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Document Name: AIMM TR34: Sampling Procedures for Inspection by Attributes of Images in Electronic Image Management and Micrographic Systems

CFR Section(s): 36 CFR 1237.28(d)(2)

Standards Body: Association for Information and Image Management

APPROVED

Official Incorporator:

THE EXECUTIVE DIRECTOR
OFFICE OF THE FEDERAL REGISTER
WASHINGTON, D.C.

ANSI/AIIM TR 34-1996

TECHNICAL

REPORT

report

report

Sampling Procedures for Inspection by Attributes of Images in Electronic Image Management (EIM) and Micrographic Systems

ANSI/AIIM TR 34-1996

Approved As
American National
Standards Institute (ANSI)
Technical Report
May 13, 1996

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AND IMAGE
MANAGEMENT
INTERNATIONAL

ANSI/AIIM TR34-1996

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ISBN 0-89258-295-2
Printed in the United States of America

ANSI/AIIM TR34-1996

Technical Report for Information and Image Management —

Sampling Procedures for Inspection by Attributes of Images in Electronic Image Management (EIM) and Micrographics Systems

An ANSI Technical Report prepared

by the Association for Information and Image Management International

Abstract:

This technical report contains procedures that may be used to sample images converted to electronic or micrographic images. Its purpose is to provide guidance in selecting a sampling procedure. This report provides background information and simple examples.

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Foreword This technical report contains procedures that may be used to sample electronic or micrographic images. Its purpose is to provide guidance in selecting a sampling procedure.

The procedures are based on ISO 2859-1 and ISO 8422. ISO 2859-1 in turn is based on MIL STD 105 which has been replaced by ANSI/ASQC Z1.4. Following the procedures in this technical report will take on added significance for those organizations requiring the ISO 9000 Quality Management and Quality Assurance Standards series of guidelines.

Figure 1 of this report is taken with permission from *Modern Methods for Quality Control and Improvement*, page 457, written by Dr. Harrison Wadsworth and published by Wiley and Sons, Inc., ©1986. Figure 2 is used with permission from the American Society for Quality Control. Table 3 is used with permission from F.E. Grubbs, "On Designing single sampling inspection plans," *Annuals of mathematical statistics*, Vol. XX (1949)
p. 256.

Tables 5, and 13 through 29 are taken with permission from ISO 8422:1991. Tables 7 through 9, 30 through 33, 35, and 36 are taken with permission from ISO 2859-1:1989. Table 10 is taken with permission from ISO CD 2859-1:1994. This material is reprinted from ISO 8422 and ISO 2859 with permission of the American National Standards Institute (ANSI) under an exclusive licensing agreement with the International Organization for Standardization. Not for resale. No part of ISO 8422 or ISO 2859 may be reproduced in any form, electronic retrieval system or otherwise without the prior written consent of the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

The users of this technical report must be familiar with sampling schemes and knowledgeable in developing procedures to implement quality control techniques. This report provides background information, simple examples, and methods of incorporating EIM and micrographic attributes. The attributes provided in this technical report are not all inclusive. Users should incorporate their own attributes to satisfy their quality requirements.

Image quality can be considered qualitative. The product is satisfactory or unsatisfactory for its intended purpose. There are a number of imaging standards and technical guidelines that detail measurable product attributes, including what is to be considered an acceptable image. Data from these standards and related technical guidelines should be used to establish measurable attributes. Most attributes of an acceptable micrographic image product are based on duplicating the quality of the original document, not improving it. Electronic image capture systems also have measurable attributes. The recorded image may be "cleaned up" to remove superfluous noise and reduce the amount of storage required, but normally not to change the original document's data content.

A producer of source or electronic documents may guarantee 100% or other levels of quality. How and when the established product is accepted can be a problem. Except when there are specific contractual agreements, it may be rare that 100% of the product, in this case images, is individually inspected against the original document. In some instances it may be necessary to perform 100% inspection of the film or electronic images. This report does not apply to that situation. Rather, the first time the product is produced, the producer and the client might need to establish a level of workmanship. They establish this level, each for his or her own reasons, even when the producer is willing to correct all identified errors. Further discussion on the role of sampling versus 100% inspection in the process of making decisions regarding the unacceptability of images is found in annex B.

A converter might want to establish Acceptable Quality Levels (*AQL*) based on a system of causes. This system is a method to statistically monitor the processes to assure that they are operating to established production standards. Users might want to have an *AQL* that meets their "normal course of business" to reduce costs associated with re-work or for legal requirements when it is possible that documents are to be used as (hearsay) evidence or in place of the originals. Often specific codes and regulations permit destruction of the original if the copy can be validated.

In any case, a statistical sampling method based on a valid procedure is very beneficial because converted images might not be used in business or for reference until some time after conversion. It may be impossible or very expensive to collect the source material for rework if problems are not addressed within a reasonable time.

Suggestions for improving this technical report are welcome. They should be sent to the Chair, AIIM Standards Board, Association for Information and Image Management International, 1100 Wayne Avenue, Suite 1100, Silver Spring, Maryland, 20910–5603.

At the time it approved this recommended practice, the AIIM Standards Board had the following members:

Name of Representative	Organization Represented
Judy Kilpatrick, *Chair*	Association for Information and Image Management International
Jewel M. Drass	Bell & Howell
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Bruce A. Holroyd	Eastman Kodak Company
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Michael L. Thomas	MSTC, Inc.
Stephen Urban	Delta Information Systems

Committee C10, Document Quality and Control, had the following members when it approved this report:

Name of Representative	Organization Represented
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Dave Westcott	Orkland Corporation
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This technical report was developed by the AIIM Sub committee on Sampling, C10.7. The Committee expresses its thanks to Bill McCallum, who early in the project provided guidance to the committee on sampling, and to Dr. Harrison Wadsworth of the School of Industrial and Systems Engineering of the Georgia Institute of Technology, who wrote the report.

The AIIM Subcommittee on Sampling, C10.7, had the following members at the time this recommended practice was approved:

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Kevin Beverly	PSI International
Betty S. Burton	Department of the Army
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Bob Saholsky	United States Government Printing Office
Robert W. Starbird	Mobil Corporation
Herbert J. White	Genealogical Society of Utah

Technical Report for Information and Image Management —

Technical Report — Sampling Procedures for Inspection by Attributes of Images in Electronic Image Management (EIM) and Micrographics Systems ANSI/AIIM TR34-1996

1 Purpose and scope

1.1 Purpose

This technical report contains procedures that may be used to select and apply sampling inspection plans to determine if a lot or batch of electronic or micrographic images meets specified quality requirements. Its purpose is to do the following:

— provide guidance to the user when selecting a sampling procedure that will meet risk requirements

— enable the user to develop a sampling plan for individual images in a scientific manner

1.2 Scope

The sampling plans in this technical report apply to document management programs for microform and paper scanning as well as to microfilm of paper and coded data and electronic images of coded data. The sampling procedures will apply to most types of document management programs, including in-house and subcontracted conversion programs.

Only attributes sampling will be addressed and only as it is appropriate for the inspection of images. Furthermore, only single sampling plans and item-by-item sequential plans will be presented. Single sampling plans are the easiest to use and will probably be used most often. If average sample size is a critical consideration, sequential sampling will result in the most savings and is thus recommended. This report does not address multiple and double sample plans.

The sampling plans may be used when the extent of nonconformity is expressed in terms of either proportion (or percent) of nonconforming images or the number of nonconformities per image (per 100 images) when an image may have more than one nonconformity.

The sampling plans are based on the assumption that nonconformities occur randomly and with statistical independence. If it is known that one nonconformity in an image could be caused by a condition also likely to cause other nonconformities, the images shall be considered just as conforming or not and multiple nonconformities shall be ignored.

Plans are included that may be used for single, isolated lots; or for a small number of lots (or rolls) of images. Other procedures are included for a continuing series of lots or rolls of images (for example, 100 rolls) that are sufficient to allow switching rules to be applied. These procedures provide the following:

— an automatic protection to the consumer if a deterioration in quality is detected (by switching to tightened inspection or discontinuing inspection)

— an incentive to reduce inspection costs by switching to reduced inspections if consistently good quality is achieved

Clause 11 contains procedures for developing sampling plans that may be used for isolated or a small number of lots or rolls of images. For a large number of lots or rolls, clause 12 contains a discussion of

— the sampling procedures used for a continuing series of lots

— single plans used in ISO 2859–1 (ANSI/ASQC Z1.4.)

— item–by–item sequential plans using ISO 8422

2 References

The following standards contain provisions that, through reference in this text, constitute parts of this technical report. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this technical report are encouraged to investigate the possibility of applying the most recent editions of the standards listed in this clause. Members of IEC and ISO maintain registers of currently valid international standards.

2.1 Referenced international standards

ISO 2859-1:1996, Sampling procedures for inspection by attributes — Part 1: Sampling plans indexed by acceptable quality level (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 8422:1991, Sequential sampling plans for inspection by attributes.

ISO 3534-1:1993, Statistics — Vocabulary and symbols — Part 1: Probability and general statistical terms.

ISO 3534-2:1993, Statistics — Vocabulary and symbols — Part 2: Statistical quality control.

ISO 8402:1994, Quality management and quality assurance — Vocabulary.

2.2 Referenced American national standards

ANSI/ASQC Z1.4:1993, Sampling procedures and tables for inspection by attributes.

ANSI/AIIM MS1-1988, Recommended practice for alphanumeric Computer Output Microforms (COM) — Operational practice for inspection and quality control.

ANSI/AIIM MS23-1991, Practice for operational procedures/inspection and quality control of first-generation silver-gelatin microfilm of documents.

ANSI/AIIM MS32-1996, Microrecording of engineering source documents on 35mm microfilm.

ANSI/AIIM MS43-1988, Recommended practice for operational procedures/inspection and quality control of duplicated microforms of documents and from COM.

2.3 Referenced publications

ANSI/AIIM TR2–1992, Technical report for the Association for Information and Image Management International — Glossary of imaging technology.

Grubbs, F. E., "On designing single sampling inspection plans," *Annuals of mathematical statistics*, Vol. XX (1949).

3 Definitions

3.1 Definitions of terms

For the purpose of this technical report, the definitions given in ISO 3534-1, ISO 3534-2, ISO 2859-1, and ISO 8422, together with the following definitions, apply. Some of the definitions are slight modifications of those found in the ISO standards. They are modified for the purposes of this report, but their meaning is not changed.

Other terms may be defined in *ANSI/AIIM TR2, Technical report for the Association of Information and Image Management International — Glossary of imaging technology.*

3.1.1 Acceptable Quality Level (*AQL*): When a continuing series of lots is considered, the *AQL* is the quality level that, for the purposes of sampling inspection, is the limit of a satisfactory process average. (See clause 6 for further explanation.)

3.1.2 defect: Nonfulfillment of an intended usage requirement (e.g., blurred, cut off, etc.). Clause 9 includes a partial list of defects.

Notes:

The term "defect" is appropriate for use when a quality characteristic of an image is evaluated in terms of usage (as contrasted to conformance to specifications).

Since the term "defect" has a definite meaning within the law, it should not be used as a general term.

This report does not describe defects; however, clause 9 contains a partial list of attributes that may be nonconforming enough to be classed as defects. Refer to ANSI/AIIM standards and technical reports for complete listings of such image attributes.

3.1.3 image: Unit of inspection. An image is inspected to determine its classification as conforming or not, or to count the number of nonconformities. An image will have a number of components or attributes that may be nonconforming. Refer to clause 9 for a list of attributes.

3.1.4 inspection by attributes: Inspection whereby either the image is classified simply as conforming or nonconforming, or the number of nonconformities in the images inspected is counted, with respect to a given list of attributes.

3.1.5 lot: Definite quantity of images, each having uniform characteristics, collected together and submitted for examination. A lot may also be a single roll or set of rolls of images received at one time, an optical disk, a magnetic tape, or a single box of microfiche, etc.

3.1.6 lot size: Number of images in a lot, disk, or roll.

3.1.7 nonconforming image: Image with one or more nonconformities.

Note: Nonconforming images generally will be classified by their degree of seriousness, such as:

- class A. An image that contains one or more nonconformities of class A and may also contain nonconformities of class B and/or class C.
- class B. An image that contains one or more nonconformities of class B and may also contain nonconformities of class C, but contains no nonconformity of class A.

3.1.8 nonconformities per 100 images: One hundred times the number of nonconformities contained in the sample (one or more nonconformities being possible in any image) divided by the total number of images.

3.1.9 nonconformity: Nonfulfillment of a specified requirement.

Notes:

In some situations, specified requirements coincide with customer usage requirements (see defect). In other situations, they might not coincide, being either more or less stringent, or the exact relationship between the two might not be fully known or understood.

Nonconformities generally will be classified according to their degree of seriousness such as:

— class A. The most serious nonconformities (e.g., loss of information). Such nonconformities will be assigned a very small *AQL* value.

— class B. Less serious nonconformities (e.g., slightly skewed image). These can be assigned a higher *AQL* value than those in Class A and a smaller *AQL* value than those in class C, if a third class exists, etc.

The user is cautioned that adding characteristics and classes of nonconformities generally will affect the overall probability of acceptance of a lot.

3.1.10 percent nonconforming: One hundred times the number of nonconforming images divided by the total number of images inspected.

3.1.11 sample: One or more images taken from a lot, disk, or roll and intended to provide information on the lot or roll.

3.1.12 sample size: Number of images in the sample.

3.1.13 sampling plan: Specific plan that states the sample size to be used and the associated criteria for accepting the lot.

Notes:

An example of a criterion is the number of nonconforming images in a sample is less than or equal to the acceptance number.

A sampling plan does not contain the rules on how to take a sample.

A distinction should be made between the terms sampling plan, sampling scheme, and sampling system.

3.1.14 sampling scheme: Combination of sampling plans with rules for changing from one plan to another. Sampling schemes are used when there is a continuing series of lots to be submitted for acceptance inspection purposes.

3.1.15 sampling system: Collection of sampling schemes, each with its own rules for changing plans, together with criteria by which appropriate schemes may be chosen. ISO 2859-1 is such a sampling system.

3.2 Parameters and variables used in sequential sampling schemes

3.2.1 Acceptance number for a corresponding single sampling plan (*Ac*): This is the acceptance number for a single sampling plan that has essentially the same operating characteristic as the sampling plan under consideration.

3.2.2 Acceptance number for sequential sampling (*A*): Value calculated from the specified parameters of the sampling plan and the cumulative sample size. The cumulative count is compared to the acceptance number after each image is inspected to determine if the lot may be accepted.

3.2.3 A_t: Acceptance number corresponding to the curtailed value of the cumulative sample size.

3.2.4 cumulative count (*c*): When sampling inspection from a lot is performed sequentially, c is the total number of nonconforming images found during inspection, counting from the start of inspection and including the last image inspected.

3.2.5 cumulative sample size (n_{cum}): When sampling inspection of images is performed sequentially, n_{cum} is the total number of images inspected, counting from the start of inspection and including the last image inspected.

3.2.6 h_A: Constant that is used to determine the acceptance number; h_A is the intercept of the acceptance line.

3.2.7 h_R: Constant that is used to determine the rejection number; h_R is the intercept of the rejection line.

3.2.8 multiplier of the cumulative sample size (*g*): Multiplier of the cumulative sample size that is used to determine the acceptance and rejection numbers; g is the slope of the acceptance and rejection lines.

3.2.9 n_{av}: Average sample size.

3.2.10 n_s: Sample size for a single sampling plan that has essentially the same operating characteristic as the sampling plan under consideration.

3.2.11 n_t: Curtailment value of the cumulative sample size.

3.2.12 *p*: Lot quality level in proportion nonconforming.

3.2.13 Rejection number for sequential sampling (*R*): Value calculated from the specified parameters of the sampling plan and the cumulative sample size. The cumulative count is compared to the rejection number after each image is inspected to determine if the lot should be rejected.

