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Sampling procedures for inspection by attributes —

Part 5: System of sequential sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection

Règles d'échantillonnage pour les contrôles par attributs —

Partie 5: Système de plans d'échantillonnage progressif pour le contrôle lot par lot, indexés d'après la limite d'acceptation de qualité (LAQ)

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Foreword

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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.

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ISO 2859-5 was prepared by Technical Committee ISO/TC 69, *Applications of statistical methods*, Subcommittee SC 5, *Acceptance sampling*.

This first edition cancels and replaces Annex A of ISO 8422:1991, which has been technically revised to greatly improve its compatibility with the sampling systems in ISO 2859-1.

ISO 2859 consists of the following parts, under the general title *Sampling procedures for inspection by attributes*:

— *Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

— *Part 2: Sampling plans indexed by limiting quality (LQ) for isolated lot inspection*

— *Part 3: Skip-lot sampling procedures*

— *Part 4: Procedures for assessment of declared quality levels*

— *Part 5: System of sequential sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

— *Part 10: Overview of the ISO 2859 attribute sampling systems*

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 (10^{-6}). Under such circumstances, popular acceptance sampling plans, such as those presented in ISO 2859-1, require prohibitively large sample sizes. To overcome this problem, users apply acceptance sampling plans with higher probabilities of wrong decisions or, in extreme situations, abandon the use of acceptance sampling procedures altogether. However, in many situations there is still a need to accept products of high quality using standardized statistical methods. In such cases, there is a need to apply statistical procedures that require the smallest possible sample sizes. Sequential sampling plans are the only statistical procedures that satisfy that need as, among all possible sampling plans having similar statistical properties, the sequential sampling plan has the smallest average sample number. Therefore, there is a strong need to present sequential sampling plans which are statistically equivalent to the commonly used acceptance sampling plans from ISO 2859-1, but which require significantly smaller average sample numbers.

The principal advantage of sequential sampling plans is the reduction in the average sample number. The average sample number is the weighted average of all the sample sizes that may occur under a sampling plan for a given lot or process quality level. Like double and multiple sampling plans, the use of sequential sampling plans leads to a smaller average sample number than single sampling plans having the equivalent operating characteristics. However, the average savings are even greater when using a sequential sampling plan than when a double or multiple sampling plan is used. For lots of very good quality, the maximum savings for sequential sampling plans may reach 85 %, as compared to 37 % for double sampling plans and 75 % for multiple sampling plans. On the other hand, 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 double and multiple sampling plans, there is an upper limit of 1,25 n_0 to the actual number of items to be inspected. For classical sequential sampling plans there is no such limit, 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 this part of ISO 2859, a curtailment rule has been introduced involving an upper limit of 1,5 n_0 on the actual number of items to be inspected.

Other factors that should be taken into account include the following.

a) Simplicity

   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 organisational difficulties. For example, scheduling of inspection operations may be difficult.

c) Ease of drawing sample items

   If drawing sample items is expensive at different times, the reduction in the average sample number 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 representative sample under a sequential sampling plan is far more awkward than under 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 number 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.

The choice between the use of a single, double, multiple, or sequential sampling plan shall be made before the inspection of a lot is started. During the 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 use of sequential sampling plans is on average much more economical than the use of corresponding single sampling plans, during inspection of a particular lot, acceptance or non-acceptance may occur at a very late stage due to the cumulative count of nonconforming items (or nonconformities) remaining between the acceptance number and the rejection number for a long time. When using the graphical method, this corresponds to the random progress of the step curve remaining in the indecision zone. Such a situation is most likely to occur when the lot or process quality level (in terms of percent nonconforming or in nonconformities per 100 items) is close to $(100g)$, where g is the parameter giving the slope of the acceptance and rejection lines.

To improve upon this situation the sample size curtailment value is set before the inspection of a lot begins. If the cumulative sample size reaches the curtailment value n_t without determination of lot acceptability, inspection terminates and the acceptance or non-acceptance of the lot is then determined using the curtailment values of the acceptance and rejection numbers.

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 2859; 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.