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SELECTION OF METHODS OF ACCEPTANCE INSPECTION IN PRODUCTION

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ABSTRACT

Product quality control in production is carried out by various methods. But the most effective method is based on actual observations or calculations. This article provides an acceptance method for product quality control in production lines by various types of control. A decision is given on how to organize or draw up a product control plan, registration of control data, analysis of these results and conclusions for their improvement.

KEYWORDS: *Single-Stage, Multi-Stage, Sequential, Classification Of Methods, Operational Characteristics, Test Results, Samples, Value Of The Rejection Level, Efficiency Assessment.*

1. INTRODUCTION

Consider control plans, which are based on the principle of inadmissibility of consignments entering the goods, the quality level of which is lower than the acceptable in operation. In practice, three types of acceptance control plans are most common:

- One-stage - the decision to accept or rejected lot is made on the basis of checking a single sample from it;

- Multistage - the decision to accept or rejected a lot is made on the basis of tests ($k \geq 2$) samples, and the maximum number of samples is limited and predetermined. In practice, two-stage control is most often used, in which the number of samples does not exceed two;

- Sequential - the decision on batch acceptance, rejection or continuation of testing is made after evaluating each sequentially inspected product, and the number of products subject to inspection is not limited in advance.

Each of these plans has a number of advantages and disadvantages. One-step inspection plans are much simpler from an organizational point of view, as they provide for a basic inspection procedure in which the sample size is constant and known in advance. In other plans, the control procedures are much more complicated; their application in production requires qualified personnel. At the same time, with multi-stage and sequential control with the same average sample size equal to the sample size of one-stage control, greater reliability of decisions is achieved.

Further classification of acceptance control methods is related to the principle of classification of test results.

The fact is that the degree of suitability of products for further use can be determined in various ways. For example, you can register the exact numerical values of the parameters, or you can make one of two decisions: is the product suitable for further use or not, that is, divide products into good and defective. In the first case, they talk about the so-called quantitative quality attribute, in the second - about the alternative.

Accordingly, two main statistical control methods are distinguished: by alternative and quantitative criteria. There is also quality control (a special case of which is control by an alternative indicator), but for this method no standardized control plans have been developed and therefore it is practically not used.

Alternative trait control has several advantages over quantitative trait control. First, it is simpler both in terms of the amount of computation and its organization in production. Secondly, the control technique does not depend on the type of distribution of the measured parameters and therefore is more universal (when controlling by quantitative criteria, in most cases it is assumed that the measured parameters have a normal distribution).

However, when testing on an alternative basis, only a small part of the information contained in the observations is used, which leads to the need for a large number of measurements.

In accordance with the decision on the further use of the batch, inspection plans are divided into two types:

D1 - when the conclusion of the rejection of the batch leads to a decision to reject the batch as unfit;

D2 - when the conclusion of the rejection of the lot leads to a decision on its sorting and removal of defective products (with or without replacement of defective products with good ones).

If control is destructive, then only plans of the first type can be used; in all other cases, the choice of the type of plan is determined by purely economic considerations and specific production conditions.

Main characteristics of statistical acceptance control plans. Since, during statistical acceptance control, a judgment on the quality of a lot is made on the basis of testing only a part of the products from a lot (sample), errors associated with the rejection of good and acceptance of bad

lots are inevitable. With a random selection of products, it is possible, with a small total of defective products in the lot, to select a significant number of defective products for inspection, which will lead to a false decision about rejecting a good lot (error of the first kind). On the other hand, if the lot is littered with defective products, there may be a relatively small number of defective products in the sample, and a bad lot will be accepted (type II error).

The challenge is to ensure that such erroneous conclusions are made extremely rarely under sampling conditions, and the degree of their possibility is predetermined. Errors of the first and second kind should be taken into account when planning acceptance inspection, as well as proof tests.

To assess the effectiveness of a sampling plan, a so-called operational characteristic, or, as it is otherwise called, performance characteristic, is used. The operational characteristic of a control plan is understood as a function P (q) equal to the probability of accepting a batch with a quality level q.

2. RESULTS

Let's consider the operational characteristics of the plan of continuous control.

