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Sampling procedures for inspection by attributes — Introduction to the ISO 2859 series of standards for sampling for inspection by attributes

Règles d'échantillonnage pour les contrôles par attributs — Introduction au système d'échantillonnage pour les contrôles par attributs de l'ISO 2859

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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Foreword

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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

This first edition of ISO 28590 cancels and replaces ISO 2859-10:2006, of which it constitutes a minor revision to change the reference number from 2859-10 to 28590.

With the view to achieve a more consistent portfolio, TC 69/SC 5 has simultaneously renumbered the following standards, by means of minor revisions:

Old reference	New reference	Title
ISO 2859-10:2006	ISO 28590:2017	Sampling procedures for inspection by attributes — Introduction to the ISO 2859 series of standards for sampling for inspection by attributes
ISO 8422:2006	ISO 28591:2017	Sequential sampling plans for inspection by attributes
ISO 28801:2011	ISO 28592:2017	Double sampling plans by attributes with minimal sample sizes, indexed by producer's risk quality (PRQ) and consumer's risk quality (CRQ)
ISO 18414:2006	ISO 28593:2017	Acceptance sampling procedures by attributes — Accept-zero sampling system based on credit principle for controlling outgoing quality
ISO 21247:2005	ISO 28594:2017	Combined accept-zero sampling systems and process control procedures for product acceptance
ISO 14560:2004	ISO 28597:2017	Acceptance sampling procedures by attributes — Specified quality levels in nonconforming items per million
ISO 13448-1:2005	ISO 28598-1:2017	Acceptance sampling procedures based on the allocation of priorities principle (APP) — Part 1: Guidelines for the APP approach
ISO 13448-2:2004	ISO 28598-2:2017	Acceptance sampling procedures based on the allocation of priorities principle (APP) — Part 2: Coordinated single sampling plans for acceptance sampling by attributes

Cross references between the above listed documents have been corrected in the minor revisions.

A list of all documents in the new ISO 28590 - ISO 28599 series of International Standards can be found on the ISO website.

Introduction

This general introduction to the ISO 2859 acceptance sampling series describes the attribute sampling schemes and plans set forth in ISO 2859-1, ISO 2859-2, ISO 2859-3, ISO 2859-4 and ISO 2859-5. This introduction treats the subject of sampling inspection by attributes in a general way, introducing the essential operating procedures and the ways in which the systems were designed to be used. To understand fully the concepts and their applications, it is necessary to consult ISO 2859-1, ISO 2859-2, ISO 2859-3, ISO 2859-4, ISO 2859-5 and ISO/TR 8550-1.

The individual parts of this series of international standards extend this introductory explanation to more specific applications that are appropriate for the particular standard.

It is emphasized that ISO 2859-1 provides sampling schemes indexed by acceptance quality limit (AQL). The quality measure used can be percent nonconforming or the number of nonconformities per 100 items. ISO 2859-1 was developed primarily for the inspection of a continuing series of lots all originating from the same production or servicing process. In this situation, adequate protection (or the maximum process average percent nonconforming) is maintained by use of the switching rule from normal to tightened inspection should a certain (limiting) number of unacceptable lots be found in a short series of successive lots.

ISO 2859-2 provides sampling plans applicable for use when individual or isolated lots are to be sampled. These sampling plans are in many instances identical to those in ISO 2859-1. The tables of sampling plans in ISO 2859-2 include information regarding the quality level required to assure a high probability of lot acceptance.

ISO 2859-3 provides skip-lot procedures for use when the process quality is markedly superior to the AQL for a defined long period of delivery or observation. When the quality level is in this state of excellence, it is sometimes more economical to use ISO 2859-3 than to use the reduced sampling procedure of ISO 2859-1. Like ISO 2859-1, ISO 2859-3 is applicable to a continuing series of lots from a single source.

ISO 2859-4 provides a procedure that may be used to verify a quality level that has been declared for some entity. This function is not appropriate for the other parts of the series. The main reason for this is that those procedures have been indexed in terms of quality levels that are relevant solely for the purpose of acceptance sampling, and the various risks have been balanced appropriately. The procedures in ISO 2859-4 have been developed in response to the need for sampling procedures suitable for formal, systematic inspections such as reviews or audits.

ISO 2859-5 provides a method of establishing sequential sampling plans of discriminatory power essentially equivalent to that of corresponding plans of ISO 2859-1.

