall terminate.

b) If the point lies in the rejection zone for the upper specification limit, the lot shall be considered not acceptable with respect to the upper specification limit and inspection with respect to both limits shall terminate.

c) If the point lies in the indecision zone for the upper specification limit, another item shall be sampled and inspected with respect to the upper specification limit.

11.4.10.2.3 Determination of acceptability for the lower specification limit

a) If the point lies in the acceptance zone for the lower specification limit, the lot shall be considered acceptable with respect to the lower specification limit and inspection with respect to that limit shall terminate.

b) If the point lies in the rejection zone for the lower specification limit, the lot shall be considered not acceptable with respect to the lower specification limit and inspection with respect to both limits shall terminate.

c) If the point lies in the indecision zone for the lower specification limit, another item shall be sampled and inspected with respect to the lower specification limit.

12 Further information

12.1 Operating characteristic (OC) curves

The operating characteristic curves for normal and tightened inspection indicate the percentage of lots that may be expected to be accepted under the various sampling plans for a given process quality. The sampling plans in this part of ISO 3951 have been determined such that their operating characteristics (OC) curves match as closely as practicable the OC curves of the corresponding sampling plans in ISO 3951-1 and ISO 2859-1. The OC curves for these sampling plans may be calculated from a formula given in Annex M of ISO 3951-1:2005, and producer's risks when the process average is equal to AQL are given in Tables L.2, L.4 , and L.6 of ISO 3951-1:2005.

12.2 Use of individual plans

This part of ISO 3951 is intended to be used as a system employing tightened, normal and reduced inspection on a successive series of lots to achieve consumer protection while assuring the producer that acceptance will occur most of the time if quality is better than the AQL.

Occasionally, specific individual plans are selected from this part of ISO 3951 and used without the switching rules. For example, a purchaser may be using the plans for verification purposes only. This is not the intended application of the system given in this part of ISO 3951 and its use in this way shall not be referred to as "inspection in compliance with ISO 3951-5:2006". When used in this way, this part of ISO 3951 simply represents a repository for a collection of individual sequential sampling plans indexed by AQL. The operating characteristic curves and other measures of a plan so chosen shall be assessed individually for a plan from the tables provided in ISO 3951-1.

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13 Examples

EXAMPLE 1

The specified minimum yield point for certain steel castings is 400 N/mm^2.

A lot of 500 items is submitted for inspection.

Inspection level II, normal inspection, with AQL = 1,5 %, is to be used.

The value of σ is considered to be 21 N/mm^2.

From Table 3, it is seen that the sample size code letter is H. Then, from Table A.1, it is seen that for an AQL of 1,5 % the parameters of the sequential procedure are the following: h_A = 2,135, h_R = 3,063, g = 1,665, and n_t = 18.

Suppose the yield points of the consecutive sample specimens are 431; 417; 469; 407; 450; 452; 427; 411; 429; 420; 400; ... Compliance with the acceptability criterion is to be determined.

Information needed		Value obtained
g	slope of the acceptance and rejection lines	1,665
h_A	intercept of the acceptance line	2,135
h_R	intercept of the rejection line	3,063
n_t	curtailment value	18
σ	known standard deviation	21 N/mm^2
L	lower specification limit	400 N/mm^2

Table 1 — Example of the operation of the sequential sampling plan in the case of a single specification limit

Cumulative sample size n_{cum}	Inspection result x N/mm^2	Leeway y	Rejection value R	Cumulative leeway Y	Acceptance value A
1	431	31	–29,358	31	79,8
2	417	17	5,607	48	114,765
3	469	69	40,572	117	149,73
4	407	7	75,537	124	184,695
5	450	50	110,502	174	219,66
6	452	52	145,467	226	254,625
7	427	27	180,432	253	289,59
8	411	11	215,397	264	324,555
9	429	29	250,362	293	359,52
10	420	20	285,327	313	394,485
11	400	0	320,292	313	429,45
			The lot is rejected		

The estimated mean of the lot does not meet the acceptability criterion so the lot is not acceptable.

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EXAMPLE 2

The specification for electrical resistance of a certain electrical component is 520 ± 50 Ω.

Production is at a rate of 2 500 items per inspection lot.