3.2.14 R_t: Rejection number corresponding to the curtailed value of the cumulative sample size.

4 Acronyms and abbreviations

AQL Acceptable Quality Level
CRQ Consumer's Risk Quality
EIM Electronic Image Management
EIMS Electronic Image Management System
PRQ Producer's Risk Quality

5 Expression of nonconformity

The extent of nonconformity may be expressed in terms of either percent nonconforming or nonconformities per 100 images. The procedures assume that nonconformities occur randomly and with statistical independence. If it is known that a nonconforming component may be caused by a condition also likely to cause others, the image shall be considered as either conforming or nonconforming and multiple nonconformities shall be ignored.

A component may be nonconforming for a number of reasons depending on the system and the needs of the user. A partial list of attributes that may be nonconforming is provided in clause 9. Depending on the user requirements, these nonconformities may be classified as class A, class B, class C, etc.

6 Use and application of Acceptable Quality Level (*AQL*)

The *AQL*, together with the sample size code letter, is used for indexing the sampling plans and schemes provided by ISO 2859-1 (ANSI/ASQC Z1.4) and ISO 8422 which are discussed in clause 12 of this technical report. The *AQL* has no meaning for isolated lot inspection. (See clause 11 of this technical report for information about isolated, or single, lot inspection.)

6.1 *AQL* designation

To use the sampling schemes (i.e., sets of plans with rules for switching between plans), an *AQL* must be designated for each class of nonconformities. The effect of this designation is that the majority of lots submitted with quality levels (percent nonconforming or nonconformities per 100 images) equal to or less than this value will be accepted.

The sampling plans provided by ISO 2859-1 and ISO 8422 are arranged in such a way that the probability of acceptance at the designated *AQL* value depends upon the sample size (and thus the lot size) being higher for large samples than for small ones.

6.2 *AQL* and process average

The *AQL* is a parameter of the sampling scheme and should not be confused with the process average, which describes the operating level of an imaging process. The process average is expected to be less than or equal to the *AQL* to avoid excessive rejections.

The designation of an *AQL* does not imply that the supplier has the right to knowingly supply any nonconforming images. The term *AQL* does not apply to isolated lot sampling plans. For such plans, the producer's risk and producer's risk quality along with the consumer's risk and consumer's risk quality are used. These concepts are discussed in 10.1 and 10.2.

7 Types of sampling plans

7.1 Attributes and variables sampling plans

Sampling plans may be classified as attributes or variables plans. The sampling plans discussed in this technical report are all of the attributes type. Each component inspected is classified as conforming or not conforming to specifications.

Variables plans require the calculation of one or more statistics and are not practical for the type of inspections with which this technical report is concerned.

Attributes inspections are usually easier to make because they may be of the "Go, No–Go" variety or they may be visual inspections.

7.2 Single attribute sampling plans

The simplest type of sampling plans are those involving a single sample. That is, in the attributes case, a sample of size n is selected from the lot, and the lot is accepted if no more than c nonconforming images are found in the sample. Otherwise, the lot is rejected.

Procedures for selecting single sampling plans for isolated lots are found in clause 11. Procedures for selecting single plans for a continuing series of lots are found in clause 12.

7.3 Sequential attributes sampling plans

Item-by-item sequential sampling requires that one of the following three decisions be made after each image is inspected:

— accept the lot

— reject the lot

— inspect another image

This process is continued until the lot is accepted or rejected.

8 Considerations when choosing an attribute sampling procedure

The use of sequential sampling results in an average sample size savings over single plans. However, sequential sampling is harder to administer, so that the administrative costs must be balanced against cost savings due to decreased sample size. A simple cost model to assist in the choice of one of these sampling procedures is presented as annex A.

9 Image attributes

The attributes listed in table 1, Some EIM attributes, and table 2, Some film attributes, can be identified visually to determine the quality of images during capture, presentation, and distribution in an Electronic Image Management System in accordance with a prescribed sampling scheme.

The person(s) evaluating the image can do so by comparing the original page to the image on a monitor or on a printed output. The attributes listed in tables 1 and 2 should be measured in an output mode similar to their intended application. A quantified measure of each attribute must be made to determine the Producer's Risk Quality (*PRQ*) and the Consumer's Risk Quality (*CRQ*) for each sample. (*PRQ* and *CRQ* are explained in 10.1 and 10.2.)

For each batch, lot, or document, the producer's and consumer's risk factors must be specified for each attribute to be factored with the *PRQ* and the *CRQ*. This is necessary to determine the acceptance and rejection criteria for each lot. Each attribute listed in table 1 and table 2 must have these measurable parameters so that statistically valid acceptance and rejection decisions can be made on a lot basis. This process is described in clause 10.

EIM Attribute	Class A	Class B
Size of image relative to the original (measured in both horizontal and vertical direction)	X	
Adequate contrast — For text there should be a high contrast ratio between the text and the background — For gray scale images the contrast should represent the original image		 X X
Adequate brightness (more of a monitor problem)		X
Color dropout (dropout of specific colors from a test target)		X
Poor thresholding (dropped low contrast features, dark background obscuring foreground)		X
Image skew on the page		X
Incorrect image orientation on the page		X
Speckle or noise in the background of the image		X
Character dropout (a missing character)	X	
Legibility of small characters or features (poor focus)	X	
Separation of black from white features (bar chart may be required)	X	
Scan line drop out (missing scan lines, single or multiple, across the image, either white or black)	X	
Repeated scan lines on successive images	X	
Repeated pixel on successive images (consistent noise or spot on each image at the same location)		X
Borders not cropped		X
Missing portion of edge of image	X	

Table 1 — Some EIM attributes

Film Attribute	Class A (Major)	Class B (Minor)
Blank film	X	
Blurry images	X	
Chemical residue	X	
Double exposure	X	
Dust*	X	
Edge fog (not affecting coding or image)	X	
Edge fog (affecting coding or image)	X	
Fingerprints*		
Fog (all types, not affecting coding or image)*		
Fog (all types, affecting coding or image)	X	
Frilling	X	
Illegible	X	
Milky film*		
Mottle		X
Newton rings		X
Off tracking*		
Out of focus*		
Pressure marks*		
Excessive residual thiosulfate		
Resolution loss (more than one pattern)*		
Reticulation*		
Scratch (base)*		
Scratch (emulsion not affecting image)*		
Scratch (emulsion affecting legibility)	X	
Static mark*		
Streaks, light or dark*		
Density too high (dark images)*		
Density too low (light images)*		
Uneven density*		
Washboard*		X
Waterspots*		
Image contraction		
Image overlap	X	

Table 2 — Some film attributes

* All defects not identified as major, minor, or cosmetic must be determined by the application and by referring to 12.2.2. of ANSI/AIIM MS23.

10 Sampling risks and costs

Whenever sampling inspection is used (as opposed to 100% inspection) certain risks of making errors are always incurred. In situations where 100% inspections are not used, we cannot know everything about the lot. We only know about the images in the sample. Thus, we incur risks of making two types of errors in our decision to accept or not accept.

We can reject (not accept) a lot that should have been accepted. The risk of doing this is called the producer's risk. The second error is that we can accept a lot that we should not have accepted. The risk of doing this is called the consumer's risk. Although sampling always incurs both of these risks, the risks can be measured and controlled if proper statistical procedures are used.

10.1 Producer's risk and Producer's Risk Quality (*PRQ*)

Often, the producer's risk is stated in terms of a probability or risk level denoted by the Greek letter alpha (α). The producer's risk is the probability that a lot with a quality level (e.g., the fraction nonconforming) at a certain acceptable level or better is not accepted by the sampling procedure. (Stated another way, a good lot is not accepted.) For the purposes of this guide, the symbol *PR* will be used for this risk. The producer's risk quality is the quality level for which the probability of non-acceptance is just equal to the producer's risk. The producer's risk quality is denoted by the symbol *PRQ*.

10.2 Consumer's risk and Consumer's Risk Quality (*CRQ*)

The consumer's risk is sometimes denoted by the Greek letter beta (β). However, in this guide it will be denoted by the symbol *CR*. The consumer's risk is the probability that a bad lot is accepted. The quality level associated with the consumer's risk is called the consumer's risk quality (*CRQ*).

10.3 Allowable nonconformities and risks associated with complete inspection

Both the consumer's risk and the producer's risk should be small, but they can only be zero when 100% inspection is used. Both the *PRQ* and the *CRQ* should be small also. The *PRQ* cannot be zero without the use of 100% inspection, and the *CRQ* must be larger than the *PRQ*. In general, the smaller the values of these risks and quality levels and the closer the two quality levels are to each other, the larger the sample size must be. That is, we must pay for additional discrimination in our sampling procedure.

The fact that the *PRQ* (our definition of acceptable quality) must be greater than zero does not mean that a certain fraction of a lot may be nonconforming to specifications. It means that we are recognizing that since we have not completely inspected a lot, it is possible for a small number of nonconforming images to be present. If a series of lots are submitted with a quality level equal to or better than the *PRQ*, the sampling procedure will reject only a small fraction (*PR*) or less of them.

If the images being inspected are of a critical nature and inspection is not destructive, complete inspection may be necessary. Even complete inspection may not be enough, however, to assure us that only conforming images are present. This is because of errors in inspection. If a large number of images must be inspected, the chance of such inspection errors increases rapidly. For this reason, complete inspection may actually result in more nonconforming images being passed than under sampling, when more care may be made during the inspection of each image and the risks are known.

11 Sampling plans for single lots

The sampling procedures described in 11.1 and 11.2 are for use in situations in which all of the lots (images) are received at one time. In cases where there is a continuing series of lots of technically equivalent images from the same supplier, sampling systems such as those described in clause 12 are preferred. The procedures in clause 12 provide a means to

— reduce the sampling intensity when a supplier regularly submits superior quality images

— increase the sampling intensity when a supplier has a history of submitting product that does not meet specifications

When the number of lots to be submitted is not sufficient to permit the use of switching rules to change the sampling intensity, the procedures described in 11.1 and 11.2 should be used in preference to merely selecting a plan from one of the tables provided in clause 12.

Single sampling plans are described in 11.1. Item–by–item sequential plans are described in 11.2. In both cases, it is necessary for the user to have chosen a definition of good and bad quality (i.e., *PRQ* and *CRQ*), along with producer's and consumer's risks.

11.1 Single sampling plans

The sampling procedures described here are the simplest plans that can be used when an isolated lot is submitted for inspection. A single sampling plan is described by a sample size, *n*, and an acceptance number, *Ac*. A sample of *n* images is selected from the lot submitted for inspection. If no more than *Ac* of the images inspected are nonconforming, the lot is accepted.

11.1.1 Sampling risks

To choose a sampling plan, the user must decide the risks he/she is willing to take that a roll or platter is accepted when it should be rejected, or is rejected when it should be accepted.

To simplify the process of selecting sampling plans and for the purpose of this guide, a Producer's Risk (*PR*) of 5% and a Consumer's Risk (*CR*) of 10% have been used. The user must choose the producer's risk quality, *PRQ*, and the consumer's risk quality, *CRQ*. In other words, the user must decide what percent nonconforming levels should be accepted 95% of the time, and what percent nonconforming levels should be accepted 10% of the time. These two quality levels define the sampling plan to be used.

11.1.2 Tabular method for selecting a plan

A single sampling plan may be derived using table 3, Values for single sampling plans.

AC	$n \times CRQ$	$n \times PRQ$	*CRQ/PRQ*
0	2.303	0.0513	44.84
1	3.890	0.355	10.96
2	5.322	0.818	6.51
3	6.681	1.366	4.89
4	7.994	1.970	4.06
5	9.274	2.613	3.55
6	10.532	3.286	3.21
7	11.771	3.981	2.96
8	12.995	4.695	2.77
9	14.207	5.426	2.62
10	15.407	6.169	2.50
11	16.598	6.924	2.40
12	17.782	7.690	2.31
13	18.958	8.464	2.24
14	20.128	9.246	2.18
15	21.292	10.035	2.12

Table 3 — Values for single sampling plans*

* Used with permission from F. E. Grubbs, "On designing single sampling inspection plans," *Annuals of mathematical statistics*, Vol. XX (1949), p. 256.

The following steps illustrate the use of table 3.

A. First, we choose a *PRQ* and *CRQ*. Suppose we choose a *PRQ* of 4% and a *CRQ* of 12.5% (i.e., *PRQ* is 0.04; *CRQ* is 0.125). That is, we wish to find a sampling plan that will accept lots that are 4% or less nonconforming 95% of the time (because *PR* is 5%) and accept lots that are 12.5% nonconforming only 10% of the time (because *CR* is 10%).

B. We determine ratio of *CRQ* to *PRQ*.

$$CRQ/PRQ = 0.125/0.04 = 3.125$$

C. Next, we look in the *CRQ/PRQ* column of table 3, Values for single sampling plans, and locate the value nearest to our calculated value. From the *CRQ/PRQ* column, we find that 3.21 is the number nearest to 3.125.

D. We locate the acceptance number in table 3 by looking at the *AC* value that corresponds to 3.21. Our acceptance number is 6.

E. Next, we determine the sample size by dividing $n \times CRQ$ by the *CRQ* and $n \times PRQ$ by the *PRQ* (rounding up).

$$n = n \times CRQ/CRQ = 10.532/0.125 = 85$$

$$n = n \times PRQ/PRQ = 3.286/0.04 = 83$$

F. Finally, we choose the sampling plan. We use the highest result of the two calculations for our sampling plan. In this case, we would choose the following sampling plan:

$$n = 85$$

$$Ac = 6$$

We would sample 85 images. If no more than 6 of the images inspected are nonconforming, the lot would be accepted.

11.1.3 Nomograph method for selecting a plan

Another way to select a sampling plan is to use the nomograph method. Figure 1, Nomograph, can be used to select a sampling plan. The following steps describe how to use the nomograph.

A. First, we choose a *PRQ* and *CRQ*. We will choose the same *PRQ* and *CRQ* used in 11.1.2 — a *PRQ* of 4% and a *CRQ* of 12.5% (i.e., *PRQ* is 0.04; *CRQ* is 0.125). We wish to find a sampling plan that will accept lots that are 4% nonconforming 95% of the time and accept lots that are 12.5% nonconforming only 10% of the time.

B. Draw a straight line between the following:
   — *CRQ* (0.125) on the left–hand scale
   — consumer's risk (0.10) on the right–hand scale

(In figure 1, the left–hand scale is labeled "fraction defective" and the right–hand scale is labeled "probability of acceptance.")