A complementary system of sampling plans for inspection by variables, also indexed by AQL, is provided by the ISO 3951 series, *Sampling procedures for inspection by variables*.

Sampling procedures for inspection by attributes — Introduction to the ISO 2859 series of standards for sampling for inspection by attributes

1 Scope

This International Standard provides a general introduction to acceptance sampling by attributes and provides a brief summary of the attribute sampling schemes and plans used in ISO 2859-1, ISO 2859-2, ISO 2859-3, ISO 2859-4 and ISO 2859-5, which describe specific types of attribute sampling systems. It also provides guidance on the selection of the appropriate inspection system for use in a particular situation.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 2859-2:1985, *Sampling procedures for inspection by attributes — Part 2: Sampling plans indexed by limiting quality (LQ) for isolated lot inspection*

ISO 2859-3, *Sampling procedures for inspection by attributes — Part 3: Skip-lot sampling procedures*

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

ISO 2859-5:2005, *Sampling procedures for inspection by attributes — Part 5: System of sequential sampling plans 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*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 2859-1, ISO 2859-2, ISO 2859-3, ISO 2859-4, ISO 2859-5, ISO 3534-1 and ISO 3534-2 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 General introduction to acceptance inspection

4.1 Aim of sampling inspection

The principal purpose of acceptance sampling inspection is to see that the producer submits lots of a quality that is at, or better than, a mutually agreed level. All ISO 2859 series standards are based on a common parameter, e.g. AQL or LQ.

The producer may use these sampling procedures to ensure that the quality level will be acceptable to the consumer. In all these procedures, it must be recognized that the financial resources are not unlimited. The cost of the item should reflect the cost of inspection as well as the cost of production.

A real effort shall be made to ensure that a system is devised that clearly places responsibility for quality with the producer. Inspection can appear to divert the responsibility for quality from the producer to the inspector. This may happen whenever there is a belief that the inspector is there to sort things out, so that, within limits, what happens in production will be caught by inspection. Sampling inspection has little effect on the quality of the product lot or batch.

Sampling schemes and plans designated in the ISO 2859 series are applicable, but not limited, to inspection of

— end items,

— components and raw materials,

— operations,

— materials in process,

— supplies in storage,

— maintenance operations,

— data or records, and

— administrative procedures.

4.2 Acceptance sampling

Acceptance sampling inspection has the merit of putting the responsibility for quality where it belongs, with the producer. The inspector is no longer regarded as the person who corrects errors. The producer must see that the product is of high quality, otherwise there will be inconvenience and expense with unacceptable lots. Sampling inspection can and should lead to less inspection work, lower cost and good quality for the consumer.

The sampling inspection schemes of ISO 2859-1, ISO 2859-2, ISO 2859-3 and ISO 2859-5 provide for quantification of the risk of accepting unsatisfactory product (known as the consumer's risk) and the risk of not accepting satisfactory product (known as the producer's risk), and for choosing a plan that allows no more risk than is acceptable.

4.3 Other inspection practices

4.3.1 General

In addition to the sampling plans of ISO 2859-1, ISO 2859-2, ISO 2859-3, ISO 2859-4 and ISO 2859-5, which are based on the mathematical theory of probability, there are other inspection practices, for example:

a) sampling based on experience with the product, the process, the supplier and the consumer (see 4.3.2);

b) ad hoc sampling, for example the inspection of a fixed percentage, or occasional random checks (see 4.3.3);

c) 100 % inspection (see 4.3.4);

d) other “sampling” practices (see 4.3.5).

4.3.2 Statistical sampling

Sampling based on experience with the product, the process, the producer and the consumer can be statistically evaluated, provided that random sampling and a predefined set of rules for varying sample size and sampling frequency are used.

An example is the procedure described in ISO 2859-1, which uses a set of switching rules. When the quality is very good, it is possible to switch to reduced inspection. This provides a procedure where, if smaller samples are used, the producer’s risk is reduced but the consumer’s risk is increased. If the process average is consistently smaller than the specified acceptance quality limit (AQL), this is justified. When the process average over at least 10 lots has been very much smaller than the AQL, some consumers resort to skip-lot procedures (see ISO 2859-3). This can be even more economical than the reduced inspection described in ISO 2859-1.