During the inspection of each sample in the lot, the exact number of defective samples in the lot is known. If this quantity is greater than a certain critical value $M_{cr} = N_{qcr}$ (N is the volume of the batch), then such a batch will necessarily (with a probability equal to one) be rejected as not meeting the requirements of the consumer. If the number of defective samples in the sample is less than M_{cr}, then the lot will be accepted with a probability of one. At the same time, it is considered that errors associated with determining the degree of suitability of the sample are excluded. The operational characteristics of the complete control plan are shown in Figure 1.1, a. This operational characteristic will be called ideal. However, it is impossible to build a sample plan with such a performance characteristic. In these cases, the supplier and the consumer agree on two quality levels q_0 and q_m: lots with a quality level $q \geq q_0$ are considered to be known to be good, and lots with a quality level $q \geq q_m$, with $q > q_0$, are considered bad.

The interval $q_0 \leq q \leq q_m$ is considered a zone of uncertainty. Lots of this quality level are still considered acceptable. The q_0 value is called the acceptance quality level, the q_m value is called the rejection quality level.

Thus, all products are divided into three categories:

-products of the first category, the quality level of which is $q \leq q_0$;

-products of the second category, the quality level of which is $q \leq q_m$;

-products of the third category, the quality level of which satisfies the ratio $q_0 \leq q \leq q_m$.

Requirements are imposed on the control plan, which are that the parties of the first category should, if possible, be accepted, the second, if possible, rejected. In quantitative terms, these requirements are expressed in the fact that the probability of accepting a batch with a quality level $q \leq q_0$ should be less than $1-\alpha$, and the probability of accepting batches for which $q \leq q_m$ should not exceed β.

The values α and β are referred to as the supplier's risk and the consumer's risk, respectively, and represent the probabilities of errors of the first and second kind. Supplier's risk α is the probability of making a false decision about rejecting a good lot (the supplier risks incurring unjustified losses). The consumer's risk β is the probability of making a false decision to accept a bad batch (the consumer is at risk of incurring losses).

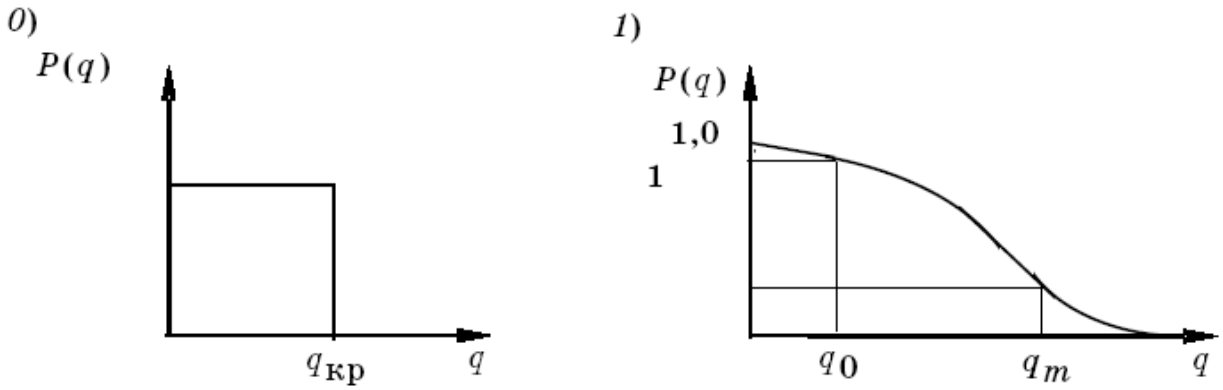

Figure 1.1. Operational characteristics of the control plan: a - continuous; b - statistical

The assignment of risks α and β provides guarantees for the supplier and the consumer regarding the rejection of good and acceptance of bad lots. In practice, the values of α and β are chosen equal to 0.1; 0.01; 0.05. Their appointment is not a statistical task, but is completely determined by the consequences of incorrect decisions (errors of the first and second kind).