C. Draw another line between the following:
   — *PRQ* (.04) on the left–hand scale
   — the one-minus-the-producer's-risk (1 – .05 = 0.95) on the right–hand scale

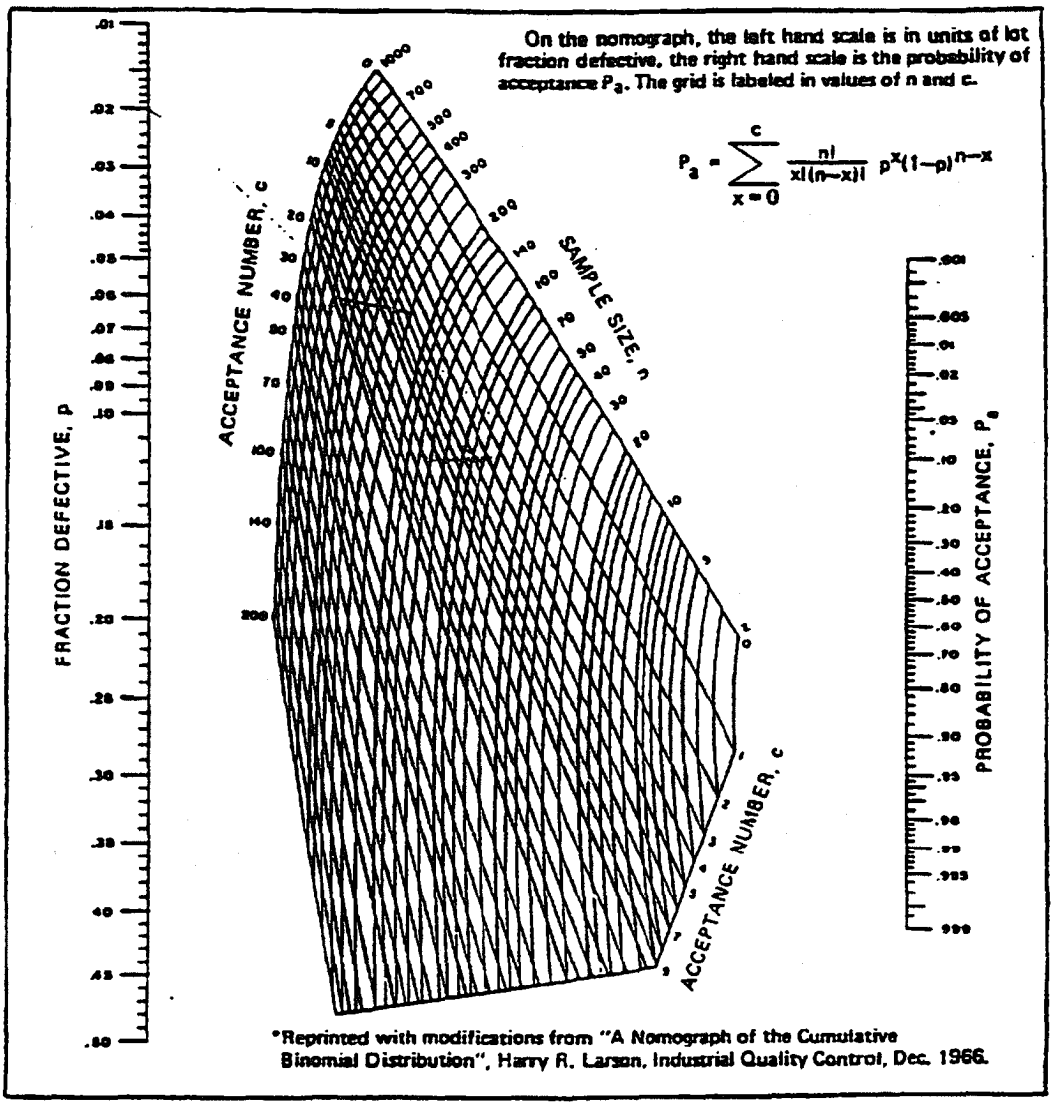
(In figure 1, the left–hand scale is labeled "fraction defective" and the right–hand scale is labeled "probability of acceptance.")

D. Determine the point at which the two lines cross.

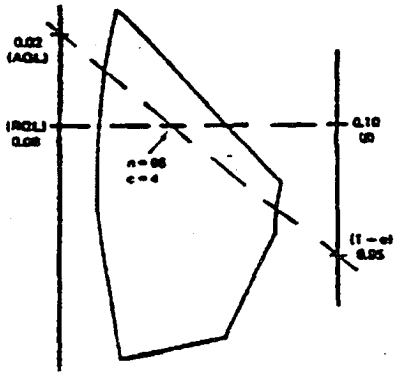
E. Read the sample size and the acceptance number from the two scales in the middle of the graph.

For this example, the nomograph results in the same plan as the tabular method described in 11.1.2. The sampling plan is one in which *n* is 85 and *Ac* is 6. We would sample 85 images. If no more than 6 of the images inspected are nonconforming, the lot would be accepted.

TECHNIQUE OF THE MONTH #10
ATTRIBUTE SAMPLING PLANS



*Reprinted with modifications from "A Nomograph of the Cumulative Binomial Distribution", Harry R. Larson, Industrial Quality Control, Dec. 1966.



In this example, Producer's Risk Quality (PRQ) was taken as 0.02 fraction defective with a producer's risk of 0.05. The Consumer's Risk Quality, (CRQ) was chosen at 0.08 fraction defective with a consumer's risk of 0.10. The required sample size *n* and acceptance number *Ac* were found as shown on the nomograph to be 98 and 4 respectively. Thus, to limit the producer's and consumer's risks to 0.05 and .10 respectively, the lot is rejected if a sample of 98 units selected randomly from the lot contains more than four defectives. The lot is accepted if the sample contains four or fewer defectives.

Figure 1 — Nomograph

11.1.4 Operating Characteristic (OC)

The operating characteristic is the probability of acceptance as a function of the fraction of the lot that is nonconforming. When this function is plotted it is called an operating characteristic curve, or OC curve. This function can be used to determine the likelihood that a lot of any stated quality will be accepted.

The chart in figure 2, Curves for determining probability of acceptance, can be used to determine the probability of acceptance for any lot quality. The abscissa (horizontal axis) of the chart is the product *np* (the product of the sample size, *n*, and the fraction nonconforming, *p*). This product is the average number of nonconforming images in submitted lots.

Each curve on the chart is an acceptance number, *Ac*. The ordinate (vertical axis) of the chart is the probability of acceptance expressed in percent. For the example used in both 11.1.2 and 11.1.3

$$n \times (PRQ) = 85(0.04) = 3.4$$

$$n \times (CRQ) = 85(0.125) = 10.625.$$

It may then be observed that the curve for $Ac = 6$ does indeed go through the two points 3.4,95 and 10.625,10.

We also could determine from the chart in figure 2 that, with the plan $n = 85$, $Ac = 6$, an np of 6.7 gives a p of 6.7/85 = 7.9% nonconforming and has a 50% chance of acceptance.

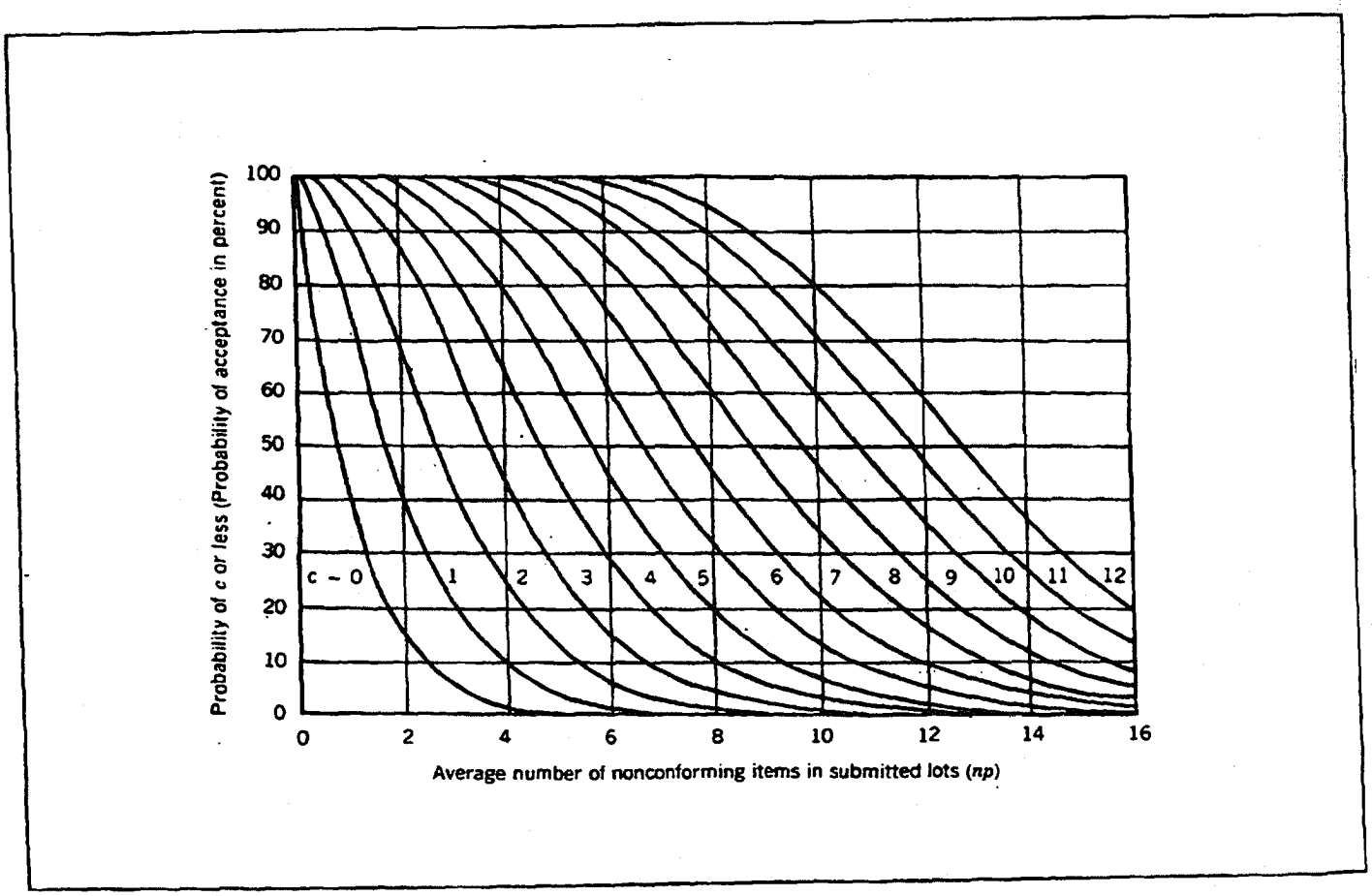


Figure 2 — Curves for determining probability of acceptance

11.2 Item-by-item sequential sampling plans

The procedure and tables in 11.2.1, 11.2.2, and 11.2.3 are based on ISO 8422. To obtain complete sequential sampling procedures, refer to that standard.

11.2.1 Principles of sequential sampling

When using a sequential sampling plan by attributes, images are selected at random and subjected to inspection one at a time. A cumulative count is kept of the number of nonconforming images (or number of nonconformities) and the number of images inspected. After each image is inspected, this count is used to assess whether sufficient information exists to either accept or reject the lot. Table 4 outlines the sequential sampling decision process.

If the cumulative count...	Then...	And then...
is such that the risk of accepting a lot with unsatisfactory quality (the consumer's risk) is sufficiently low	the lot is considered acceptable	the inspection is terminated.
is such that the risk of not accepting a lot with satisfactory quality (the producer's risk) is sufficiently low	the lot is considered not acceptable	the inspection is terminated.
does not allow you to decide if the lot is considered acceptable or not acceptable	an additional image is selected and inspected	this process is continued until you have accumulated sufficient information to make a decision as to the acceptability of the lot.

Table 4 — Sequential sampling decision process

11.2.2 Choosing *PR* and *CR*

As with single sampling, to evaluate the consumer's risk and the producer's risk, the producer's and consumer's risk qualities must be chosen. As with single sampling, we will use, for the purpose of this guide, a producer's and consumer's risk of 5% and 10%, respectively. This leaves only the *PRQ* and *CRQ* to be selected by the user.

The average sample size is the average number of images for a series of lots that will be inspected, all at a stated quality level, before a decision is made to accept or reject the lot. Using a sequential plan leads to a smaller average sample size than a single sampling plan with the same operating characteristic. For very good lots, this savings may reach or exceed 50%.

On the other hand, the actual number of images o attributes of images inspected for a particular lot ma exceed that required by a single sampling plan with the same operating characteristic. In fact, a sequential sampling plan may not reach a decision until the entire lot has been inspected. To preclude such events, a curtailment rule has been established and is discussed in 11.2.4.

Because the ultimate sample size for a particular lot when using sequential sampling is not known in advance, selecting images for inspection can present operational difficulties. The user must decide if a smaller average sample size outweighs a sample size that is not known in advance. This becomes a matter of evaluating inspection costs versus the cost of selecting images for inspection. A simple cost model to assist this evaluation is found in annex A, Sampling costs.

It should be pointed out that the type of sampling plan must be selected before sampling begins. If a switch is made during inspection of a lot, the operating characteristic of the resulting plan may be changed drastically because the inspection results would influence the choice of acceptance criteria.

11.2.3 Selecting sequential sampling plan parameters

The general procedure described here is to be used when both the producer's risk quality and the consumer's risk quality have been designated. Thus, the sampling plan will have approximately the same operating characteristic as the single sampling plan, which was developed in 11.1, using the same two points (*PR* = 5% and *CR* =10%).

A. The first step is to choose the two values — *CRQ* and *PRQ*.

B. The next step is to use table 5, Sequential sampling plans for inspection for percent nonconforming for producer's risk = 0.05 and consumer's risk = 0.10, to determine the values of the plan parameters h_1, h_2 and g.

   1. Locate the *CRQ* value (column).

   2. Locate the *PRQ* value (row).

   3. Identify the plan parameter values listed in the column/row intersection.

An example of the steps follows:

A. Determine the producer's and consumer's risk quality. In this example, a sequential sampling plan is desired for a producer's risk quality (*PRQ*) of 4% and a consumer's risk quality (*CRQ*) of 12.5%. (These criteria mean that a lot with 4% nonconforming images has a probability of acceptance of 95% and a lot with 12.5% nonconforming images has a probability of acceptance of 10%.)

B. Use table 5 to locate the parameters of the sequential plan that satisfy the criteria. The values are as follows:
   — $h_A = 1.827$
   — $h_R = 2.346$
   — $g = 0.0752$

11.2.4 Determining the curtailment value of the sample size

A curtailment rule ensures that a sequential sampling plan decision is made before an entire lot has to be inspected. If the sample size of the single sampling plan that matches the sequential plan is known, the curtailment number is 1.5 times the single sample size rounded up to the nearest integer. (It was determined in 11.1 that a single sampling plan with a sample size of 85 images and an acceptance number of 6 would meet the criteria.)

For the example in 11.2.3, the curtailment value (n_t) is

$$n_t = (1.5)n$$

$$n_t = (1.5)(85) = 128.$$

If the sample size of the equivalent single sampling plan is unknown, the curtailment value is calculated as

$$n_t = \frac{2h_A h_R}{g\ (1-g)}$$

rounded up to the nearest integer.

In this case, n_t is

[2(1.827)(2.346)]/[0.0752(1-0.0752)] = 124.

11.2.5 Operation of the plan

For each value, n_{cum}, that is less than the curtailment value, the acceptance number A is found by rounding the quantity $gn_{cum} - h_A$ down to the nearest integer.

The rejection number, R, is found by rounding the quantity $gn_{cum} + h_R$ up to the nearest integer.

The acceptance number corresponding to the curtailed sample size, A_t, is determined by rounding the quantity, gn_t, down to the nearest integer.

The corresponding rejection number is $A_t + 1$.

If the acceptance number, A, is negative, the cumulative sample size is too small to allow acceptance of the lot. Conversely, if the rejection number, R, is larger than the cumulative sample size, the cumulative sample size is too small to reject the lot.

The smallest cumulative sample size permitting lot acceptance can be obtained by rounding h_A/g up to the nearest integer. The smallest cumulative sample size permitting rejection of the lot is obtained by rounding $h_R/(1-g)$ up to the nearest integer.

The example started in 11.2.3, has the following parameters:
— $h_A = 1.827$
— $h_R = 2.346$
— $g = 0.0752$

The curtailment sample size is 128.

The curtailment acceptance number, A_t, is found by rounding $gn_t = 9.63$ down to the nearest integer. The curtailment acceptance number, A_t is 9.

The curtailment rejection number, R_t is $A_t + 1$, which would be 10.

The formula for the acceptance number, A, is

$$0.0752n_{cum} - 1.827$$

rounded down to the nearest integer. See table 6, Example chart for sequential sampling plan.

The formula for the rejection number, R, is

$$0.0752n_{cum} + 2.346$$

rounded up to the nearest integer. See table 6, Example chart for sequential sampling plan.