In some instances, particularly when routine or non-critical items are involved, some consumers may feel safe in resorting to the practice of inspecting small samples of the product and, provided there are zero nonconforming items, accepting the lot. For example, a sample size of eight with an acceptance number of zero is equivalent to the small lot sampling plans with an AQL of 1,5 % normal, or 0,65 % reduced inspection. See Tables 2-A and 2-C in ISO 2859-1:1999.

Conversely, in ISO 2859-1, when two out of five or fewer successive lots fail inspection, normal inspection is discontinued and tightened inspection is instituted. Once tightened inspection has been instituted, normal inspection is not restored until five successive lots have been accepted on tightened inspection. This requirement is intentionally severe, because evidence of unacceptable quality has been found, as a result of which, the producer forfeits the right to the benefit of the doubt. If, while operating on tightened inspection, the cumulative number of lots not accepted on original tightened inspection reaches five, inspection by sampling shall be discontinued until there is evidence that corrective action has been taken and has been fully effective.

4.3.3 Ad hoc sampling

Ad hoc sampling should not be used because it will lead to unknown risks that may be too high. Furthermore, there is no formal basis for either the acceptance or non-acceptance of the lot. Examples of ad hoc sampling include sampling of a fixed percentage of a lot or a convenience sample taken at haphazard times.

4.3.4 100 % inspection

100 % inspection can be a formidable task unless it is performed with automatic test equipment, or lot sizes are small. In addition, it is not always fully effective, particularly when a large number of items have one or more characteristics that are marginal in appearance, performance or dimension (close to or concentrated about a tolerance or limit of appearance or performance). Sampling inspection may be done with more care and is less prone to the effects of human fatigue. Under these conditions, sorting by manual or automatic methods is likely to classify some conforming items as nonconforming and vice versa. In addition, 100 % inspection can sometimes degenerate into superficial 100 % inspection when, in fact, sufficient money, time and staff are not available. In addition, 100 % inspection is not viable if the inspection method necessitates destruction of the product. It has to be understood, however, that 100 % inspection may form a necessary part of the inspection process for both the consumer and the producer, or a rejected lot must be screened to remove nonconforming product. There are situations in which it cannot be avoided, for example, when inspecting for critical nonconformities that are so important that every item must be examined when inspections are non-destructive. When inspection is destructive, some risks are inevitable.

4.3.5 Other sampling practices

Various sampling systems exist, but only those available as international standards in the ISO 2859 series will be considered in detail in this International Standard. This does not mean that the others are not important. It is merely that the main purpose of this International Standard is to introduce the ISO 2859 family of standards.

In many instances, consumers do not perform any regular sampling but rely on their experience and past sampling evidence that the producer is maintaining statistical control of the production process and is forthright in the evaluation of what is being shipped.

If, in a particular situation, information is available of the true costs of the mistaken non-acceptance of good articles and the acceptance of bad ones, and if it is known how often lots of any given quality are presented, this may be one of the occasions when it would be better to determine a more efficient scheme on the basis of the economic information available. In such instances, it is possible to develop sampling plans that are more cost-effective than those in the ISO 2859 series. ISO/TR 8550-1 includes procedures for developing such plans.

4.4 Concepts of AQL and LQ

The sampling plans in the ISO 2859 series are indexed by AQL or LQ. AQL stands for acceptance quality limit and is defined as the worst tolerable product quality level in a lot. LQ stands for limiting quality. It is the quality level, for a lot in isolation, which, for the purpose of sampling inspection, is limited to a low probability of acceptance.

5 The ISO 2859 series

5.1 ISO 2859-1, *Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

5.1.1 General

ISO 2859-1 specifies an acceptance sampling system for inspection by attributes. It is indexed in terms of lot size, inspection level and acceptance quality limit (AQL).

Its purpose is to induce the producer through the economic and psychological pressures of lot non-acceptance to maintain a process average at least as good as the specified acceptance quality limit. In fact, to be reasonably assured of lot acceptance, the process average should be much less than the AQL. The International Standard also provides an upper limit for the risk to the consumer of accepting the occasional poor lot.

5.1.2 Application

The sampling schemes in ISO 2859-1 are intended primarily to be used for the acceptance of mass produced items from a production line where the items are formed into a continuing series of lots for inspection purposes. As a minimum, the series should include at least 10 lots of similar size to allow the switching rules to have proper effect. These switching rules are an integral part of the sampling schemes and are designed to provide:

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

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

For isolated lots, it is recommended that the user consult the sampling plans indexed by limiting quality (LQ) given in ISO 2859-2. Sampling plans in ISO 2859-1 may also be used for the inspection of lots in

isolation, but in this case, the user is strongly advised to consult the operating characteristic curves to find a plan that will yield the desired protection.