Inspection level II, normal inspection, with a single AQL of 4 %, is to be used for the two specification limits (470 and 570). The value of σ is known to be 21,0.

Entering Table 3 with the lot size and inspection level, it is found that the sample size code letter is K. Then, from Table A.1, it is seen that for an AQL of 4 % the parameters of the sequential procedure are the following: $h_A = 2{,}764$, $h_R = 3{,}895$, $g = 1{,}383$, and $n_t = 27$.

Suppose the values of the sample resistance in Ω are as follows: 515; 491; 479; 507; 543; 521; ...

Information needed		**Value obtained**
f_σ	factor from Table B.1	0,223
g	slope of the acceptance and rejection lines	1,383
h_A	intercept of the acceptance line	2,764
h_R	intercept of the rejection line	3,895
n_t	curtailment value	27
σ	known standard deviation	21 Ω
L	lower specification limit	470 Ω
U	upper specification limit	570 Ω
Maximum process standard deviation, MPSD: $(U - L) f_\sigma$		22, 3 Ω

As σ is less than the MPSD, the sample is analysed further for lot acceptability.

Table 2 — Example of the operation of the sequential sampling plan in the case of the combined control of double specification limits

Cumulative sample size n_{cum}	Inspection result x (in Ω)	Leeway y	Rejection value R_L	Acceptance value A_L	Cumulative leeway Y	Acceptance value A_U	Rejection value R_U
1	515	45	–52,752	87,087	45	12,913	152,752
2	491	21	–23,709	116,13	66	83,870	223,709
3	479	9	5,334	145,173	75	154,827	294,666
4	507	37	34,377	174,216	112	225,784	365,623
5	543	73	63,42	203,259	185	296,741	436,580
6	521	51	92,463	232,302	236	367,698	507,537
					The lot is accepted		

The sample mean of the lot meets the acceptability criterion so the lot is acceptable.

NOTE 1 For a single sampling plan from ISO 3951-1, the required sample size is $n = 18$.

NOTE 2 If, for example, σ had been known to be 25, then σ exceeds the MPSD and therefore sampling inspection should not even have taken place.

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14 Tables

Table 3 should be used for the determination of the sample size code letter.

Sequential sampling plans for normal inspection are given in Table A.1.

Sequential sampling plans for tightened inspection are given in Table A.2.

Sequential sampling plans for reduced inspection are given in Table A.3.

Values of f_σ for maximum process standard deviation (MPSD) for combined control of double specification limits: σ method are given in Table B.1.

Values of f_σ for maximum process standard deviation (MPSD) for separate control of double specification limits: σ method are given in Table B.2.

Table 3 — Sample size code letters

Lot size	Special levels				General inspection levels		
	S-1	S-2	S-3	S-4	I	II	II
2 to 8	B	B	B	B	B	B	B
9 to 15	B	B	B	B	B	B	C
16 to 25	B	B	B	B	B	C	D
26 to 50	B	B	B	C	C	D	D
51 to 90	B	B	C	C	C	E	F
91 to 150	B	B	C	D	D	F	G
151 to 280	B	C	D	E	E	G	H
281 to 500	B	C	D	E	F	H	J
501 to 1 200	C	C	E	F	G	J	K
1 201 to 3 200	C	D	E	G	H	K	L
3 201 to 10 000	C	D	F	G	J	L	M
10 001 to 35 000	C	D	F	H	K	M.	N
35 001 to 150 000	D	E	G	J	L	N	P
150 001 to 500 000	D	E	G	J	M	P	Q
500 001 and over	D	E	H	K	K	Q	R

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Annex A
(normative)

Sampling plans for normal, tightened and reduced inspection

This Annex contains the tables of sequential sampling plans for normal inspection.

Table A.1 contains the parameters of the sequential sampling plans corresponding to single sampling plans for normal inspection from ISO 3951-1 "σ" method.

Table A.2 contains the parameters of the sequential sampling plans corresponding to single sampling plans for tightened inspection from ISO 3951-1 "σ" method.

Table A.3 contains the parameters of the sequential sampling plans corresponding to single sampling plans for reduced inspection from ISO 3951-1 "σ" method.

