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An American National Standard

Standard Practice for Use of Process Oriented AOQL and LTPD Sampling Plans[1]

This standard is issued under the fixed designation E1994; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

This standard is an abbreviated compilation of the sampling plans presented by H.F. Dodge and H.G. Romig in their classic development of sampling plans for use with the process associated with a continuing supply of products. The so called AOQL plans provide a means for disposition of product whether or not the process is in control as well as incentives for process improvement in terms of reduced sample size as the process average percent defective is lowered. In addition, so called LTPD plans are provided for use with individual lots of product, not necessarily associated with a process stream.

The sampling plans and parts of the text given here are taken from the Wiley Classics Library Edition of the Dodge-Romig tables (copyright 1998).[2] Additional tables and detailed discussion of the plans, OC curves, and their derivation will be found in that text. The theoretical development of the Dodge-Roming plans will be found in Volumes 8 and 20 of the Bell System Technical Journal[3,4] and an amplification of the plans is given in *Acceptance Sampling in Quality Control.*[5]

1. Scope

1.1 This practice is primarily a statement of principals for the guidance of ASTM technical committees and others in the use of average outgoing quality limit, AOQL, and lot tolerance percent defective, LTPD, sampling plans for determining acceptable of lots of product.

1.2 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[6]

E178 Practice for Dealing With Outlying Observations

E456 Terminology Relating to Quality and Statistics

3. Terminology

3.1 *Definitions*—Terminology E456 provides a more extensive list of terms in E11 standards.

3.1.1 *average outgoing quality (AOQ), n*—the average percent defective of outgoing product including all accepted lots or batches, after any defective units found in them are replaced by acceptable units, plus all lots or batches which are not accepted after such lots or batches have been effectively 100 % inspected and all defective units replaced by acceptable units.

3.1.2 *average outgoing quality limit (AOQL), n*—the maximum of the AOQs for all possible incoming percentages defective for the process, for a given acceptance sampling plan.

3.1.3 *average quality protection, n*—a type of protection in which there is prescribed some chosen value of average percent defective in the product after inspection (average outgoing quality limit (AOQL), that shall not be exceeded in the long

[1] This practice is under the jurisdiction of ASTM Committee E11 on Quality and Statistics and is the direct responsibility of Subcommittee E11.30 on Statistical Quality Control.

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[2] Available from John Wiley and Sons, Inc., 605 Third Ave., New York, NY 10158.

[3] Dodge, H. F. and Romig, H. G., "A Method of Sampling Inspection," *The Bell System Technical Journal*, Vol 8 , No. 10, 1924, pp. 613–631.

[4] Dodge, H. F. and Romig, H. G., "Single Sampling and Double Sampling Inspection Tables," *The Bell System Technical Journal*, Vol 20, No. 1, 1941, pp. 1–61.

[5] Schilling, E. G., *Acceptance Sampling in Quality Control*, Marcel Dekker Inc., NY, 1982, pp. 372–399.

[6] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

run no matter what may be the level of percent defective in the product submitted to the inspector.

3.1.4 *lot quality protection, n*—a type of protection in which there is prescribed some chosen value of limiting percent defective in a lot (lot tolerance percent defective (LTPD)) and also some chosen value for the probability (called the consumer's risk) of accepting a submitted lot that has a percent defective equal to the lot tolerance percent defective.

3.1.5 *lot tolerance percent defective (LTPD), n*—for purposes of acceptance sampling, the percentage of defective units in a lot for which the consumer has a stated low probability of acceptance of the lot.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *consumer's risk, n*—the probability that a lot whose percentage defective is equal to the LTPD will be accepted by the plan.

4. Significance and Use

4.1 Two general types of tables (Note 1) are given, one based on the concept of lot tolerance, LTPD, and the other on AOQL. The broad conditions under which the different types have been found best adapted are indicated below.