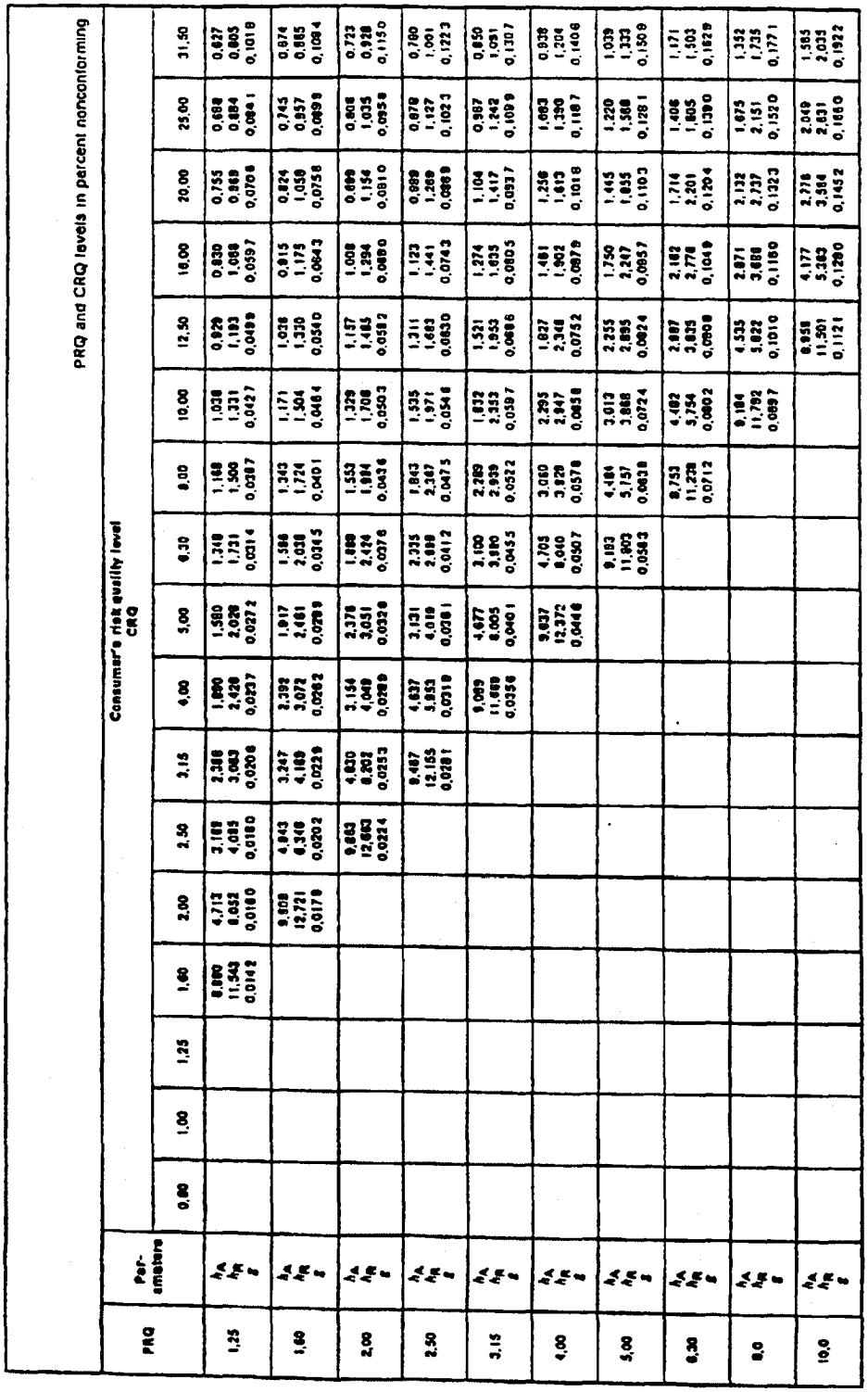
The acceptance and rejection numbers corresponding to the cumulative sample sizes n_{cum} = 1,2,..., 127 are determined by successively inserting the values of n_{cum} in these formulas and rounding appropriately. The acceptance number cannot be more than 9, and the rejection number cannot be more than 10. The results are shown in table 6.

Sequential sampling plans for inspection for percent nonconforming for producer's risk = 0.05 and consumer's risk = 0.10

PRQ and CRQ levels in percent nonconforming

PRQ	Parameters	Consumer's risk quality level CRQ																
		0,80	1,00	1,25	1,60	2,00	2,50	3,15	4,00	5,00	6,30	8,00	10,00	12,50	16,00	20,00	25,00	31,50
0,100	h_A h_R g	1,078 1,385 0,00337	0,974 1,250 0,00381	0,887 1,139 0,00458	0,808 1,037 0,00543	0,747 0,959 0,00637	0,694 0,891 0,00750	0,647 0,830 0,00881	0,604 0,775 0,0107	0,568 0,729 0,0127	0,535 0,687 0,0152	0,504 0,647 0,0185	0,478 0,614 0,0222	0,454 0,583 0,0267	0,429 0,551 0,0330	0,408 0,524 0,0402	0,388 0,498 0,0484	0,367 0,472 0,0616
0,125	h_A h_R g	1,209 1,551 0,00364	1,076 1,384 0,00421	0,973 1,249 0,00490	0,878 1,127 0,00560	0,806 1,035 0,00678	0,746 0,957 0,00797	0,691 0,887 0,0094	0,642 0,825 0,0113	0,602 0,773 0,0134	0,565 0,726 0,0160	0,531 0,682 0,0194	0,502 0,644 0,0232	0,475 0,610 0,0279	0,448 0,575 0,0344	0,425 0,546 0,0419	0,403 0,518 0,0513	0,381 0,489 0,0658
0,160	h_A h_R g	1,393 1,789 0,00398	1,223 1,570 0,00439	1,089 1,399 0,00531	0,972 1,247 0,00627	0,885 1,136 0,00731	0,812 1,042 0,00855	0,748 0,960 0,0101	0,691 0,887 0,0120	0,645 0,828 0,0142	0,602 0,774 0,0170	0,564 0,724 0,0205	0,531 0,682 0,0245	0,501 0,644 0,0294	0,471 0,605 0,0362	0,446 0,572 0,0439	0,422 0,542 0,0536	0,398 0,511 0,0686
0,200	h_A h_R g	1,617 2,076 0,00433	1,392 1,787 0,00488	1,221 1,568 0,00574	1,075 1,381 0,00675	0,970 1,245 0,00784	0,883 1,134 0,00915	0,808 1,037 0,0108	0,742 0,952 0,0128	0,689 0,884 0,0151	0,641 0,823 0,0180	0,597 0,767 0,0216	0,561 0,720 0,0257	0,528 0,677 0,0308	0,494 0,635 0,0378	0,466 0,598 0,0456	0,440 0,565 0,0558	0,414 0,532 0,0692
0,250	h_A h_R g	1,926 2,473 0,00473	1,615 2,074 0,00541	1,390 1,785 0,00622	1,204 1,546 0,00729	1,074 1,378 0,00844	0,969 1,243 0,00981	0,878 1,128 0,0115	0,801 1,028 0,0136	0,739 0,949 0,0160	0,684 0,878 0,0190	0,635 0,815 0,0228	0,594 0,762 0,0271	0,557 0,715 0,0324	0,520 0,667 0,0397	0,489 0,628 0,0479	0,460 0,591 0,0583	0,432 0,555 0,0721
0,315	h_A h_R g	2,403 3,085 0,00521	1,937 2,487 0,00593	1,622 2,083 0,00679	1,374 1,764 0,00792	1,207 1,549 0,00914	1,075 1,381 0,0106	0,966 1,240 0,0124	0,873 1,121 0,0146	0,800 1,028 0,0171	0,736 0,945 0,0202	0,679 0,872 0,0242	0,632 0,812 0,0287	0,591 0,758 0,0342	0,549 0,705 0,0416	0,515 0,661 0,0503	0,483 0,620 0,0611	0,452 0,580 0,0753
0,40	h_A h_R g	3,229 4,146 0,00577	2,441 3,134 0,00655	1,961 2,518 0,00747	1,610 2,067 0,00867	1,385 1,778 0,00996	1,214 1,559 0,0115	1,076 1,382 0,0134	0,962 1,236 0,0157	0,875 1,123 0,0184	0,799 1,026 0,0217	0,732 0,940 0,0258	0,678 0,871 0,0305	0,630 0,809 0,0363	0,583 0,749 0,0441	0,545 0,700 0,0530	0,509 0,654 0,0642	0,475 0,610 0,0790
0,50	h_A h_R g	4,759 6,110 0,00638	3,224 4,140 0,00722	2,437 3,129 0,00819	1,917 2,461 0,00947	1,606 2,062 0,0108	1,381 1,774 0,0125	1,205 1,548 0,0145	1,064 1,366 0,0169	0,959 1,231 0,0197	0,868 1,114 0,0232	0,790 1,014 0,0275	0,727 0,934 0,0324	0,673 0,863 0,0384	0,618 0,795 0,0466	0,576 0,740 0,0558	0,537 0,689 0,0674	0,498 0,640 0,0827
0,63	h_A h_R g	9,357 12,013 0,00712	4,834 6,206 0,00801	3,256 4,180 0,00905	2,390 3,069 0,0104	1,926 2,472 0,0119	1,611 2,069 0,0136	1,377 1,768 0,0157	1,196 1,535 0,0183	1,064 1,366 0,0212	0,953 1,224 0,0249	0,860 1,104 0,0294	0,786 1,009 0,0346	0,723 0,928 0,0408	0,662 0,849 0,0494	0,613 0,787 0,0590	0,568 0,729 0,0710	0,526 0,675 0,0868
0,80	h_A h_R g		9,999 12,837 0,00986	4,994 6,411 0,0101	3,210 4,122 0,0115	2,425 3,113 0,0131	1,946 2,499 0,0149	1,614 2,073 0,0172	1,371 1,760 0,0200	1,200 1,541 0,0231	1,062 1,363 0,0269	0,947 1,215 0,0317	0,858 1,102 0,0371	0,783 1,006 0,0437	0,712 0,914 0,0526	0,656 0,842 0,0626	0,605 0,777 0,0751	0,557 0,715 0,0916
1,00	h_A h_R g			9,976 12,808 0,0112	4,729 6,071 0,0126	3,201 4,110 0,0144	2,417 3,103 0,0164	1,925 2,472 0,0186	1,589 2,040 0,0217	1,364 1,751 0,0250	1,189 1,525 0,0290	1,046 1,343 0,0341	0,939 1,205 0,0397	0,850 1,091 0,0466	0,767 0,984 0,0559	0,702 0,901 0,0664	0,644 0,827 0,0794	0,590 0,757 0,0965

Table 5 — Sequential sampling plans for inspection for percent nonconforming for producer's risk = 0.05 and consumer's risk= 0.10



PRQ and CRQ levels in percent nonconforming

PRQ	Parameters	Consumer's risk quality level CRQ																			
		0.80	1.00	1.25	1.60	2.00	2.50	3.15	4.00	5.00	6.30	8.00	10.00	12.50	16.00	20.00	25.00	31.50
1.25	h_A				0.880	4.713	3.168	2.368	1.890	1.580	1.340	1.168	1.038	0.929	0.830	0.755	0.688	0.627
	h_R				11.543	8.652	4.085	3.063	2.420	2.028	1.731	1.500	1.331	1.193	1.068	0.969	0.884	0.805
	g				0.0142	0.0160	0.0160	0.0206	0.0237	0.0272	0.0314	0.0367	0.0427	0.0499	0.0597	0.0706	0.0841	0.1018
1.60	h_A					9.808	4.943	3.247	2.392	1.917	1.586	1.343	1.171	1.028	0.915	0.824	0.745	0.674
	h_R					12.721	6.346	4.189	3.072	2.481	2.038	1.724	1.504	1.330	1.175	1.058	0.957	0.865
	g					0.0170	0.0202	0.0229	0.0262	0.0299	0.0345	0.0401	0.0464	0.0540	0.0643	0.0758	0.0898	0.1084
2.00	h_A						9.863	4.830	3.154	2.378	1.888	1.553	1.329	1.157	1.008	0.899	0.808	0.723
	h_R						12.663	6.293	4.049	3.051	2.424	1.994	1.708	1.485	1.294	1.154	1.035	0.928
	g						0.0224	0.0253	0.0289	0.0328	0.0378	0.0436	0.0503	0.0582	0.0680	0.0810	0.0958	0.1150
2.50	h_A							9.487	4.837	3.131	2.335	1.843	1.535	1.311	1.123	0.999	0.878	0.780
	h_R							12.155	3.953	4.018	2.988	2.367	1.971	1.683	1.441	1.269	1.127	1.001
	g							0.0281	0.0319	0.0361	0.0412	0.0475	0.0546	0.0630	0.0743	0.0889	0.1023	0.1223
3.15	h_A								9.069	4.677	3.100	2.289	1.832	1.521	1.274	1.104	0.987	0.850
	h_R								11.668	6.005	3.880	2.939	2.353	1.953	1.635	1.417	1.242	1.091
	g								0.0358	0.0401	0.0455	0.0522	0.0597	0.0686	0.0805	0.0937	0.1089	0.1307
4.00	h_A									9.037	4.705	3.060	2.295	1.827	1.481	1.256	1.063	0.938
	h_R									12.372	8.040	3.829	2.947	2.348	1.902	1.613	1.390	1.204
	g									0.0446	0.0507	0.0578	0.0658	0.0752	0.0879	0.1018	0.1187	0.1406
5.00	h_A										9.183	4.484	3.013	2.255	1.750	1.445	1.220	1.039
	h_R										11.903	5.157	3.868	2.885	2.247	1.855	1.568	1.333
	g										0.0583	0.0658	0.0724	0.0824	0.0957	0.1103	0.1281	0.1509
6.30	h_A											8.753	4.402	2.887	2.182	1.714	1.406	1.171
	h_R											11.238	5.754	3.835	2.778	2.201	1.805	1.503
	g											0.0712	0.0802	0.0908	0.1049	0.1204	0.1390	0.1629
8.0	h_A												8.184	4.335	2.871	2.132	1.675	1.352
	h_R												11.792	5.822	3.688	2.737	2.151	1.735
	g												0.0897	0.1010	0.1180	0.1323	0.1520	0.1771
10.0	h_A													8.958	4.177	2.776	2.049	1.585
	h_R													11.501	5.383	3.564	2.631	2.035
	g													0.1121	0.1280	0.1452	0.1680	0.1922

Table 5 — Sequential sampling plans for inspection for percent nonconforming for producer's risk = 0.05 and consumer's risk = 0.10 (concluded)

Cumulative Sample Size n_{cum}	Acceptance Number $gn_{cum} - h_A$	Rounded Acceptance Number A	Rejection Number $gn_{cum} + h_R$	Rounded Rejection Number R
1	-1.752	*	2.421	**
2	-1.677	*	2.496	**
3	-1.912	*	2.572	3
4	-1.526	*	2.647	3
..	....	..	....	..
8	-1.225	*	2.948	3
9	-1.150	*	3.023	4
..	....	..	....	..
20	-.323	*	3.850	4
21	-.248	*	4.925	4
22	-0.173	*	4.000	4
23	-0.097	*	4.076	5
24	-0.022	*	4.151	5
25	0.053	0	4.226	5
..	....	..	....	..
31	0.050	0	4.677	5
..	....	..	....	..
35	0.805	0	4.978	5
36	0.880	0	5.053	6
37	0.955	0	5.128	6
38	1.031	1	5.204	6
..	....	..	....	..
48	1.783	1	5.956	6
49	1.858	1	6.031	7
50	1.933	1	6.106	7
51	2.008	2	6.181	7
..	....	..	....	..
61	2.760	2	6.933	7
62	2.835	2	7.008	8
63	2.911	2	7.084	8
64	2.986	2	7.159	8
65	3.061	3	7.234	8
..	....	..	....	..
75	3.813	3	7.986	8
76	3.888	3	8.061	9
77	3.963	3	8.136	9
78	4.039	4	8.212	9
..	....	..	....	.
88	4.791	4	8.964	9
89	4.866	4	9.039	10
90	4.941	4	9.114	10
91	5.016	5	9.189	10
..	....	..	....	..
104	5.994	5	10.167	10
105	6.069	6	--	10
..	....	..	....	..
117	6.971	6	--	10
118	7.047	7	--	10
..	....	..	....	..
127	7.723	7	--	10
128	--	9	--	10

Table 6 — Example chart for sequential sampling plan

* Cumulative sample size is too small to permit acceptance. ** Cumulative sample size is too small to permit rejection.