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Table A.1 — Parameters for sequential sampling plans corresponding to ISO 3951-1 "σ" method single sampling plans for normal inspection (Master table)

Code letter	n_0	n_t	h_A	h_R	Acceptance quality limit, AQL, in percent nonconforming															
					0,01	0,015	0,025	0,04	0,065	0,10	0,15	0,25	0,40	0,65	1,0	1,5	2,5	4,0	6,5	10,0
					g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g
B	2				↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	⇩	*	*	*
C	3	5	0.317	0,875	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	⇩	1,096	0,946	0,748	0,517
D	4	6	0,703	1,340	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	⇩	1,387	1,239	1,055	0,851	0,569
E	6	9	1,213	1,932	↓	↓	↓	↓	↓	↓	↓	↓	↓	⇩	1,652	1,506	1,330	1,142	0,892	0,602
F	8	12	1,579	2,372	↓	↓	↓	↓	↓	↓	↓	↓	⇩	1,885	1,746	1,581	1,408	1,185	0,936	0,628
G	10	15	1,878	2,739	↓	↓	↓	↓	↓	↓	↓	⇩	2,087	1,954	1,799	1,638	1,435	1,214	0,950	0,732
H	12	18	2,135	3,063	↓	↓	↓	↓	↓	↓	⇩	2,275	2,148	2,001	1,852	1,665	1,464	1,231	1,043	0,823
J	15	23	2,459	3,474	↓	↓	↓	↓	↓	⇩	2,457	2,336	2,197	2,056	1,882	1,697	1,486	1,320	1,129	0,926
K	18	27	2,764	3,895	↓	↓	↓	↓	⇩	2,619	2,502	2,370	2,236	2,072	1,900	1,705	1,554	1,383	1,205	0,962
L	21	32	3,026	4,232	↓	↓	↓	⇩	2,778	2,667	2,540	2,414	2,258	2,097	1,916	1,777	1,622	1,462	1,250	↑
M	25	38	3,366	4,661	↓	↓	⇩	2,926	2,819	2,697	2,576	2,429	2,276	2,106	1,977	1,833	1,686	1,495	↑	↑
N	32	48	3,889	5,379	↓	⇩	3,073	2,969	2,852	2,736	2,595	2,451	2,290	2,168	2,033	1,898	1,722	↑	↑	↑
P	40	60	4,408	6,095	⇩	3,215	3,115	3,003	2,891	2,756	2,618	2,465	2,350	2,223	2,097	1,934	↑	↑	↑	↑
Q	50	75	4,995	6,886	3,345	3,248	3,139	3,031	2,901	2,768	2,622	2,513	2,393	2,273	2,120	↑	↑	↑	↑	↑
R	65	98	5,767	7,929	3,382	3,277	3,173	3,048	2,920	2,781	2,676	2,562	2,449	2,304	↑	↑	↑	↑	↑	↑

NOTE 1 The sample size code letters in this part of ISO 3951 correspond to those given in ISO 3951-1:2005.

NOTE 2 Symbols:

* Use corresponding "σ" method single sampling plan in Table C.1 of ISO 3951-1:2005.

⇩ There is no suitable plan in this area; use the first sampling plan below the arrow.

⇧ There is no suitable plan in this area; use the first sampling plan above the arrow.

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Table A.2 — Parameters for sequential sampling plans corresponding to ISO 3951-1 "σ" method single sampling plans for tightened inspection (Master table)

