AMERICAN NATIONAL STANDARD

SAMPLING PROCEDURES AND TABLES FOR INSPECTION BY VARIABLES FOR PERCENT NONCONFORMING

AMERICAN SOCIETY FOR QUALITY
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PREPARED BY
ACCREDITED STANDARDS COMMITTEE
Z1 SUBCOMMITTEE ON STATISTICS

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ABSTRACT

Sampling Procedures and Tables for Inspection by Variables for Percent Nonconforming is an acceptance sampling system to be used on a continuing stream of lots for AQL specified. It provides tightened, normal, and reduced plans to be used on measurements which are normally distributed. Variation may be measured by sample standard deviation, sample range, or known standard deviation. It is applicable only when the normality of the measurements is assured.

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Published by:

ASQ
AMERICAN SOCIETY FOR QUALITY™

Quality Press
600 N. Plankinton Avenue
Milwaukee, Wisconsin 53203
Call toll free 800-248-1946
Fax 414-272-1734
www.asq.org
http://qualitypress.asq.org
http://standardsgroup.asq.org
E-mail: authors@asq.org

FOREWORD

(This foreword is not a part of Draft American National Standard—Sampling Procedures and Tables for Inspection by Variables for Percent Nonconforming, ANSI/ASQ Z1.9-2003)

This revision of ANSI/ASQC Z1.9-1993, "Sampling Procedures and Tables for Inspection by Variables for Percent Nonconforming" was undertaken to allow for aligning the terminology of the standard with the terms of ANSI/ISO/ASQ A3534-2-2004 (to be published), change the term Acceptable Quality Level (AQL) to Acceptance Quality Limit (AQL), change the definition and explanation of AQL, change the Discontinuation of Inspection Rule, and to correct typographical and computational errors within the standard.

The present revision ANSI/ASQ Z1.9-2003 continues to allow complete interchangeability of the tabulated plans with ISO 3951-1, which provided a graphical means for implementation of the plans. ANSI/ASQ Z1.9-2003 is also roughly matched to ANSI/ASQ Z1.4-2003, which corresponds directly to the old military standard MIL-STD-105E. The matching is sufficient to allow inspection under either standard for stated AQLs and inspection levels with reasonably equivalent protection. Tables are given in Section E—Appendix that show differences in protection between ANSI/ASQ Z1.9-2003 and ANSI/ASQ Z1.4-2003. These are for use in critical applications to determine whether moving from one standard to the other is appropriate.

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INTRODUCTION

This standard was prepared to meet a need for the use of standard sampling plans for inspection by variables in procurement, supply and storage, and maintenance inspection operations. The variables sampling plans apply to a single quality characteristic which can be measured on a continuous scale, and for which quality is expressed in terms of percent nonconforming. The theory underlying the development of the variables sampling plans, including the operating characteristic curves, assumes that measurements of the quality characteristics are independent, identically normally distributed random variables.

It is important to note that variables sampling plans are not to be used indiscriminately, simply because it is possible to obtain variables measurement data. The users are advised to consult their technical agency to determine the feasibility of application in considering applications where the normality or independence assumptions may be questioned.

In comparison with attributes sampling plans, variables sampling plans have the advantage of usually resulting in considerable savings in sample size for comparable assurance as to the correctness of decisions in judging a single quality characteristic, or for the same sample size, greater assurance is obtained using variables plans. Attributes sampling plans have the advantage of greater simplicity, of being applicable to either single or multiple quality characteristics, and of requiring no knowledge about the distribution of the continuous measurements of any of the quality characteristics.

This standard is divided into four sections. Section A describes general procedures of the sampling plans. Sections B and C describe specific procedures and applications of the sampling plans when variability is unknown. In Section B the standard deviation is used as the basis for an estimate of the unknown variability, and in Section C the average range of the sample is used. Section D describes the plans when variability is known.

Each of Sections B, C, and D is divided into two parts: (I) Sampling Plans for the Single Specification Limit Case, and (II) Sampling Plans for the Double Specification Limit Case. For the single specification limit case, the acceptability criterion is given in two forms: Form 1 and Form 2. Either of the forms may be used, since they are identical as to sample size and decision for lot acceptability or rejectability. In deciding whether to use Form 1 or Form 2, the following points should be borne in mind. Form 1 provides the lot acceptability criterion without estimating lot percent nonconforming. The Form 2 lot acceptability criterion requires estimates of lot percent nonconforming.

Operating characteristic curves in Table A-3 are for the Normal Inspection sampling plans and show the relationship between quality and percent of lots expected to be accepted for the quality characteristic inspected. As stated, these operating characteristic curves are based on the assumption that measurements are selected at random from a normal distribution.

The corresponding sampling plans in Sections B, C, and D were matched as closely as possible under a system of fixed sample size with respect to their operating characteristic curves. Operating characteristic curves in Table A-3 have been computed for the sampling plans based on the standard deviation estimate of unknown variability. They are equally applicable for sampling plans based on the average range of the sample and those based on known variability.

Certain characteristics concerning the sampling plans in Section B and C and those in Section D should be noted. Plans based on the estimate of unknown variability require fewer sample units for comparable assurance when the standard deviation is used than when the average range of the sample is used. On the other hand, plans using the average range of the sample require simpler computations and may be better understood by operating personnel. Plans using known variability require considerably fewer sample units for comparable assurance than either of the plans of unknown variability; however, the requirement of known variability is a stringent one. The user is well advised to consult a statistician before applying sampling plans using known variability.

Table B-6 provides values of the factor F to compute the maximum standard deviation: MSD. The MSD serves as a guide for the maximum allowable magnitude of the estimate of lot standard deviation when using plans for the double specification limit case, based on the standard deviation. Similarly Table C-6 provides values of the factor f to compute the maximum average range: MAR. The MAR serves as a guide for the maximum allowable magnitude of the average range of the sample when using plans for the double specification limit case, based on the average range. The estimate of lot standard deviation or average range of the sample, if it is less than the MSD or MAR, respectively, helps to ensure, but does not guarantee, lot acceptability.

All symbols and their definitions are given in the appendix of the applicable section. An illustration of the computations and procedures used in the sampling plans is given in the examples in Parts I and II of the applicable section. The computations involve simple arithmetic operations such as addition, subtraction, multiplication, and division of numbers, or at most, the taking of a square root of a number. The user should become familiar with the general procedures of Section A, and refer to the applicable section for detailed instructions regarding specific procedures, computations, and tables for the sampling plans.

Section E—Appendix provides information about the match between this variables standard, ANSI/ASQ Z1.9-2003, and the corresponding attributes standard, ANSI/ASQ Z1.4-2003.

The flowchart in Figure 1 shows the basic procedure for using the standard.