Single, double, and multiple sampling plans and a wide range of AQLs are included in ISO 2859-1. These plans were developed so that their operating characteristics closely match. That is, users of single, double, or multiple plans would incur the same risks.

EXAMPLE 1 A product has five dimensions to be checked. Dimensions 1 and 2 are in Class A with an AQL of 0,65 % and the other three dimensions are Class B with an AQL of 2,5 %. It was specified that general inspection level III should be used for all of the dimensions. The product is produced in lots of 900 items. Table 1, in ISO 2859-1:1999, gives code letter K for this situation. Table 2-A, also in ISO 2859-1:1999, indicates the single sample size for normal inspection to be 125 and the acceptance numbers are 2 and 7 for AQL of 0,65 % and 2,5 %, respectively. For a particular lot, the results are

— one item nonconforming in dimension 1 only,

— one item nonconforming in dimensions 2 and 4,

— two items nonconforming in dimension 3 only, and

— three items nonconforming in dimensions 3 and 4.

There are two nonconforming items in Class A and five in Class B, therefore the lot is accepted.

EXAMPLE 2 Another product is being supplied in lots of 4 000. The AQL is 1,5 % nonconforming. The general inspection level is III with single sampling. Table 1 in ISO 2859-1:1999 gives code letter M, and Tables 2-A, 2-B and 2-C in ISO 2859-1:1999 gives the following sampling plans (see Table 1 below).

Table 1 — Example of sampling plans

	Normal inspection	Tightened inspection	Reduced inspection
Sample size	315	315	125
Acceptance number	10	8	6
Rejection number	11	9	7

Inspection starts with the normal plan. Lots 10 and 12 were not accepted, requiring a switch to tightened inspection. Normal inspection cannot be resumed until five successive lots have been accepted. If five lots are not accepted while on tightened inspection, the sampling inspection will be discontinued. ISO 2859-1 contains a procedure for a switching score. If this score reaches 30, reduced inspection may be used. Reduced inspection may be used until a lot is not accepted.

5.2 ISO 2859-2, *Sampling plans indexed by limiting quality (LQ) for isolated lot inspection*

5.2.1 General

ISO 2859-1 is an acceptance sampling system indexed by the acceptance quality limit (AQL). It is widely used for various purposes, but it was originally designed for the inspection of a continuing series of lots where switching rules are employed. However, there are situations where the switching rules of ISO 2859-1 are not applicable, such as when lots are isolated. ISO 2859-2 is designed for such situations.

ISO 2859-2 provides sampling plans indexed by limiting quality (LQ). AQLs are not directly used for entries. This is a major difference from the special procedures for limiting quality protection given in ISO 2859-1.

The selection of sampling plans in ISO 2859-2 has been designed in accordance with the following principles.

a) As far as possible, single sampling plans under normal inspection from ISO 2859-1 were used in the construction of the tables in ISO 2859-2.

b) The series of preferred LQs for indexing should be different from the series of preferred AQLs, to avoid confusion.

c) Whenever practical, the following five basic values associated with a single sampling plan may be found in the same table:

   1) lot size;

   2) sample size;

   3) acceptance number;

   4) producer's risk quality or AQL;

   5) LQ.

5.2.2 Application

ISO 2859-2 specifies an acceptance sampling system for inspection by attributes, indexed by limiting quality (LQ). This sampling system is used for lots in isolation, i.e. an isolated lot from a sequence of lots or a unique lot, where the switching rules of ISO 2859-1 are not applicable. The purpose of ISO 2859-2 is to supplement ISO 2859-1 by providing sampling plans that are compatible with ISO 2859-1.

The sampling plans in ISO 2859-2 are indexed by a series of preferred values of limiting quality (LQ), where the consumer's risk is usually below 10 % and is almost always below 13 %. This method of indexing provides a standard procedure, which is more convenient than the special procedure for limiting quality protection of ISO 2859-1.

ISO 2859-2 is intended to be used for inspection for nonconforming items. It is also applicable for inspection for number of nonconformities per 100 items except where the LQ is too large. If ISO 2859-2 is not applicable, users should refer to the special procedures for limiting quality protection given in ISO 2859-1.