Code letter	n_0	n_t	h_A	h_R	Acceptance quality limit, AQL, in percent nonconforming															
					0,01	0,015	0,025	0,04	0,065	0,10	0,15	0,25	0,40	0,65	1,0	1,5	2,5	4,0	6,5	10,0
					g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g
B	2				↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	*	*
C	3	5	0.317	0,875	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1,096	0,946	0,748
D	4	6	0,703	1,340	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1,387	1,239	1,055	0,851
E	6	9	1,213	1,932	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1,652	1,506	1,330	1,142	0,892
F	8	12	1,579	2,372	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1,885	1,746	1,581	1,408	1,185	0,936
G	10	15	1,878	2,739	↓	↓	↓	↓	↓	↓	↓	↓	↓	2,087	1,954	1,799	1,638	1,435	1,214	0,950
H	12	18	2,135	3,063	↓	↓	↓	↓	↓	↓	↓	↓	2,275	2,148	2,001	1,852	1,665	1,464	1,231	0,965
J	15	23	2,459	3,474	↓	↓	↓	↓	↓	↓	↓	2,457	2,336	2,197	2,056	1,882	1,697	1,486	1,251	1,023
K	18	27	2,764	3,895	↓	↓	↓	↓	↓	↓	2,619	2,502	2,370	2,236	2,072	1,900	1,705	1,492	1,288	1,058
L	21	32	3,026	4,232	↓	↓	↓	↓	↓	2,778	2,667	2,540	2,414	2,258	2,097	1,916	1,721	1,537	1,333	↑
M	25	38	3,366	4,661	↓	↓	↓	↓	2,926	2,819	2,697	2,576	2,429	2,276	2,106	1,924	1,755	1,570	↑	↑
N	32	48	3,889	5,379	↓	↓	↓	3,073	2,969	2,852	2,736	2,595	2,451	2,290	2,119	1,961	1,790	↑	↑	↑
P	40	60	4,408	6,096	↓	↓	3,215	3,115	3,003	2,891	2,756	2,618	2,465	2,303	2,156	1,997	↑	↑	↑	↑
Q	50	75	4,995	6,886	↓	3,345	3,248	3,139	3,031	2,901	2,768	2,622	2,469	2,329	2,180	↑	↑	↑	↑	↑
R	65	98	5,767	7,929	3,477	3,382	3,277	3,173	3,048	2,920	2,781	2,634	2,501	2,360	↑	↑	↑	↑	↑	↑

NOTE 1 The sample size code letters in this part of ISO 3951 correspond to those given in ISO 3951-1:2005.

NOTE 2 Symbols:

* Use corresponding "σ" method single sampling plan in Table C.2 of ISO 3951-1:2005.

↓ There is no suitable plan in this area; use the first sampling plan below the arrow.

↑ There is no suitable plan in this area; use the first sampling plan above the arrow.

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Table A.3 — Parameters for sequential sampling plans corresponding to ISO 3951-1 "σ" method single sampling plans for reduced inspection (Master table)

Code letter	n_0	n_t	h_A	h_R	Acceptance quality limit, AQL, in percent nonconforming															
					0,01	0,015	0,025	0,04	0,065	0,10	0,15	0,25	0,40	0,65	1,0	1,5	2,5	4,0	6,5	10,0
					g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g
B					↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
C					↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
D	2				↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	*	*	*	*	*
E	3	5	0,317	0,875	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1,096	1,036	0,946	0,748	0,517	0,172
F	4	6	0,703	1,340	↓	↓	↓	↓	↓	↓	↓	↓	↓	1,387	1,327	1,239	1,055	0,851	0,569	0,220
G	6	9	1,213	1,932	↓	↓	↓	↓	↓	↓	↓	↓	1,652	1,592	1,506	1,330	1,142	0,892	0,602	0,397
H	8	12	1,579	2,372	↓	↓	↓	↓	↓	↓	↓	1,885	1,828	1,746	1,581	1,408	1,185	0,936	0,769	0,486
J	10	15	1,878	2,739	↓	↓	↓	↓	↓	↓	2,087	2,032	1,954	1,799	1,638	1,435	1,214	1,069	0,833	0,638
K	12	18	2,135	3,063	↓	↓	↓	↓	↓	2,275	2,222	2,148	2,001	1,852	1,665	1,464	1,335	1,130	0,965	0,823
L	15	23	2,459	3,474	↓	↓	↓	↓	2,457	2,407	2,336	2,197	2,056	1,882	1,697	1,580	1,396	1,251	1,129	↑
M	18	27	2,764	3,895	↓	↓	↓	2,619	2,570	2,502	2,370	2,236	2,072	1,900	1,791	1,623	1,492	1,383	↑	↑
N	21	32	3,026	4,232	↓	↓	2,778	2,731	2,667	2,540	2,414	2,258	2,097	1,996	1,841	1,721	1,622	↑	↑	↑
P	25	38	3,366	4,661	↓	2,926	2,881	2,819	2,697	2,576	2,429	2,276	2,181	2,035	1,924	1,833	↑	↑	↑	↑
Q	32	48	3,889	5,379	3,073	3,030	2,969	2,852	2,736	2,595	2,451	2,360	2,223	2,119	2,033	↑	↑	↑	↑	↑
R	40	60	4,408	6,096	3,173	3,115	3,003	2,891	2,756	2,618	2,532	2,402	2,303	2,223	↑	↑	↑	↑	↑	↑

NOTE 1 The sample size code letters in this part of ISO 3951 correspond to those given in ISO 3951-1:2005.