Two examples of the operation of sequential sampling plans follow.

A. Assume that the first 20 images inspected were conforming to specifications. The 21st image was nonconforming. If no other nonconforming images were found, the lot may be accepted after 38 images are inspected. (This can be seen by looking at *A* in table 6. At image 38, a lot can be accepted if only 1 image has been rejected. Until the 38th image has been checked, a lot with one image rejected cannot be accepted.)

B. On the other hand, suppose the 5th, 10th 18th, 24th, and 31st images were found to be nonconforming. The lot would then be rejected after inspection of the 31st image. (This can be seen by looking at *R* in table 6. At the 31st image, the lot can be rejected if 5 images are rejected. In this example, 5 images have been rejected, the 5th, 10th, 18th, 24th and 31st.)

The earliest that a lot may be accepted is after the inspection of 25 images, if all are found to be conforming.

11.2.6 Graphical method of operating the plan

The examples above also can be presented graphically, if desired. Figure 3, Graph for example sequential plan, illustrates the same information shown in table 6. To use the graph, do the following:

A. Start inspection at the origin.

B. For each image inspected, move one unit to the right.

C. If an image is nonconforming, move up one unit.

D. Check if the lower or upper line is crossed.

   — If the lower decision line is crossed, accept the lot.

   — If the upper line is crossed, reject the lot.

E. Continue sampling as long as the location is between the two lines.

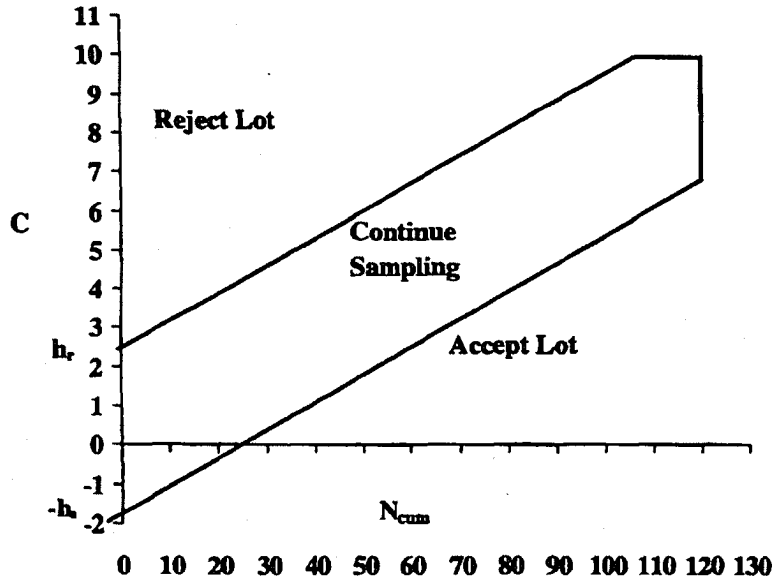


Figure 3 — Graph for example sequential plan

12 Sampling plans for a continuing series of lots

12.1 Single sampling using ISO 2859-1

ISO 2859-1 is an international standard that was updated and improved in 1989 and again in 1996 to use modern concepts of quality assurance. The 1996 edition is used in this technical report. Early versions were similar to MIL-STD 105, which has now been discontinued and replaced by ANSI/ASQC Z1.4

ISO 2859-1 uses the concept of sampling, each designated by *AQL* and sample size code letter, which is addressed in 12.1.1. Each sampling scheme consists of three sampling plans — normal, tightened, and reduced plans — together with rules for switching between the plans.

ISO 2859-1 contains single, double, and multiple sampling plans that are matched as closely as possible; that is, they give approximately the same protection to both the producer and the consumer. Double plans have a smaller average sample size than single plans. Multiple plans have a smaller average sample size than double plans. However, single plans are the easiest to use because they always require the same sample size.

Details on the use of double and multiple plans are found in the standard; however, they will not be discussed in this technical report. Sequential plans with approximately the same protection as the schemes in ISO 2859-1 can be found in ISO 8422. Sequential sampling using ISO 8422 is discussed in 12.2.

12.1.1 Sample size code letters and inspection levels

The sample size code letter depends on the lot size and the inspection level. The sample size code letters are found in table 7. The inspection level is designated by the user. The purpose of inspection levels is to allow the user to maintain greater discrimination for some suppliers of conversion services and lesser discrimination for others. Inspection level II is usually used.

At each inspection level, the switching rules shall operate to require normal, tightened, and reduced inspection as specified in 12.1.3. The choice of inspection level is quite separate from these three forms of inspection intensity. Thus, the inspection level that has been specified shall be kept unchanged when switching between normal, tightened, and reduced inspection.

The amount of information about the quality of a lot gained from examining samples drawn from the lot depends on the absolute size of the sample, not on the fraction of the lot sampled, providing the lot is large relative to the sample size. In spite of this, three reasons exist for varying the sample size with the lot size.

— When the risk is high, it is more important to make the correct decision.

— With a large lot, a sample size can be afforded that would not be economical for a small lot.

— A truly random selection is relatively more time consuming if the sample is too small a proportion of the lot (e.g., a sample of 5 images from a lot of 35,000 images).

12.1.2 Obtaining a sampling plan

The *AQL* and the sample size code letter should be used to obtain the sampling plan from tables 8, 9, and 10, which are respectively the normal, tightened, and reduced plans.

When no sampling plan is available for a given combination of *AQL* and sample size code letter, the tables direct the user to a new letter by means of arrows. The sample size to be used is given by the new sample size code letter, not the original letter. If this procedure leads to different sample sizes for different classes of nonconformities, the sample size code letter corresponding to the largest sample size can be used for all classes of nonconformities.

Lot or batch size	Inspection levels		
	I	II	III
2 to 8	A	A	B
9 to 15	A	B	C
16 to 25	B	C	D
26 to 50	C	D	E
51 to 90	C	E	F
91 to 150	D	F	G
151 to 280	E	G	H
281 to 500	F	H	J
501 to 1200	G	J	K
1,201 to 3,200	H	K	L
3,201 to 10,000	J	L	M
10,001 to 35,000	K	M	N
35,001 to 150,000	L	N	P
150,001 to 500,000	M	P	Q
500,001 and over	N	Q	R

Table 7 — Sample size code letters

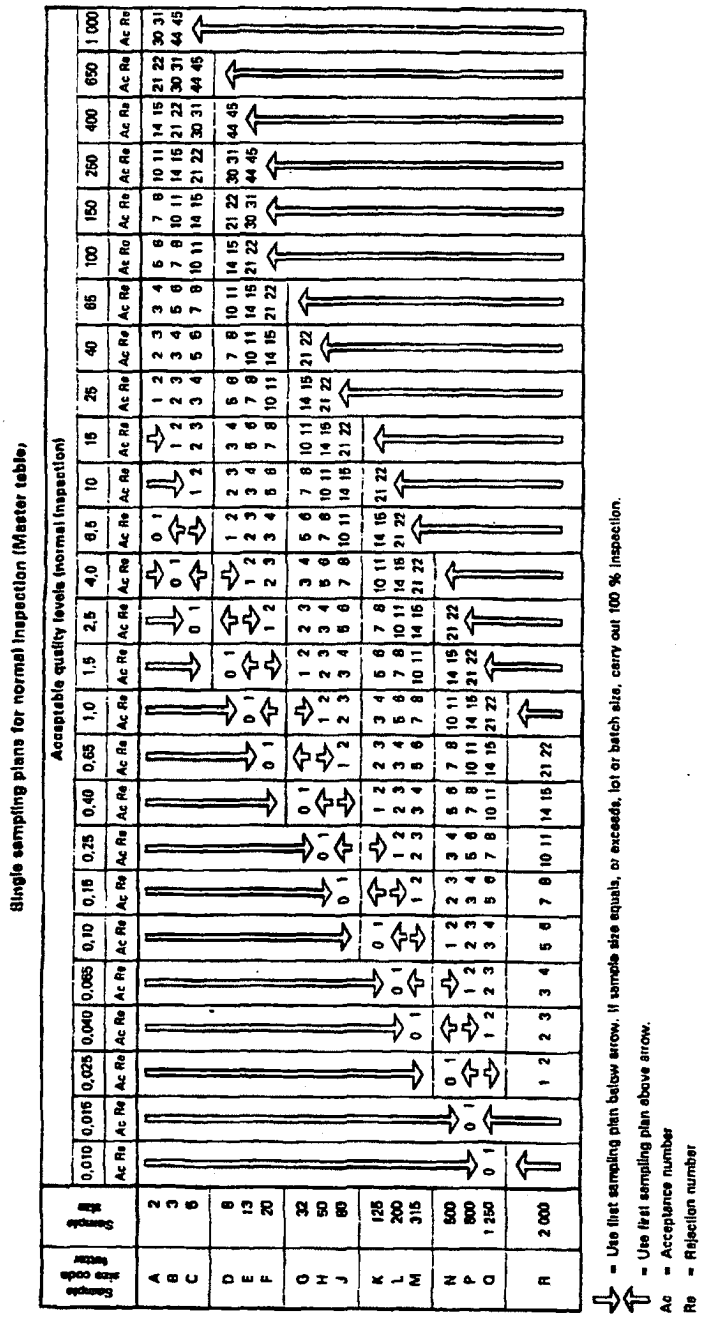


Table 8 — Single sampling plans for normal inspection (Master table)

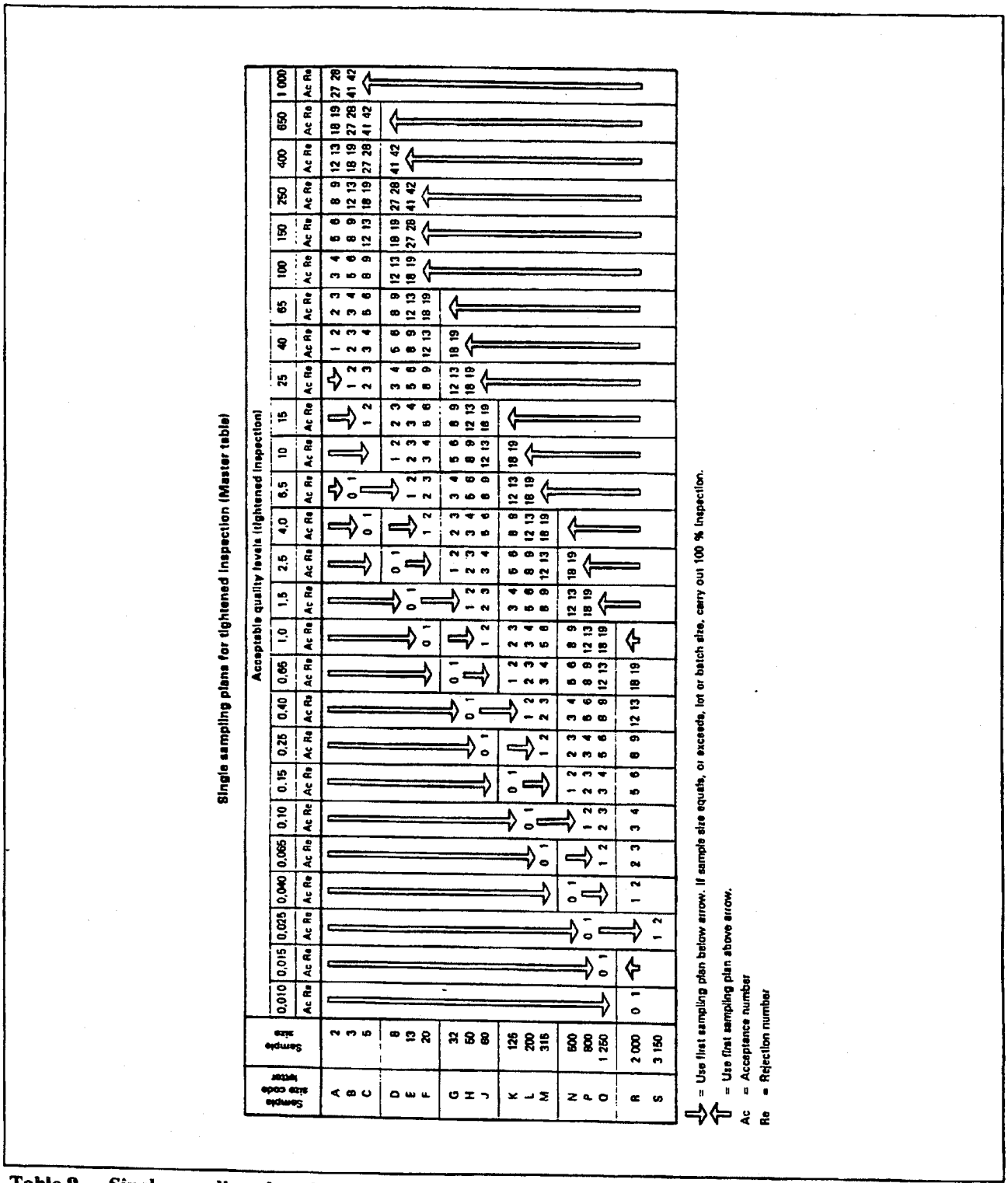


Table 9 — Single sampling plans for tightened inspection (Master table)

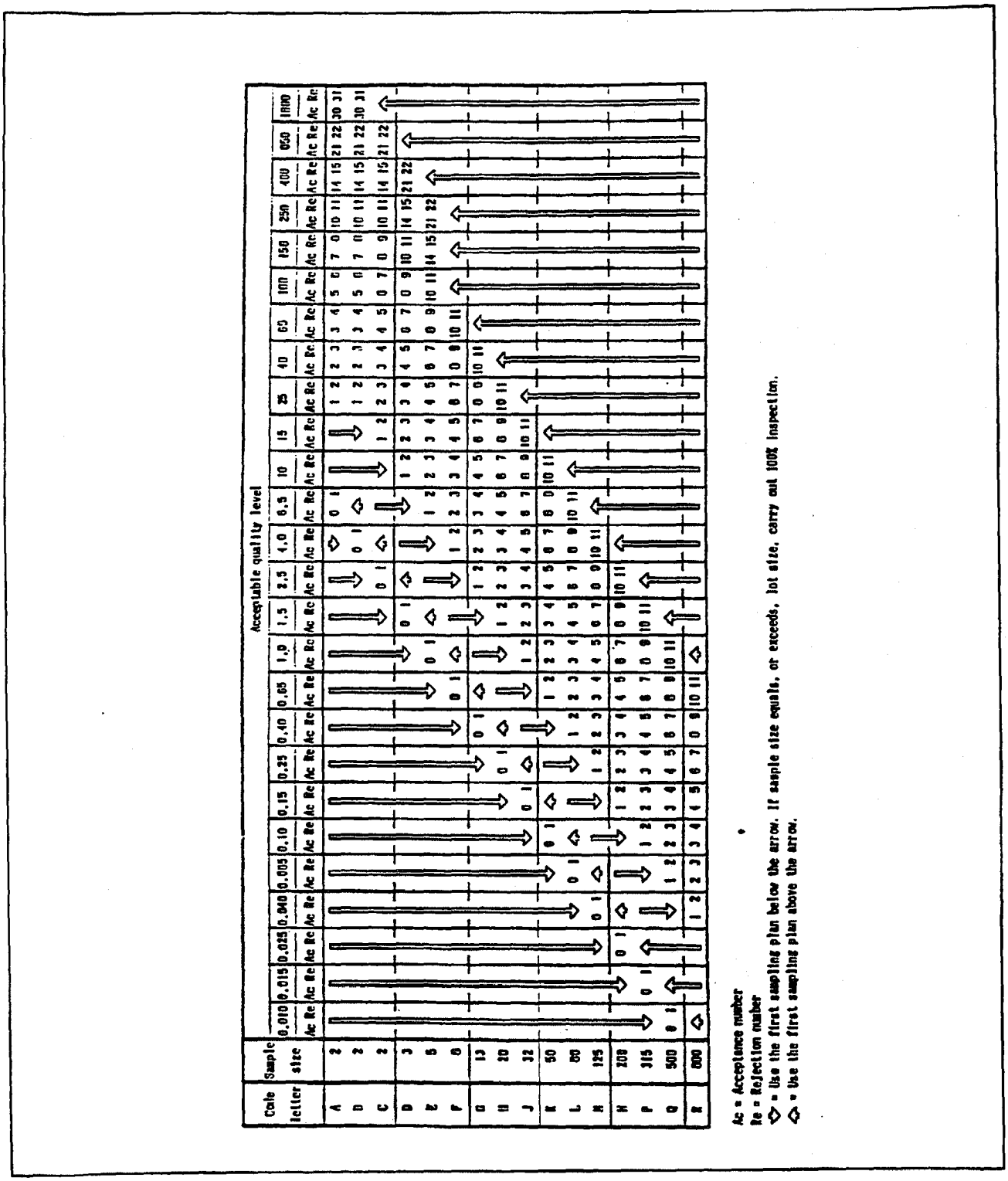


Table 10 — Single sampling plans for reduced inspection (Master table)

12.1.3 Normal, tightened, and reduced inspection

Normal inspection shall be carried out at the start of inspection. Normal, tightened or reduced inspection shall continue unchanged on successive lots of images until the switching procedures require a change. The switching rules should be applied to each class of nonconformities independently. Table 11 provides the switching rules.