ISO 2859-2 provides the following two procedures, one of which is to be chosen according to the application:

a) Procedure A

This procedure may be used when the producer and the consumer both wish to regard the lot to be in isolation. That is, it is a unique lot.

b) Procedure B

This procedure may be used when the producer considers that the lot is one of a continuing series, but the consumer considers that the lot is received in isolation.

Procedure B sampling plans are given in Tables B.1 to B.10 of ISO 2859-2:1985. These tables also provide summarized information on the relationship between ISO 2859-1 and ISO 2859-2. Table C of ISO 2859-2:1985 contains double and multiple sampling plans for isolated lots.

EXAMPLE 1 A consumer wishes to purchase pre-packed sets of 10 screws to be included in the self-assembly bookcase kits he plans to sell. While he prefers each set to contain exactly 10 screws, he can tolerate 1 % of the packs with fewer screws, but he does not want to risk accepting a much higher percentage of deficient packs. He plans to produce 5 000 kits in lots of 1 250.

The supplier agrees to use Procedure A with a limiting quality level (LQ) of 3,15 %. For lots of size 1 250, the selected sampling plan will be n = 125 and Ac = 1.

The supplier offers to provide the packs needed for all 5 000 kits as a single lot. The new sampling plan is n = 200, Ac = 3.

The single lot requires proportionately fewer items and yet the sampling plan still provides a high probability of rejection for quality as poor as 3,15 %. It increases the probability of acceptance for a lot with a quality of 1 % nonconforming from 0,64 to 0,86.

EXAMPLE 2 The same consumer wishes to produce the wooden components of his self-assembly bookcase kits as plastic-faced chipboard panels. The supplier produces these panels as part of his regular production and regards the 7 500 panels needed for each lot of 1 250 kits as single lots in the general stream of supply to similar purchasers. Scratches on the plastic facing occur with probability 0,025 according to quality control inspections. The consumer can tolerate some scratched panels since these can be detected and set aside during the assembly of the bookcase kits. However, he decides that if 5 % of the panels were scratched, it would present assembly problems.

The consumer and supplier agree that Procedure B is appropriate and select a limiting quality of 5,0 % with inspection level III. ISO 2859-2 indicates a sampling plan of n = 315 and Ac = 10 for the lots of 7 500 panels.

5.3 ISO 2859-3, *Skip-lot sampling procedures*

5.3.1 General

ISO 2859-3 provides attribute skip-lot sampling procedures. These procedures are intended to reduce the inspection effort on products submitted by suppliers who have an effective control over all facets of quality and who consistently produce lots that meet requirements. The reduction in inspection effort is achieved by determining at random, with a specified probability, whether a lot presented will be passed without inspection. This procedure extends to the inspection of lots the principle of random selection already applied within ISO 2859-1 to the individuals comprising a lot.

5.3.2 Application

These procedures are intended only for a continuing series of lots or batches and are not to be used for isolated lots. All lots in the series are expected to be of a similar quality and there should be reason to believe that the lots not inspected are of the same quality as those inspected.

ISO 2859-3 is to be used only for characteristics inspected by attributes as designated in ISO 2859-1. Its application differs from that of reduced inspection in ISO 2859-1. When inspecting multiple characteristics, the skip-lot procedures will follow the same principles used in the associated ISO 2859-1 procedures.

The skip-lot procedures in ISO 2859-3 can only be implemented if the ISO 2859-1 procedures are in use on normal or reduced inspection, or a combination of normal and reduced inspection at general inspection levels I, II, or III.

Multiple sampling plans may only be used during the qualification phase associated with normal inspection. It is strongly recommended that single sampling plans with an acceptance number of zero not be used in ISO 2859-3. Skip-lot inspection may be used in the place of reduced inspection if it is more cost-effective.

It is essential that skip-lot procedures are not applied to the inspection of product characteristics that bear upon the safety of individuals.

Skip-lot plans consist of inspection frequencies of one lot in two, one in three, one in four, and one in five lots. Procedures include a rule for returning to inspection of each lot and rules for moving from one frequency to another.

EXAMPLE A qualified manufacturer of capacitors satisfies the general requirements for skip-lot inspection. Following the procedures in ISO 2859-3, he obtains a qualification score of 50 within 20 lots. He then qualifies for the skip-lot inspection stage. In this case, he reaches this stage in 14 lots. This qualifies him for a frequency of one in three lots to be inspected.