NOTE 2 Symbols:

* Use corresponding "σ" method single sampling plan in Table C.3 of ISO 3951-1:2005.

↓ There is no suitable plan in this area; use the first sampling plan below the arrow.

↑ There is no suitable plan in this area; use the first sampling plan above the arrow.

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Annex B
(normative)

Critical values for maximum standard deviation

This Annex contains tables of factors, f_σ, that are used for the calculation of critical values for maximum standard deviation.

Table B.1 contains the values of f_σ that are used for the calculation of the maximum process standard deviation (MPSD) for combined control of double specification limits.

Table B.2 contains the values of f_σ that are used for the calculation of the maximum process standard deviation (MPSD) for separate control of double specification limits.

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Table B.1 — Values of f_σ for maximum process standard deviation (MPSD) for combined control of double specification limits: "σ" method

Acceptance quality limit, in percent nonconforming															
0,010	0,015	0,025	0,040	0,065	0,10	0,15	0,25	0,40	0,65	1,0	1,5	2,5	4,0	6,5	10,0
Values of f_σ for calculating MPSD															
0,125	0,129	0,132	0,137	0,141	0,147	0,152	0,157	0,165	0,174	0,184	0,194	0,206	0,223	0,243	0,271

NOTE The MPSD is obtained by multiplying the standardized MPSD f_σ by the difference between the upper specification limit, U, and the lower specification limit, L, i.e. MPSD = $(U - L) f_\sigma$.

The MPSD indicates the greatest allowable magnitude of the process standard deviation when using plans for the combined control of double specification limits when the process variability is known. If the process standard deviation is less than the MPSD, there is a possibility but not a certainty that the lot will be accepted.

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Table B.2 — Values of f_σ for maximum process standard deviation (MPSD) for separate control of double specification limits: "σ" method

AQL (%) on lower specification limit	Acceptance quality limit (%) on upper specification limit															
	0,010	0,015	0,025	0,040	0,065	0,10	0,15	0,25	0,40	0,65	1,0	1,5	2,5	4,0	6,5	10,0
0,010	0,131	0,133	0,134	0,137	0,139	0,142	0,145	0,147	0,151	0,154	0,158	0,163	0,167	0,173	0,179	0,187
0,015	0,133	0,134	0,136	0,139	0,141	0,144	0,147	0,150	0,153	0,157	0,161	0,165	0,170	0,176	0,183	0,191
0,025	0,134	0,136	0,138	0,141	0,144	0,146	0,149	0,152	0,156	0,160	0,164	0,168	0,173	0,179	0,186	0,195
0,040	0,137	0,139	0,141	0,144	0,146	0,149	0,152	0,155	0,159	0,163	0,168	0,172	0,177	0,184	0,191	0,200
0,065	0,139	0,141	0,144	0,146	0,149	0,152	0,155	0,158	0,162	0,167	0,171	0,176	0,181	0,188	0,196	0,205
0,10	0,142	0,144	0,146	0,149	0,152	0,155	0,159	0,162	0,166	0,170	0,175	0,180	0,186	0,193	0,201	0,211
0,15	0,145	0,147	0,149	0,152	0,155	0,159	0,162	0,165	0,170	0,174	0,179	0,185	0,190	0,198	0,207	0,217
0,25	0,147	0,150	0,152	0,155	0,158	0,162	0,165	0,168	0,173	0,178	0,183	0,189	0,195	0,203	0,212	0,223
0,40	0,151	0,153	0,156	0,159	0,162	0,166	0,170	0,173	0,178	0,183	0,189	0,195	0,201	0,210	0,219	0,231
0,65	0,154	0,157	0,160	0,163	0,167	0,170	0,174	0,178	0,183	0,189	0,195	0,201	0,207	0,217	0,227	0,240
1,0	0,158	0,161	0,164	0,168	0,171	0,175	0,179	0,183	0,189	0,195	0,201	0,208	0,215	0,225	0,236	0,250
1,5	0,163	0,165	0,168	0,172	0,176	0,180	0,185	0,189	0,195	0,201	0,208	0,215	0,222	0,233	0,245	0,260
2,5	0,167	0,170	0,173	0,177	0,181	0,186	0,190	0,195	0,201	0,207	0,215	0,222	0,230	0,242	0,255	0,271
4,0	0,173	0,176	0,179	0,184	0,188	0,193	0,198	0,203	0,210	0,217	0,225	0,233	0,242	0,255	0,269	0,288
6,5	0,179	0,183	0,186	0,191	0,196	0,201	0,207	0,212	0,219	0,227	0,236	0,245	0,255	0,269	0,286	0,306
10,0	0,187	0,191	0,195	0,200	0,205	0,211	0,217	0,223	0,231	0,240	0,250	0,260	0,271	0,288	0,306	0,330