If the cumulative number of lots not accepted in a sequence of consecutive lots on original tightened inspection reaches five, this acceptance sampling procedure shall not be resumed until action has been taken by the supplier to improve the quality of the submitted product. Tightened inspection shall then be used as if the switching from normal to tightened inspection procedure had been invoked.

12.1.4 Determination of acceptability

The number of sample images inspected shall be equal to the sample size given by the plan. Table 12, Inspection types and determinations, provides information about percent nonconforming inspection and nonconformities per 100 images inspected.

Switching Procedure	Rules
From normal to tightened	When normal inspection is being carried out, tightened inspection shall be put into operation when 2 out of 5, or fewer, consecutive lots have been rejected on original inspection (that is, ignoring resubmitted lots).
From tightened to normal	When tightened inspection is being carried out, normal inspection shall be reverted to when 5 consecutive lots have been considered acceptable on original inspection.
From normal to reduced	Reduced inspection is an optional procedure which should be approved by all parties prior to its use. If approved, when normal inspection is being carried out, reduced inspection may be put into operation provided that all of the following conditions are satisfied: — when the acceptance number is 0 or 1, the preceding 15 lots have been submitted to normal inspection and all have been accepted on original inspection, or — when the acceptance number is 2 or more, the preceding 10 lots have been submitted to normal inspection and all would have been accepted on original inspection if the *AQL* were one step tighter.
From reduced to normal	When reduced inspection is being carried out, normal inspection shall be reverted to if a lot on original inspection is not accepted.

Table 11 — Switching rules

Inspection Type	Sample Result	Determination
Percent nonconforming inspection	Number of nonconforming images found is equal to or less than the acceptance number	The lot is considered acceptable.
	Number of nonconforming images is equal to or greater than the rejection number	The lot shall be considered not acceptable.
Nonconformities per 100 images inspection	Number of nonconformities found is equal to or less than the acceptance number	The lot is considered acceptable.
	Number of nonconformities is equal to or greater than the rejection number	The lot is considered not acceptable.

Table 12 — Inspection types and determinations

12.1.5 Operating Characteristic (OC) curves

The operating characteristic curves for normal and tightened inspection, shown in tables 13 through 29 indicate the percentage of lots that may be expected to be accepted under the various sampling plans for a given percent nonconforming. (The tables are organized by sample size code letter.)

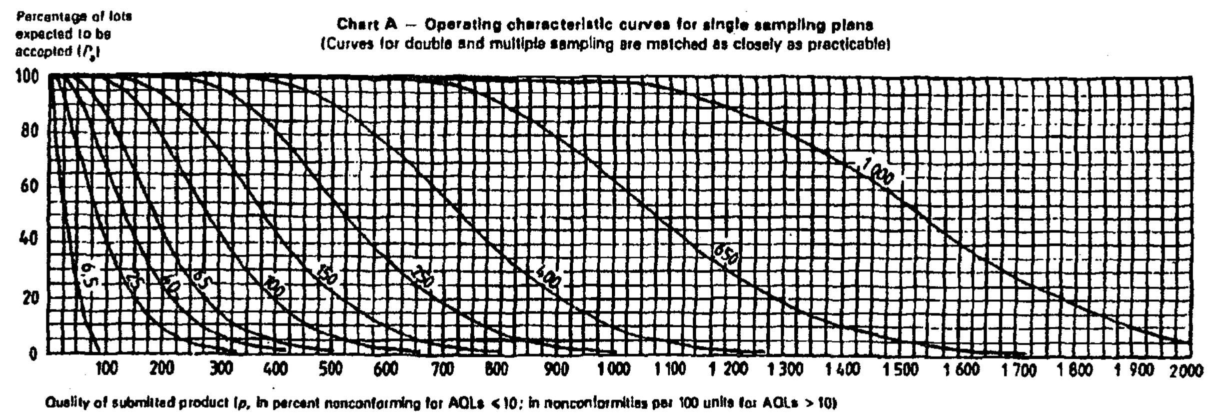
The OC curves for *AQL*s greater than 10 are based on the Poisson distribution and are applicable for nonconformities per 100 images inspection

The OC curves for *AQL*s of 10 or less are based on the binomial distribution for percent nonconforming inspection and on the Poisson distribution for number of nonconformities per 100 images inspection

Table 13 — Tables for sample size code letter A (individual plans)

A

Chart A — Operating characteristic curves for single sampling plans
(Curves for double and multiple sampling are matched as closely as practicable)



NOTE — Values on curves are Acceptable Quality Levels (AQLs) for normal inspection.

Tabulated values for operating characteristic curves for single sampling plans

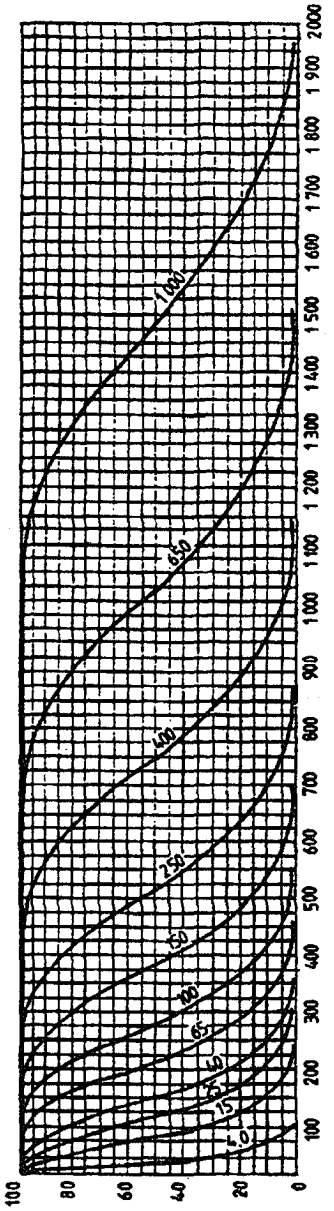
P_a	Acceptable quality levels (normal inspection)														
	6,5	6,5	25	40	65	100	150	X	250	X	400	X	650	X	1 000
	p (in percent nonconforming)	p (in nonconformities per 100 units)													
99,0	0,501	0,503	7,43	21,8	41,2	89,3	145	176	239	305	374	517	629	859	977
95,0	2,53	2,56	17,8	40,9	68,3	131	189	235	308	384	462	622	745	995	1 122
90,0	5,13	5,27	26,6	55,1	87,2	158	233	272	351	432	515	684	812	1 073	1 206
75,0	13,4	14,4	48,1	86,4	127	211	298	342	431	521	612	795	934	1 214	1 354
50,0	29,3	34,7	83,9	134	184	284	383	433	533	633	733	933	1 083	1 383	1 533
25,0	50,0	69,3	135	196	255	371	484	540	651	761	870	1 087	1 248	1 568	1 728
10,0	68,4	115	194	266	334	464	589	650	770	889	1 006	1 238	1 409	1 748	1 916
5,0	77,6	150	237	315	388	526	657	722	848	972	1 094	1 335	1 512	1 862	2 035
1,0	90,0	230	332	420	502	655	800	870	1 007	1 141	1 272	1 529	1 718	2 088	2 270
		X	40	65	100	150	X	250	X	400	X	650	X	1 000	X
	Acceptable quality levels (tightened inspection)														

NOTE — Binomial distribution used for percent nonconforming computations; Poisson for nonconformities per 100 units.

B

Tables for sample size code letter B (individual plans)

Chart B — Operating characteristic curves for single sampling plans
(Curves for double and multiple sampling are matched as closely as practicable)



NOTE – Values on curves are Acceptable Quality Levels (AQLs) for normal inspection.

Tabulated values for operating characteristic curves for single sampling plans

P_a	Acceptable quality levels (normal inspection)																		
	4,0	4,0	15	25	40	65	100	150	250	400	650	1 000
	p (in percent nonconforming)	p (in nonconformities per 100 units)																	
99,0	0,334	0,335	4,85	14,6	27,4	59,5	96,9	117	169	203	249	345	419	572	651	847	1 029
95,0	1,70	1,71	11,8	27,3	46,5	87,1	133	167	205	258	309	415	496	683	748	1 065	1 152
90,0	3,45	3,51	17,7	36,7	58,2	105	185	181	234	288	343	456	541	716	804	1 131	1 222
75,0	9,14	9,59	32,0	57,6	84,5	141	199	228	287	347	408	530	623	809	903	1 249	1 344
50,0	20,6	23,1	55,9	89,1	122	189	256	289	356	422	489	622	722	922	1 022	1 389	1 489
25,0	37,0	46,2	89,8	131	170	247	323	360	434	507	580	724	832	1 045	1 152	1 539	1 644
10,0	53,6	78,8	130	177	223	309	392	433	514	593	671	826	939	1 165	1 277	1 683	1 793
5,0	63,2	99,9	158	210	268	350	438	481	565	648	730	890	1 008	1 241	1 358	1 773	1 886
1,0	78,5	154	221	280	335	437	533	580	671	761	848	1 019	1 145	1 392	1 513	1 951	2 069
	6,5	6,5	25	40	65	100	150	250	400	650	1 000
	Acceptable quality levels (tightened inspection)																		

NOTE – Binomial distribution used for percent nonconforming computations; Poisson for nonconformities per 100 units.

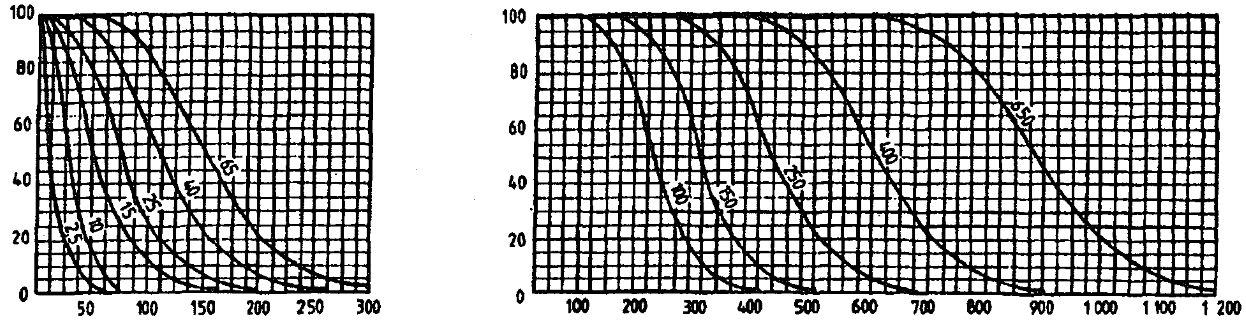
Table 14 — Tables for sample size code letter B (individual plans)

Table 15 — Tables for sample size code letter C (individual plans)

C

Tables for sample size code letter C (individual plans)

Chart C — Operating characteristic curves for single sampling plans
(Curves for double and multiple sampling are matched as closely as practicable)



Quality of submitted product (p in percent nonconforming for AQLs < 10; in nonconformities per 100 units for AQLs > 10)

NOTE — Values on curves are Acceptable Quality Levels (AQLs) for normal inspection.

Tabulated values for operating characteristic curves for single sampling plans

P_a	Acceptable quality levels (normal inspection)																	
	2,5	10	2,5	10	15	25	40	65		100		150		250		400		650
	p (in percent nonconforming)		p (in nonconformities per 100 units)															
99,0	0,201	3,27	0,201	2,97	8,72	16,5	37,5	58,1	70,1	95,4	122	150	207	251	343	391	568	618
95,0	1,02	7,64	1,03	7,11	16,4	27,3	52,3	79,6	93,9	123	154	185	249	298	398	449	639	691
90,0	2,09	11,2	2,11	10,6	22,0	34,9	63,0	93,1	109	140	173	206	273	325	429	482	679	733
75,0	5,59	19,4	5,75	19,2	34,5	50,7	84,4	119	137	172	208	245	318	374	485	542	749	806
50,0	12,9	31,4	13,9	33,6	53,5	73,4	113	153	173	213	263	293	373	433	553	613	833	893
25,0	24,2	45,4	27,7	53,9	78,4	102	148	194	216	260	304	348	435	499	627	691	923	986
10,0	36,9	58,4	46,1	77,8	106	134	185	235	260	308	356	403	495	564	699	766	1 010	1 076
5,0	45,1	65,7	59,9	94,9	126	155	210	263	289	339	389	438	534	605	745	814	1 064	1 131
1,0	60,2	77,8	92,1	133	168	201	262	320	348	403	456	509	612	687	835	908	1 171	1 241
	4,0		4,0	15	25	40	65		100		150		250		400		650	
	Acceptable quality levels (tightened inspection)																	

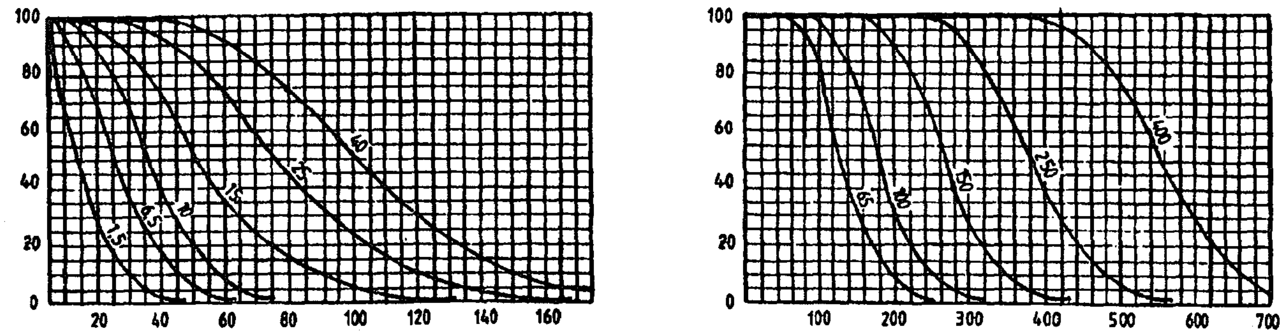
NOTE — Binomial distribution used for percent nonconforming computations; Poisson for nonconformities per 100 units.