The next 11 lots inspected are accepted. The qualification score reached 50 within these 11 lots. This qualifies him to switch to inspection of one in four lots. When a product is disqualified for skip-lot inspection, a return to normal inspection is required.

5.4 ISO 2859-4, *Procedures for assessment of declared quality levels*

5.4.1 General

The procedures in ISO 2859-4 differ in scope from the procedures in ISO 2859-1, ISO 2859-2, ISO 2859-3 and ISO 2859-5. The system of acceptance sampling procedures that are specified in ISO 2859-1, ISO 2859-2, ISO 2859-3 and ISO 2859-5 are intended to be used in bilateral agreements between two parties. These procedures are simple and pragmatic rules for releasing product after inspection of only a limited sample of a lot or consignment. Therefore they do not make reference (either explicitly or implicitly) to any formally declared quality level (DQL).

Procedures in ISO 2859-1, ISO 2859-2, ISO 2859-3 and ISO 2859-5 are well suited for acceptance sampling purposes, but they should not be used in reviews or audits to verify a quality level that has been declared for some entity. The primary reason for this is that these procedures have been indexed in terms of quality levels that are solely for the purposes of acceptance sampling. Thus, the risks of accepting nonconforming product and not accepting conforming product have been balanced accordingly.

The procedures in ISO 2859-4 have been developed as a response to the need for sampling procedures applicable to formal, systematic inspections such as reviews or audits. When performing such formal inspections, the responsible authority must consider the risks of reaching incorrect conclusions about the quality of a lot, and to consider these risks in the planning of the review or audit.

ISO 2859-4 provides guidance to assist the user in considering these risks. Rules are included so that there is only a small, limited risk of contradicting the DQL when the actual quality level conforms to the declared level. If it were also desired that there should be a small risk of not contradicting the DQL when the actual quality level fails to conform to the declared level, a very large sample would be required. To obtain the benefit of a moderate sample size, procedures are included that allow for a higher risk of failing to contradict the DQL when the actual quality level fails to conform to the DQL.

5.4.2 Application

ISO 2859-4 provides sampling plans and procedures that can be used to assess whether the quality level of a lot or process conforms to a DQL. The sampling plans have been constructed to have a risk of less than 5 % of contradicting a correct DQL, and a risk of 10 % of failing to contradict an incorrect DQL. Sampling plans are provided corresponding to three levels of discriminatory ability. In contrast to the procedures in other parts of ISO 2859, the procedures in this International Standard are not applicable to acceptance sampling.

Procedures in ISO 2859-4 may be used for various forms of quality inspection when objective evidence of conformity to some DQL is to be provided by means of the inspection of a sample. These procedures are applicable, but not limited, to lots or processes that allow for random samples of individual items to be taken. The sampling plans are applicable to the inspection of a variety of products.

The sampling plans in ISO 2859-4 are to be used when the quantity of interest is the number or fraction of nonconforming items where each inspected item is classified as conforming or nonconforming. With minor changes, the sampling plans may also be used when the quantity of interest is the number of nonconformities.

EXAMPLE During the audit of a sales department, it was revealed that the invoicing process was a source of substantial financial loss. The auditors estimated that 5 % of the invoices had been processed incorrectly. Management decided to introduce a special training program with the aim of reducing the error rate to 1 %. After the program had been completed, management wished to assess its effectiveness.

It was decided to use ISO 2859-4 to evaluate the effectiveness of the training program by selecting a DQL of 1 %. Management also wanted a small probability of concluding the program to be successful when it is not. Therefore, the sampling plan selected was a sample size of 125 invoices with no more than three nonconforming. ISO 2859-4 indicated that this sampling plan would have a 3,7 % risk of contradicting a correct DQL of 1 %, and a 10 % risk of failing to contradict when the actual level is 5,27 % incorrectly processed invoices.

When the 125 invoices were randomly selected, two were found to be nonconforming. The appropriate conclusion would then be, based on the sample of 125 invoices, that sufficient evidence was not found to contradict the DQL of 1 % for all invoices from which the 125 had been randomly selected.

5.5 ISO 2859-5, *System of sequential sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

5.5.1 General

ISO 2859-5 contains sequential sampling schemes that supplement the ISO 2859-1 acceptance sampling system for inspection by attributes.

The principal advantage of sequential sampling plans is a reduction in the average sample size. This is the average of all the sample sizes that may occur using a given sampling plan for a specific lot or process quality level. Double, multiple and sequential sampling plans all lead to smaller average sample sizes than single sampling plans with an equivalent operating characteristic. The average savings are greater when using a sequential sampling plan than for double or multiple sampling plans.