NOTE The MPSD is obtained by multiplying the standardized MPSD f_σ by the difference between the upper specification limit, U, and the lower specification limit, L, i.e. $(U - L) f_\sigma$.

The MPSD indicates the greatest allowable magnitude of the process standard deviation when using plans for the separate control of double specification limits when the process variability is known. If the process standard deviation is less than the MPSD, there is a possibility but not a certainty that the lot will be accepted.

Annex C
(informative)

Statistical characteristics

C.1 Values of the average sample number

The principal advantage of sequential sampling plans is the reduction in the average sample size. However, there exist disadvantages of sequential sampling (see Introduction). To evaluate possible profits from having small average sample sizes we need to know their values for particular sequential sampling plans. Unfortunately, there is no closed mathematical formula for the calculation of the average sample size in the case of sequential sampling. Thus, the average sample size for the given sequential sampling plan and the given quality level (in percent nonconforming) can be only found using numerical procedures. Approximate values of the average sample number (ASN) for the sequential sampling plans from this part of ISO 3951 are given in:

Table C.1 (when actual fraction of nonconforming is equal to 0,5 AQL);

Table C.2 (when actual fraction of nonconforming is equal to AQL);

Table C.3 (when actual fraction of nonconforming is equal to 2 AQL); and

Table C.4 (when actual fraction of nonconforming is equal to 5 AQL).

The sample size in the second column of these tables is the sample size of the corresponding single sampling plan from ISO 3951-1. It is easy to see that the average sample sizes for sequential sampling plans of this part of ISO 3951 are significantly smaller than the sample sizes of the corresponding single sample plans for variables.

C.2 Producer's risk

In the acceptance sampling, there exists a certain risk of non-accepting lots or processes of good quality. The probability of non-acceptance when the quality level has a value stated by the plan as acceptable is called producer's risk. In sampling plans presented in this part of ISO 3951, only these quality levels that are better than AQL are considered as acceptable. Moreover, for a given sampling plan the value of producer's risk increases together with the increasing value of the average level of the process expressed in terms of the fraction nonconforming. Thus, producer's risk calculated for the process average equal to AQL represents the highest risk of non-accepting when the actual process level is considered as acceptable. Producer's risks calculated for the process average equal to AQL for sampling plans of this part of ISO 3951 (normal inspection) are given in Table C.5. It has to be noted that when a tightened inspection is invoked the producer's risk of the respective sampling plans are smaller than those calculated for the plans of the normal inspection. On the other hand, when a reduced inspection is invoked, the producer's risk of the respective sampling plans are larger than those calculated for the plans of the normal inspection.