D

Tables for sample size code letter D (individual plans)

Chart D — Operating characteristic curves for single sampling plans
(Curves for double and multiple sampling are matched as closely as practicable)

Percentage of lots expected to be accepted (P_a)



Quality of submitted product (p, in percent nonconforming for AQLs < 10; in nonconformities per 100 units for AQLs > 10)

NOTE — Values on curves are Acceptable Quality Levels (AQLs) for normal inspection.

Tabulated values for operating characteristic curves for single sampling plans

P_a	Acceptable quality levels (normal inspection)																		
	1,5	6,5	10	1,5	6,5	10	15	25	40	X	65	X	100	X	150	X	250	X	400
	p (in percent nonconforming)			p (in nonconformities per 100 units)															
99,0	0,128	1,97	6,08	0,126	1,86	5,46	10,3	22,3	38,3	43,8	59,6	76,2	93,6	129	157	215	244	355	386
95,0	0,639	4,64	11,1	0,641	4,44	10,2	17,1	32,7	49,8	58,7	77,1	96,1	116	156	186	249	281	399	432
90,0	1,31	6,86	14,7	1,32	6,65	13,8	21,8	39,4	58,2	67,9	87,8	108	129	171	203	268	301	424	458
75,0	3,63	12,1	22,1	3,60	12,0	21,6	31,7	52,7	74,5	85,6	108	130	163	199	234	303	339	468	504
50,0	8,30	20,1	32,1	8,68	21,0	33,4	45,9	70,9	95,9	108	133	158	183	233	271	346	383	521	558
25,0	15,9	30,3	43,3	17,3	33,7	49,0	63,9	92,8	121	135	163	190	217	272	312	392	432	577	617
10,0	25,0	40,6	53,8	26,8	46,6	66,5	83,5	116	147	162	193	222	252	309	352	437	479	631	672
5,0	31,2	47,1	60,0	37,4	59,3	78,7	98,9	131	164	180	212	243	274	334	378	465	509	665	707
1,0	43,8	59,0	70,7	57,6	83,0	106	126	164	200	218	252	286	318	382	429	522	568	732	778
	2,5	10	X	2,5	10	15	25	40	X	65	X	100	X	150	X	250	X	400	X
	Acceptable quality levels (tightened inspection)																		

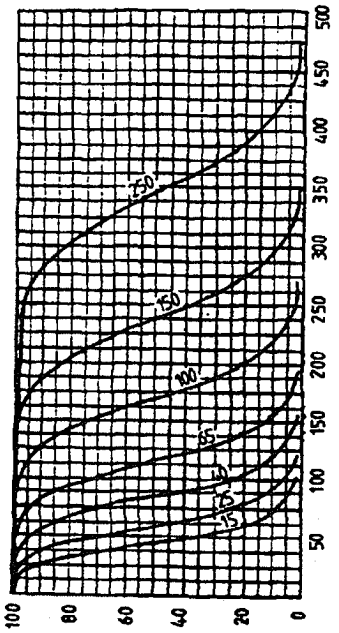
NOTE — Binomial distribution used for percent nonconforming computations; Poisson for nonconformities per 100 units.

Table 16 — Tables for sample size code letter D (individual plans)

E

Tables for sample size code letter E (individual plans)

Chart E — Operating characteristic curves for single sampling plans
(Curves for double and multiple sampling are matched as closely as practicable)



NOTE — Values on curves are Acceptable Quality Levels (AQLs) for normal inspection.

Tabulated values for operating characteristic curves for single sampling plans

P_a	Acceptable quality levels (normal inspection)																							
	1.0	4.0	6.5	10	1.0	4.0	6.5	10	15	25	40	65	100	150	250	1.0	4.0	6.5	10	15	25	40	65	100	150	250
	p (in percent nonconforming)				p (in nonconformities per 100 units)																					
99.0	0.077	1.18	3.68	6.95	0.077	1.18	3.35	6.33	13.7	22.4	27.0	36.7	46.9	67.5	79.8	96.7	132	150	219	238							
95.0	0.394	2.81	6.60	11.3	0.395	2.73	6.29	10.5	20.1	30.6	38.1	47.5	59.2	71.1	85.7	115	153	173	246	266							
90.0	0.807	4.17	8.80	14.2	0.810	4.09	8.48	13.4	24.2	35.8	41.8	54.0	66.5	79.2	105	125	165	185	261	282							
75.0	2.19	7.41	13.4	19.9	2.21	7.39	13.3	19.5	32.5	45.8	52.6	66.3	80.2	94.1	122	144	187	208	288	310							
50.0	5.19	12.6	20.0	27.5	5.33	12.9	20.6	28.2	43.6	59.0	68.7	82.1	97.4	113	144	167	213	238	321	344							
25.0	10.1	19.4	28.0	36.1	10.7	20.7	30.2	39.3	57.1	74.5	83.1	100	117	134	167	192	241	266	355	379							
10.0	16.2	26.8	35.0	44.4	17.7	29.8	40.9	51.4	71.3	90.6	100	119	137	155	190	217	269	295	388	414							
5.0	20.8	31.6	41.0	49.5	23.0	36.5	48.4	59.6	80.9	101	111	130	150	168	205	233	286	313	409	435							
1.0	29.8	41.3	50.6	59.8	35.4	51.1	64.7	77.3	101	123	134	155	176	196	235	264	321	349	450	477							
	1.5	6.5	10		1.5	6.5	10	15	25		40	65	100	150	250												
	Acceptable quality levels (tightened inspection)																										

NOTE — Binomial distribution used for percent nonconforming computations; Poisson for nonconformities per 100 units.

Table 17 — Tables for sample size code letter E (individual plans)

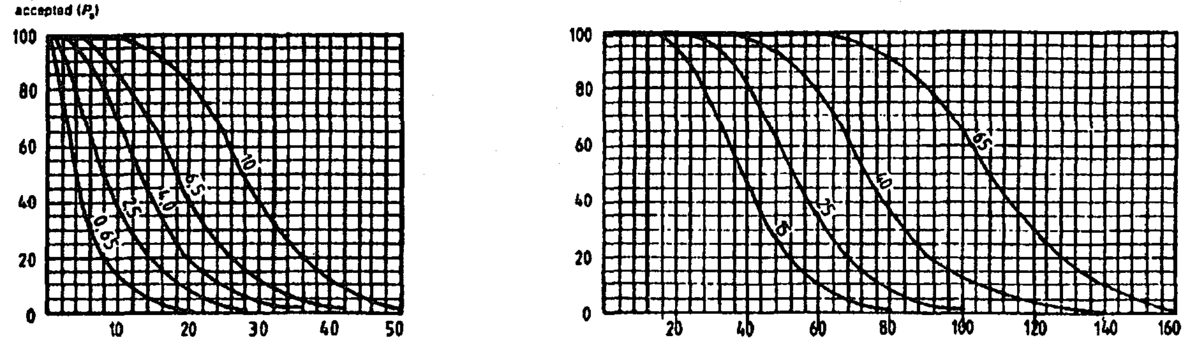
F

Tables for sample size code letter F (individual plans)

Chart F — Operating characteristic curves for single sampling plans

(Curves for double and multiple sampling are matched as closely as practicable)

Percentage of lots expected to be accepted (P_a)



Quality of submitted product (p in percent nonconforming for AQLs < 10; in nonconformities per 100 units for AQLs > 10)

NOTE — Values on curves are Acceptable Quality Levels (AQLs) for normal inspection.

Tabulated values for operating characteristic curves for single sampling plans

P_a	Acceptable quality levels (normal inspection)																
	0,65	2,5	4,0	6,5	10	0,65	2,5	4,0	6,5	10	15	X	25	X	40	X	65
	p (in percent nonconforming)					p (in nonconformities per 100 units)											
99,0	0,050 2	0,759	2,27	4,38	9,76	0,050 3	0,743	2,18	4,12	8,93	14,5	17,5	23,9	30,5	37,4	51,7	62,9
95,0	0,256	1,81	4,22	7,14	14,0	0,256	1,78	4,09	6,83	13,1	19,9	23,6	30,8	38,4	46,2	62,2	74,5
90,0	0,525	2,69	5,64	9,03	16,6	0,527	2,66	5,51	8,72	15,8	23,3	27,2	35,1	43,2	51,5	68,4	81,2
75,0	1,43	4,81	8,70	12,8	21,6	1,44	4,81	8,64	12,7	21,1	29,8	34,2	43,1	52,1	61,2	79,5	93,4
50,0	3,41	8,25	13,1	18,1	27,9	3,47	8,39	13,4	18,4	28,4	30,3	43,3	53,3	63,3	73,3	93,3	108
25,0	6,70	12,9	18,7	24,2	34,8	6,93	13,6	19,6	25,5	37,1	48,4	54,0	65,1	76,1	87,0	109	125
10,0	10,9	18,1	24,5	30,4	41,5	11,5	19,4	26,6	33,4	46,4	58,9	65,0	77,0	88,9	101	124	141
5,0	13,9	21,6	28,3	34,4	45,6	15,0	23,7	31,5	38,8	52,6	65,7	72,2	84,8	97,2	109	133	151
1,0	20,6	28,9	35,8	42,1	53,2	23,0	33,2	42,0	50,2	65,6	80,0	87,0	101	114	127	153	172
	1,0	4,0	6,5	10	X	1,0	4,0	6,5	10	15	X	25	X	40	X	65	X
	Acceptable quality levels (tightened inspection)																

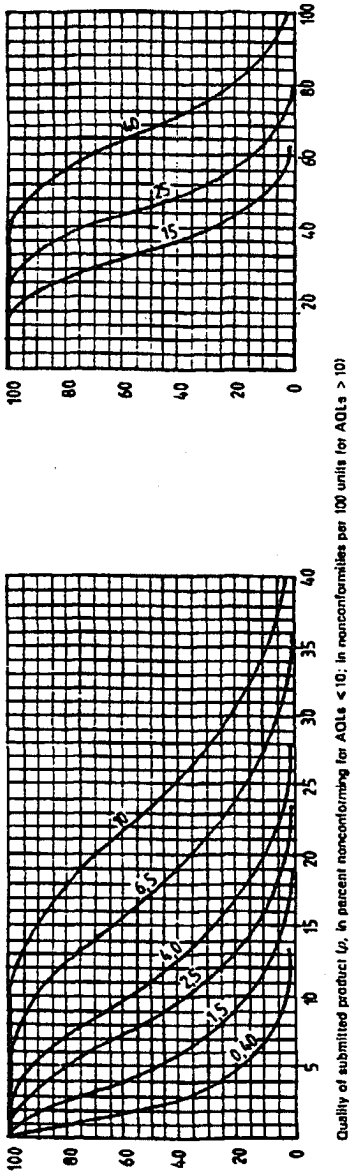
NOTE — Binomial distribution used for percent nonconforming computations; Poisson for nonconformities per 100 units.

Table 18 — Tables for sample size code letter F (individual plans)

Tables for sample size code letter G (individual plans)

G

Chart G — Operating characteristic curves for single sampling plans
(Curves for double and multiple sampling are matched as closely as practicable)



NOTE — Values on curves are Acceptable Quality Levels (AQLs) for normal inspection.

Tabulated values for operating characteristic curves for single sampling plans

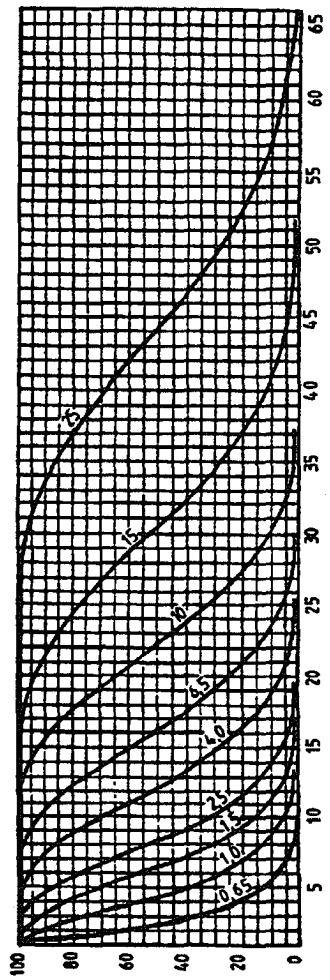
P_a	Acceptable quality levels (normal inspection)																							
	0.40	1.5	2.5	4.0	6.5	10	0.40	1.5	2.5	4.0	6.5	10	15	25	40									
	p (in percent nonconforming)						p (in nonconformities per 100 units)																	
99,0	0,031 4	0,471	1,40	2,67	5,66	9,73	0,031 4	0,484	1,36	2,67	5,58	9,08	11,0	14,9	19,1	23,4	32,3	39,3						
95,0	0,160	1,12	2,60	4,38	8,50	13,1	0,160	1,11	2,56	4,27	8,17	12,4	14,7	19,3	24,0	28,9	38,9	46,5						
90,0	0,329	1,67	3,49	5,66	10,2	15,1	0,329	1,66	3,44	5,45	9,85	14,6	17,0	21,9	27,0	32,2	42,7	50,8						
75,0	0,895	3,01	5,42	7,98	13,4	19,0	0,889	3,00	5,40	7,92	13,2	18,8	21,4	26,9	32,6	38,2	49,7	58,4						
50,0	2,14	5,19	9,27	11,4	17,6	23,7	2,17	6,24	8,36	11,5	17,7	24,0	27,1	33,3	39,6	45,8	58,3	67,7						
25,0	4,24	8,19	11,9	15,4	22,3	28,0	4,33	8,41	12,3	16,0	23,2	30,3	33,8	40,7	47,6	54,4	67,9	78,0						
10,0	8,94	11,6	15,8	19,7	27,1	34,0	7,20	12,2	16,6	20,9	29,0	36,8	40,6	48,1	55,6	62,9	77,4	88,1						
5,0	8,94	14,0	18,4	22,6	30,1	37,2	9,36	14,8	19,7	24,2	32,9	41,1	45,1	53,0	60,8	68,4	83,4	94,6						
1,0	13,4	19,0	23,8	28,1	36,0	43,2	14,4	20,7	28,3	31,4	41,0	50,0	54,4	63,0	71,3	79,6	95,8	107						
	0,65	2,5	4,0	6,5	10		0,65	2,5	4,0	6,5	10		15	25	40									
	Acceptable quality levels (tightened inspection)																							

NOTE — Binomial distribution used for percent nonconforming computations; Poisson for nonconformities per 100 units.

Table 19 — Tables for sample size code letter G (individual plans)

Tables for sample size code letter H (individual plans)

Chart H — Operating characteristic curves for single sampling plans
(Curves for double and multiple sampling are matched as closely as practicable)



Quality of submitted product (p), in percent nonconforming for AQLs < 10; in nonconformities per 100 units for AQLs > 10

NOTE — Values on curves are Acceptable Quality Levels (AQLs) for normal inspection.