4.1.1 For each of the types, tables are provided both for single sampling and for double sampling. Each of the individual tables constitutes a collection of solutions to the problem of minimizing the over-all amount of inspection. Because each line in the tables covers a range of lot sizes, the AOQL values in the LTPD tables and the LTPD values in the AOQL tables are often conservative.

NOTE 1—Tables in Annex A1 – Annex A4 and parts of the text are reproduced by permission of John R. Wiley and Sons. More extensive tables and discussion of the methods will be found in that text.

4.2 The sampling tables based on lot quality protection (LTPD) (the tables in Annex A1 and Annex A2) are perhaps best adapted to conditions where interest centers on each lot separately, for example, where the individual lot tends to retain its identity either from a shipment or a service standpoint. These tables have been found particularly useful in inspections made by the ultimate consumer or a purchasing agent for lots or shipments purchased more or less intermittently.

4.3 The sampling tables based on average quality protection (AOQL) (the tables in Annex A3 and Annex A4) are especially adapted for use where interest centers on the average quality of product after inspection rather than on the quality of each individual lot and where inspection is, therefore, intended to serve, if necessary, as a partial screen for defective pieces. The latter point of view has been found particularly helpful, for example, in consumer inspections of continuing purchases of large quantities of a product and in manufacturing process inspections of parts where the inspection lots tend to lose their identity by merger in a common storeroom from which quantities are withdrawn on order as needed.

4.4 The plans based on average quality protection (AOQL) consider the degree to which the entire inspection procedure screens out defectives in the product submitted to the inspector. Lots accepted by sample undergo a partial screening through the elimination of defectives found in samples. Lots that fail to be accepted by sample are completely cleared of defectives. Obviously, this requires a nondestructive test. The over-all result is some average percent defective in the product as it leaves the inspector, termed the *average outgoing quality*, which depends on the level of percent defective for incoming product and the proportion of total defectives that are screened out.

4.5 Given a specific problem of replacing a 100 % screening inspection by a sampling inspection, the first step is to decide on the type of protection desired, to select the desired limit of percent defective lot tolerance (LTPD) or AOQL value for that type of protection, and to choose between single and double sampling. This results in the selection of one of the appended tables. The second step is to determine whether the quality of product is good enough to warrant the introduction of sampling. The economies of sampling will be realized, of course, only insofar as the percent defective in submitted product is such that the acceptance criteria of the selected sampling plan will be met. A statistical analysis of past inspection results should first be made, therefore, in order to determine existing levels and fluctuations in the percent defective for the characteristic or the group of characteristics under consideration. This provides information with respect to the degree of control as well as the usual level of percent defective to be expected under existing conditions. Determine a value from this and other information for the *process average* percent defective that should be used in applying the selected sampling table, if sampling is to be introduced.

5. Procedure

5.1 Two distinct methods of inspection are employed, single sampling and double sampling. In single sampling only one sample is permitted before a decision is reached regarding the disposition of the lot, and the acceptance criterion is expressed as an acceptance number, c. In double sampling, a second sample is permitted and two acceptance numbers are used; the first, c_1, applying to the observed number of defectives for the first sample alone and the second, c_2, applying to the observed number of defectives for the first and second samples combined. The specific procedures assumed in the development of the tables are as follows:

5.1.1 *Single Sampling Inspection Procedure:*

5.1.1.1 Inspect a sample of n pieces.

5.1.1.2 If the number of defectives found in the sample does not exceed c, the acceptance number, accept the lot.

5.1.1.3 If the number of defectives found in the sample exceeds c, inspect all the pieces in the remainder of the lot.

5.1.1.4 Regardless of whether or not the lot was accepted, correct or replace all defective pieces found in the sample as well as in any subsequent inspection of the remainder of the lot.

5.1.2 *Double Sampling Inspection Procedure:*

5.1.2.1 Inspect a first sample of n_1 pieces.

5.1.2.2 If the number of defectives found in the first sample does not exceed c_1, the acceptance number for the first sample, accept the lot.