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C.3 Tables

Table C.1 — Average sample size for normal inspection when the process average is equal to 0,5 AQL

Code letter	Sample size	Acceptance quality limit (in percent nonconforming)															
		0,01	0,015	0,025	0,04	0,065	0,10	0,15	0,25	0,40	0,65	1,0	1,5	2,5	4,0	6,5	10,0
B	2														2	2	2
C	3													1,24	1,25	1,26	1,24
D	4												1,55	1,59	1,59	1,59	1,53
E	6											2,19	2,18	2,21	2,21	2,13	1,99
F	8										2,81	2,83	2,77	2,81	2,73	2,63	2,39
G	10									3,34	3,43	3,40	3,33	3,29	3,18	3,01	2,96
H	12								3,87	3,95	4,00	3,99	3,78	3,74	3,56	3,65	3,56
J	15							4,49	4,66	4,70	4,80	4.62	4,39	4.29	4,40	4,50	4,48
K	18						5,23	5,22	5,37	5,45	5,39	5,20	4,86	5,12	5,24	5,46	5,16
L	21					5,96	6,03	5,93	6,16	6,06	6,02	5,73	5,76	6,07	6,32	6,29	
M	25				6,68	6,93	6,90	6,84	6,89	6,80	6,67	6,84	6,83	7,33	7,29		
N	32			7,85	8,08	8,26	8,31	7,97	8,07	7,86	8,32	8,48	8,61	8,84			
P	40		8,93	9,37	7,54	9,87	9,59	9,22	9,20	9,70	10,25	10,65	10,25				
Q	50	10,49	10,53	10,92	11,21	11,22	10,94	10,36	11,19	11,75	12,67	12,47					
R	65	12,75	12,62	13,24	13,17	13,23	12,73	13,00	14,02	15,04	15,45						

Table C.2 — Average sample size for normal inspection when the process average is equal to AQL

Code letter	Sample Size	Acceptance quality limit (in percent nonconforming)															
		0,01	0,015	0,025	0,04	0,065	0,10	0,15	0,25	0,40	0,65	1,0	1,5	2,5	4,0	6,5	10,0
B	2														2	2	2
C	3													1,35	1,38	1,40	1,40
D	4												1,80	1,87	1,90	1,94	1,88
E	6											2,71	2,73	2,82	2,88	2,84	2,70
F	8										3,60	3,67	3,64	3,79	3,73	3,68	3,39
G	10									4,35	4,55	4,56	4,53	4,58	4,51	4,36	4,43
H	12								5,10	5,30	5,46	5,52	5,29	5,35	5,19	5,55	5,64
J	15							5,78	6,36	6,52	6,81	6,63	6,35	6,34	6,78	7,29	7,63
K	18						7,09	7,17	7,52	7,80	7,85	7,66	7,17	7,94	8,48	9,38	9,22
L	21					8,20	8,42	8,36	8,91	8,88	9,04	8,62	8,91	9,88	10,84	11,35	
M	25				9,25	9,81	9,89	9,92	10,20	10,24	10,20	10,81	11,09	12,64	13,12		
N	32			11,02	11,61	12,13	12,40	11,89	12,35	12,18	13,56	14,29	15,03	16,28			
P	40		12,58	13,64	14,18	15,09	14,74	14,19	14,46	16,01	17,85	19,40	19,06				
Q	50	15,04	15,29	16,33	17,23	17,55	17,21	16,16	18,61	20,60	23,73	24,09					
R	65	18,95	18,89	20,61	20,80	21,35	20,53	21,64	25,12	28,94							

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Table C.3 — Average sample size for normal inspection when the process average is equal to 2 AQL

Code letter	Sample size	Acceptance quality limit (in percent nonconforming)															
		0,01	0,015	0,025	0,04	0,065	0,10	0,15	0,25	0,40	0,65	1,0	1,5	2,5	4,0	6,5	10,0
B	2														2	2	2
C	3													1,51	1,56	1,60	1,61
D	4												2,15	2,25	2,31	2,40	2,39
E	6											3,45	3,52	3,68	3,82	3,89	3,87
F	8										4,73	4,88	4,92	5,19	5,26	5,38	5,29
G	10									5,85	6,17	6,30	7,20	6,56	6,68	6,76	7,09
H	12								6,98	7,33	7,64	7,82	7,71	7,99	8,05	8,61	8,91
J	15							8,42	9,05	9,39	9,87	9,86	9,72	10,00	10,70	11,21	11,27
K	18						10,19	10,41	11,06	11,57	11,85	11,86	11,53	12,68	13,30	13,52	13,36
L	21					11,98	12,44	12,50	13,43	13,63	14,03	13,88	14,46	15,47	15,77	15,44	
M	25				13,81	14,81	15,11	15,36	16,00	16,34	16,64	17,90	18,05	18,74	18,56		
N	32			17,05	18,25	19,31	19,96	19,56	20,60	20,81	22,67	23,45	23,88	23,75			
P	40		20,06	22,26	23,50	25,22	25,13	24,73	25,71	28,02	29,56	29,88	29,82				
Q	50	24,90	25,75	28,19	30,20	31,27	31,29	30,14	34,41	36,53	37,23	36,92					
R	65	33,70	34,09	38,27	39,35	41,14	40,53	43,15	47,46	48,35	47,08						