Thus, if the requirements of the supplier and the consumer are formulated in the form of four numbers, for example: $q_0 = 0.01$; $q_m = 0.05$; $\alpha = \beta = 0.1$ - this means that, on average, no more than five lots will be rejected out of every hundred lots with a defectiveness level of no more than 1%, and no more than 100 lots containing 5 or more defective products will be accepted.more than five parties.

Thus, for any acceptance control plan, the equations

$$P(q_0) \geq 1 - \alpha \qquad (1.1)$$

$$P(q_m) \leq \beta \qquad (1.2)$$

Considering also that P (0) = 1, P (1) = 0, it is easy to imagine the type of operational characteristics of the statistical control plan (Figure 1.1, b).

Equations (1.1), (1.2) are the basis for setting an acceptance control plan, i.e., assigning the sample size and standards with which the control results are compared, and calculating the operational characteristic P (q).

Consider how requirements and are assigned.

The value of the rejection quality level (q_m) is selected based on the requirements of the consumer who needs products with a quality level of at least q_m. The value of the acceptance level of quality (q_0) is set taking into account the capabilities of production, which must ensure the release of products with a quality level of $q_H \leq q_0$, where q_H is the average level of

contamination of batches during the normal course of production. Only in this case, the supplier guarantees itself against a vain rejection of good lots produced in compliance with the basic requirements of the technology. As a rule, the value of q0 is slightly larger than q_H. Otherwise, the effectiveness of the control plan is reduced. Indeed, if the acceptance level of quality is much less than q_H, the probability of accepting lots, as can be seen from Figure 1.2, drops sharply, and the actual risk of the supplier, α_d, increases.

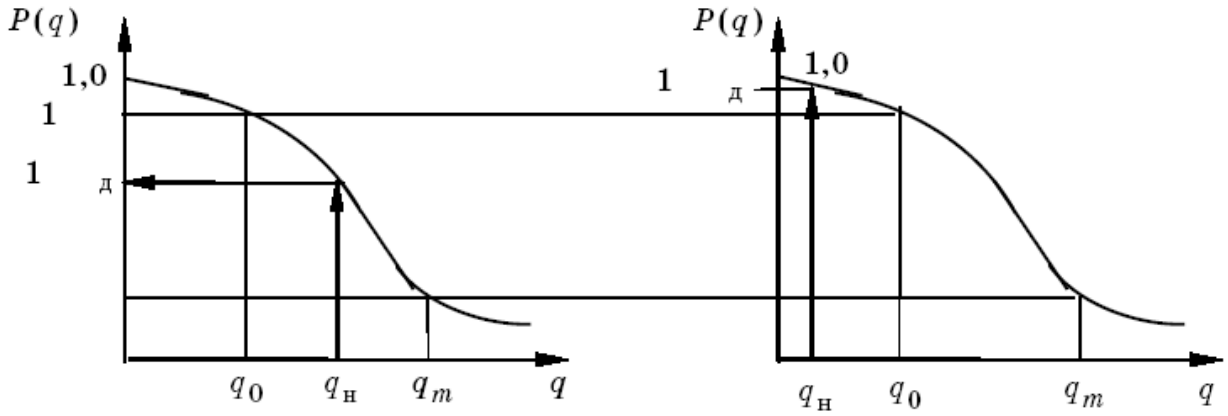

Figure 1.2. The actual risk of the supplier in case of unreasonable setting of the acceptance level of quality

If q_0 is chosen significantly greater than q_H, the actual risk of the supplier is less than a, but such a control plan will, as will be seen from what follows, actually ineffective, since it will require large sample sizes.

3. CONCLUSIONS

Thus, knowledge of: 1) consumer requirements for product quality, 2) the level achieved by the manufacturer, 3) the consequences of making false decisions on acceptance and rejection of lots - turns out to be necessary and sufficient for planning control tests on the principle of an unacceptable level in operation quality. A preliminary assessment of the effectiveness of the control plan is made using an operational characteristic, the nature of the right side of which must satisfy the requirements of the consumer, the left side - the requirements of the supplier, and the middle - one or the other, depending on the degree of responsibility of the controlled products. A more complete assessment of the effectiveness can be carried out taking into account the statistical assessment of the quality level of the accepted products. Such assessments in the statistical acceptance inspection are called follow-up.

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