For lots of very good quality, the maximum saving for sequential sampling plans may reach 85 %, compared to 37 % for double sampling plans and 75 % for multiple sampling plans. However, when using a double, multiple or sequential sampling plan, the actual number of items inspected for a particular lot may exceed the sample size of the corresponding single sampling plan, n_0. For classical sequential sampling plans, there is no limit imposed on the sample size, and the actual number of inspected items may considerably exceed the corresponding single sample size, n_0, or even the lot size, N. For the sequential sampling plans in ISO 2859-5, a curtailment rule has been introduced involving an upper limit of 1,5 n_0 on the actual number of items to be inspected.

Factors other than the average sample size that should be considered when choosing an appropriate sampling procedure include the following.

a) Complexity

The rules for a sequential plan are more difficult to understand than the simpler rules for a single sampling plan.

b) Variability in the amount of inspection

Because the actual number of items inspected for a particular lot is not known in advance, the use of sequential sampling plans introduces possible organisational difficulties. For example, scheduling of inspection operations may be difficult.

c) Difficulty of drawing sample items

If drawing sample items is at times expensive, the reduction in the average sample size for sequential sampling plans may be cancelled by the increased sampling cost.

d) Duration of inspection

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

The advantages and disadvantages of double and multiple sampling plans always lie between those of single and sequential sampling plans. The balance between the advantage of a smaller average sample size and the above disadvantages leads to the conclusion that sequential sampling plans generally are suitable only when inspection of individual items is costly compared to inspection overhead.

5.5.2 Application

Just as in the case of ISO 2859-1, the ISO 2859-5 acceptance sampling system is indexed by the acceptance quality limit (AQL). Its purpose is 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 acceptance quality limit. It also provides an upper limit to the risk to the consumer of accepting the occasional poor lot.

The schemes of ISO 2859-5 are designed for a series of lots long enough to permit the switching rules to be used. These switching rules provide:

a) enhanced protection to the consumer (by means of tightened sampling inspection or discontinuation of sampling inspection) should deterioration in quality occur;

b) an incentive, at the discretion of the responsible authority, to reduce inspection costs (by means of reduced or skip-lot sampling inspection) should consistent good quality be demonstrated.

Where lots are produced in isolation or in a series too short for ISO 2859-5 to apply, the user is advised to consult ISO 2859-2 for appropriate sampling plans.

EXAMPLE The ISO 2859-1 sampling system has been used for inspection of a certain product. The specified AQL is 4,0 % nonconforming. General inspection level I is being used. The single sampling plan for normal inspection has been used for a few lots. The lot size (N) is 1 500 items.

Management has decided to use a sequential sampling scheme from ISO 2859-5. Code letter H is identified in Table 1 of the ISO 2859-5:2005 for general inspection level I and lot size 1 500. The parameters and the curtailment values of the sequential sampling plan are found in Table A.2 of ISO 2859-5:2005. The curtailment values are as follows:

$n_t = 80$ and $Ac_t = 7$.

Therefore, rejection and acceptance values (R and A) are given by the following expressions:

$$R = 0{,}097 n_{cum} + 2{,}449$$

and

$$A = 0{,}097 n_{cum} - 1{,}426$$

where n_{cum} is the current cumulative sample size.

When the numerical method is used, the rejection and acceptance values, i.e. R and A, can be calculated for each n_{cum} from 1 to $n_t - 1$. In this example, this is 79. R and A are then rounded to determine the rejection and acceptance number, Re and Ac, respectively, where A is rounded to the nearest integer below and R is rounded to the nearest integer above it. If the rejection number is larger than the curtailment value, Re_t, the rejection number shall be equal to the curtailment value. In this case, this is 8.

Suppose now that consecutive items randomly selected from the lot are submitted for inspection. The results of the inspection are as given in Table 2, where D is the cumulative number of nonconforming items.

Table 2 — Example of inspection results

n_{cum}	Ac	Re	D
7	–1	4	1
11	–1	4	2
14	–1	4	3
21	0	5	4
24	0	5	5

For $n_{cum} = 24$, we have the number of nonconforming items, $D = 5$, and this value is greater than or equal to the calculated rejection value R. Hence the inspection is terminated and the lot is rejected. As indicated in Table 2, this is the first time that $Ac < D < Re$ is not true.

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