Table C.4 — Average sample size for normal inspection when the process average is equal to 5 AQL

Code letter	Sample size	Acceptance quality limit (in percent nonconforming)															
		0,01	0,015	0,025	0,04	0,065	0,10	0,15	0,25	0,40	0,65	1,0	1,5	2,5	4,0	6,5	10,0
B	2														2	2	2
C	3													1,71	1,73	1,73	1,68
D	4												2,56	2,62	2,63	2,54	2,41
E	6											4,29	4,32	4,32	4,19	3,94	3,56
F	8										5,93	5,95	5,92	5,73	5,47	4,97	4,39
G	10									7,50	7,49	7,43	7,33	7,00	6,55	5,85	4,59
H	12								9,02	9,03	8,90	8,69	8,60	8,05	7,49	5,99	4,63
J	15							11,26	11,25	11,08	10,64	10,41	10,23	9,43	7,88	6,11	4,65
K	18						13,54	13,53	13,31	12,88	12,39	12,03	11,90	9,93	8,14	6,18	4,93
L	21					15,77	15,66	15,57	14,92	14,47	13,70	13,36	12,15	9,85	7,88	6,30	
M	25				18,74	18,49	18,25	17,94	17,16	16,44	15,56	13,86	12,47	9,81	8,22		
N	32			23,94	23,58	22,86	22,12	22,05	20,61	19,71	16,76	14,73	12,88	10,59			
P	40		29,88	29,23	28,28	26,54	26,07	25,81	24,03	20,57	17,20	14,75	13,61				
Q	50	37,13	36,73	35,11	33,04	31,34	30,51	30,67	25,23	21,36	17,47	15,18					
R	65	46,28	45,51	47,93	39,44	36,55	35,90	32,20	25,99	21,55	18,73						

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Table C.5 — Producer's risk when the process average is equal to AQL (normal inspection)

Code letter	Sample size	Acceptance quality limit (in percent nonconforming)															
		0,01	0,015	0,025	0,04	0,065	0,10	0,15	0,25	0,40	0,65	1,0	1,5	2,5	4,0	6,5	10,0
B	2														5,49	7,14	7,69
C	3													6,64	7,77	8,58	8,62
D	4												4,75	5,95	6,49	7,26	6,13
E	6											3,54	3,72	4,39	4,87	4,56	3,44
F	8										3,13	3,50	3,32	4,12	3,79	3,53	2,27
G	10									2,54	3,20	3,29	3,21	3,33	3,08	2,56	2,82
H	12								2,25	2,79	3,25	3,46	2,75	2,95	2,47	3,54	3,91
J	15							1,68	2,36	2,68	3,36	2,92	2,32	2,29	3,29	4,72	5,90
K	18						1,59	1,68	2,20	2,66	2,76	2,42	1,70	2,92	4,11	6,72	6,15
L	21					1,58	1,85	1,75	2,46	2,45	2,63	2,08	2,46	4,18	6,56	8,13	
M	25				1,20	1,67	1,74	1,78	2,06	2,10	2,06	2,79	3,17	6,03	7,18		
N	32			0,82	1,12	1,42	1,61	1,26	1,56	1,44	2,57	3,34	4,29	6,31			
P	40		0,50	0,80	1,00	1,42	1,25	1,00	1,12	1,95	3,41	5,12	4,70				
Q	50	0,39	0,43	0,64	0,87	0,97	0,86	0,60	1,35	2,31	4,72	5,03					
R	65	0,33	0,33	0,55	0,58	0,68	0,54	0,74	1,69	3,49	5,11						

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