H

Tabulated values for operating characteristic curves for single sampling plans

P_a	Acceptable quality levels (normal inspection)																								
	0,25	1,0	1,5	2,5	4,0	6,5	X	10	0,25	1,0	1,5	2,5	4,0	6,5	X	10	X	15	X	25
	p (in percent nonconforming)								p (in nonconformities per 100 units)											
99,0	0,020 1	0,300	0,866	1,68	3,69	6,07	7,36	10,1	0,020 1	0,297	0,872	1,65	3,67	5,81	7,01	9,54	12,2	15,0	20,7	25,1
95,0	0,103	0,716	1,66	2,78	5,38	8,22	9,72	12,9	0,103	0,711	1,64	2,73	5,23	7,96	9,39	12,3	15,4	18,5	24,9	29,8
90,0	0,210	1,07	2,22	3,63	6,43	9,84	11,2	14,5	0,211	1,06	2,20	3,49	6,30	9,31	10,9	14,0	17,3	20,6	27,3	32,5
75,0	0,674	1,92	3,46	5,10	8,51	12,0	13,6	17,5	0,676	1,92	3,45	5,07	8,44	11,9	13,7	17,2	20,8	24,5	31,8	37,4
50,0	1,38	3,33	5,31	7,29	11,3	16,2	17,2	21,2	1,39	3,36	5,35	7,34	11,3	16,3	17,3	21,3	25,3	29,3	37,3	43,3
25,0	2,73	5,29	7,69	10,0	14,5	18,8	21,0	25,2	2,77	5,39	7,84	10,2	14,8	19,4	21,6	25,8	30,4	34,8	43,5	49,8
10,0	4,60	7,68	10,3	12,9	17,8	22,4	24,7	29,1	4,61	7,76	10,6	13,4	18,5	23,5	26,0	30,8	35,6	40,3	49,5	56,4
5,0	6,82	9,14	12,1	14,8	19,9	24,7	27,0	31,6	6,89	9,49	12,6	15,5	21,0	26,3	28,9	33,9	38,9	43,8	53,4	60,8
1,0	8,00	12,6	15,8	18,7	24,2	29,2	31,7	36,3	9,21	13,3	16,8	20,1	26,2	32,0	34,8	40,3	46,6	50,9	61,2	68,7
	0,40	1,5	2,5	4,0	6,5	X	10	X	0,40	1,5	2,5	4,0	6,5	X	10	X	15	X	25	X
	Acceptable quality levels (tightened inspection)								Acceptable quality levels (tightened inspection)											

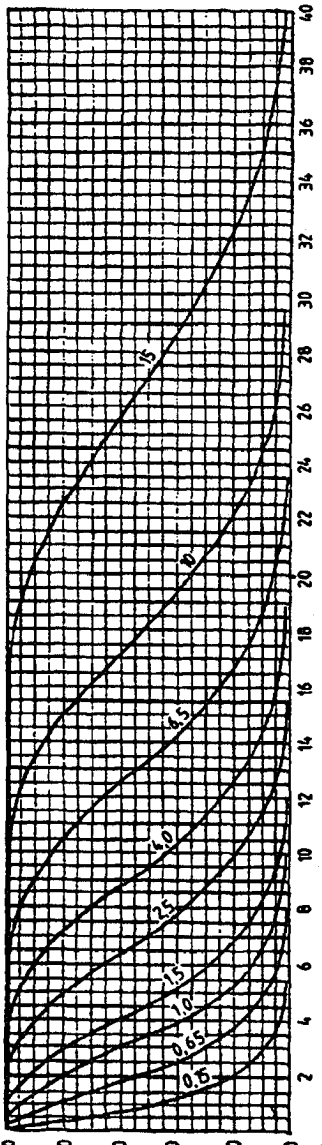
NOTE — Binomial distribution used for percent nonconforming computations; Poisson for nonconformities per 100 units.

Table 20 — Tables for sample size code letter H (individual plans)

Tables for sample size code letter J (individual plans)

J

Chart J — Operating characteristic curves for single sampling plans
(Curves for double and multiple sampling are matched as closely as practicable)



NOTE — Values on curves are Acceptable Quality Levels (AQLs) for normal inspection.

Tabulated values for operating characteristic curves for single sampling plans

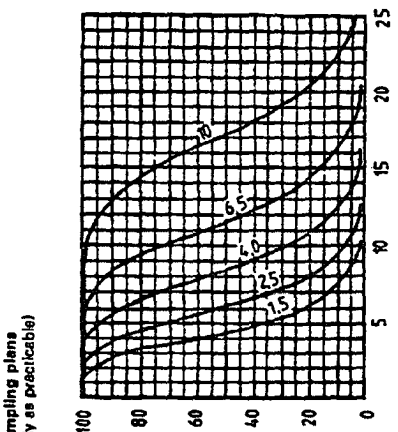
	Acceptable quality levels (normal inspection)																								
P_a	0.015	0.65	1.0	1.5	2.5	4.0	6.5	10	0.15	0.65	1.0	1.5	2.5	4.0	6.5	10	15								
	p (in percent nonconforming)								p (in nonconformities per 100 units)																
99.0	0.012 6	0.187	0.55	1.04	2.28	3.73	4.81	6.17	7.93	9.76	0.012 6	0.188	0.545	1.03	2.23	3.63	4.38	5.96	7.62	9.35	12.9	15.7			
95.0	0.064 1	0.448	1.03	1.73	3.32	5.07	6.00	7.91	9.89	11.9	0.064 1	0.444	1.02	1.71	3.27	4.98	5.87	7.71	9.61	11.6	15.6	18.6			
90.0	0.132	0.667	1.39	2.20	3.99	6.01	6.90	8.95	11.0	13.2	0.132	0.665	1.38	2.18	3.94	5.62	6.78	8.78	10.8	12.9	17.1	20.3			
75.0	0.353	1.20	2.16	3.18	5.30	7.50	8.81	10.9	13.2	15.8	0.360	1.20	2.16	3.17	5.27	7.45	8.65	10.8	13.0	15.3	19.9	23.4			
50.0	0.863	2.09	3.33	4.57	7.08	9.65	10.8	13.3	15.8	18.3	0.866	2.10	3.34	4.58	7.09	9.59	10.8	13.3	15.8	18.3	23.3	27.1			
25.0	1.72	3.33	4.84	6.30	9.14	11.9	13.3	16.0	18.6	21.3	1.73	3.37	4.90	6.39	9.26	12.1	13.5	16.3	19.0	21.7	27.2	31.2			
10.0	2.84	4.78	6.62	8.16	11.3	14.3	15.7	18.6	21.4	24.2	2.86	4.86	6.65	8.35	11.6	14.7	16.2	19.3	22.2	25.2	30.9	35.2			
5.0	3.68	5.79	7.88	9.41	12.7	15.8	17.3	20.3	23.2	26.0	3.74	5.93	7.87	9.69	13.1	16.4	18.0	21.2	24.3	27.4	33.4	37.8			
1.0	5.59	8.01	10.1	12.0	15.6	18.9	20.5	23.6	26.6	29.5	5.76	8.30	10.5	12.8	18.4	20.0	21.8	25.2	28.5	31.8	38.2	42.9			
	0.25	1.0	1.5	2.5	4.0		6.5		10		0.25	1.0	1.5	2.5	4.0		6.5		10		15				
	Acceptable quality levels (tightened inspection)																								

NOTE — Binomial distribution used for percent nonconforming computations; Poisson for nonconformities per 100 units.

Table 21 — Tables for sample size code letter J (individual plans)

Tables for sample size code letter K (individual plans)

Chart K — Operating characteristic curves for single sampling plans
(Curves for double and multiple sampling are matched as closely as practicable)



NOTE — Values on curves are Acceptable Quality Levels (AQLs) for normal inspection.

Tabulated values for operating characteristic curves for single sampling plans

P_a	Acceptable quality levels (normal inspection)											
	0,10	0,40	0,65	1,0	1,5	2,5	4,0	6,5	10
	p (in percent nonconforming or nonconformities per 100 units)											
99,0	0,008 04	0,119	0,349	0,659	1,43	2,32	2,81	3,82	4,88	5,98	8,28	10,1
95,0	0,041 0	0,284	0,654	1,09	2,09	3,18	3,78	4,94	6,15	7,40	9,95	11,9
90,0	0,084 3	0,425	0,882	1,40	2,52	3,72	4,35	5,62	6,92	8,24	10,9	13,0
75,0	0,230	0,789	1,38	2,03	3,39	4,76	5,47	6,90	8,34	9,79	12,7	14,9
50,0	0,685	1,34	2,14	2,94	4,64	6,14	6,94	8,53	10,1	11,7	14,9	17,3
25,0	1,11	2,15	3,14	4,08	5,94	7,78	8,64	10,4	12,2	13,9	17,4	20,0
10,0	1,84	3,11	4,26	5,34	7,42	9,42	10,4	12,3	14,2	16,1	19,8	22,5
5,0	2,40	3,80	5,04	6,20	8,41	10,5	11,5	13,6	15,6	17,5	21,4	24,2
1,0	3,68	5,31	6,72	8,04	10,5	12,8	13,9	16,1	18,3	20,4	24,6	27,5
	0,15	0,65	1,0	1,5	2,5	4,0	6,5	10	Acceptable quality levels (tightened inspection)			

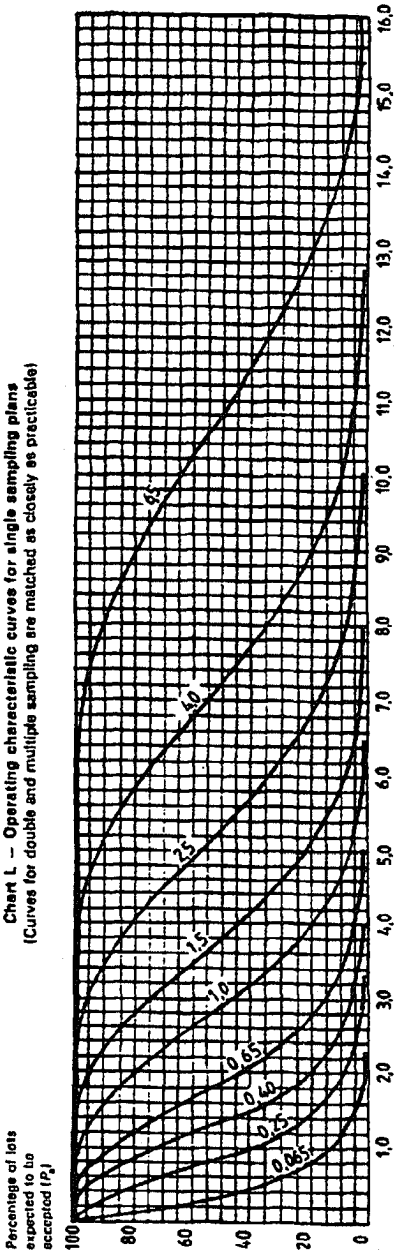
NOTE — All the values given in the table above are based on Poisson distribution as an approximation to the binomial distribution.

Table 22 — Tables for sample size code letter K (individual plans)

L

Tables for sample size code letter L (individual plans)

Chart L – Operating characteristic curves for single sampling plans
(Curves for double and multiple sampling are matched as closely as practicable)



Quality of submitted product in percent nonconforming or in nonconformities per 100 units

NOTE – Values on curves are Acceptable Quality Levels (AQLs) for normal inspection.

Tabulated values for operating characteristic curves for single sampling plans

P_a	Acceptable quality levels (normal inspection)												
	0,065	0,25	0,40	0,65	1,0	1,5	2,5	4,0	6,5
	p (in percent nonconforming or nonconformities per 100 units)								
99,0	0,005 03	0,074 3	0,218	0,412	0,693	1,45	1,76	2,39	3,05	3,74	5,17	6,29
95,0	0,025 6	0,178	0,409	0,683	1,31	1,99	2,35	3,08	3,84	4,62	6,22	7,45
90,0	0,052 7	0,266	0,551	0,872	1,58	2,33	2,72	3,51	4,32	5,15	6,84	8,12
75,0	0,144	0,481	0,864	1,27	2,11	2,98	3,42	4,31	5,21	6,12	7,95	9,34
50,0	0,347	0,839	1,34	1,84	2,84	3,83	4,33	5,33	6,33	7,33	9,33	10,8
25,0	0,693	1,35	1,96	2,55	3,71	4,84	5,40	6,51	7,61	8,70	10,9	12,5
10,0	1,15	1,94	2,66	3,34	4,64	6,89	6,50	7,70	8,88	10,1	12,4	14,1
5,0	1,60	2,37	3,15	3,88	5,26	6,87	7,22	8,48	9,72	10,9	13,3	15,1
1,0	2,30	3,32	4,20	5,02	6,65	8,00	8,70	10,1	11,4	12,7	15,3	17,2
	0,10	0,40	0,65	1,0	1,5	2,5	4,0	6,5
	Acceptable quality levels (tightened inspection)											

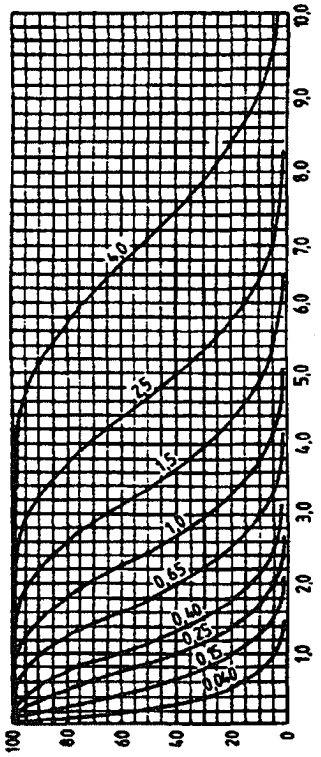
NOTE – All the values given in the table above are based on Poisson distribution as an approximation to the binomial distribution.

Table 23 — Tables for sample size code letter L (individual plans)

M

Tables for sample size code letter M (individual plans)

Chart M — Operating characteristic curves for single sampling plans
(Curves for double and multiple sampling are matched as closely as practicable)



NOTE — Values on curves are Acceptable Quality Levels (AQLs) for normal inspection.

Tabulated values for operating characteristic curves for single sampling plans

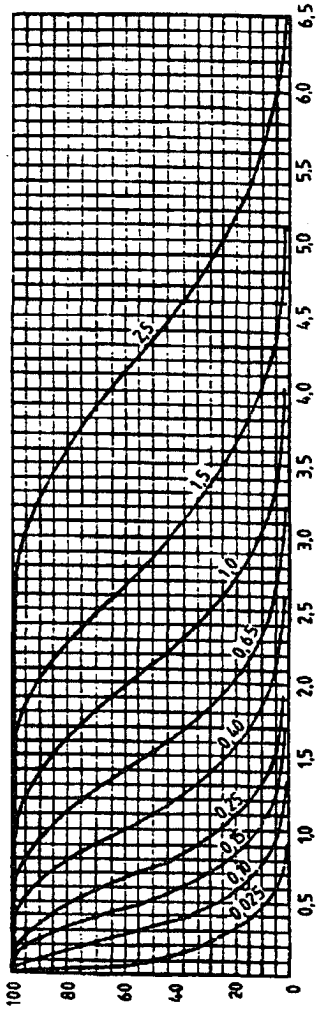
P_a	Acceptable quality levels (normal inspection)												
	0,040	0,15	0,25	0,40	0,65	1,0	1,5	2,5	4,0				
	p (in percent nonconforming or nonconformities per 100 units)												
99,0	0,003 19	0,047 2	0,138	0,281	0,557	0,923	1,11	1,61	1,94	2,37	3,28	3,99	
95,0	0,016 3	0,113	0,260	0,434	0,830	1,26	1,49	1,96	2,44	2,94	3,95	4,73	
90,0	0,033 5	0,169	0,350	0,564	1,00	1,46	1,72	2,23	2,74	3,27	4,34	5,18	
75,0	0,091 3	0,305	0,548	0,805	1,34	1,89	2,17	2,74	3,31	3,89	5,05	6,03	
50,0	0,220	0,533	0,849	1,17	1,80	2,43	2,76	3,39	4,02	4,66	5,93	6,88	
25,0	0,440	0,855	1,24	1,62	2,36	3,07	3,43	4,13	4,83	5,52	6,90	7,92	
10,0	0,731	1,23	1,63	2,12	2,94	3,74	4,13	4,89	5,64	6,39	7,86	8,95	
5,0	0,951	1,51	2,00	2,46	3,34	4,17	4,58	5,38	6,17	6,95	8,47	9,60	
1,0	1,46	2,11	2,67	3,19	4,18	5,08	5,52	6,40	7,24	8,08	9,71	10,9	
	0,065	0,25	0,40	0,65	1,0	1,5	2,5	4,0					
	Acceptable quality levels (tightened inspection)												

NOTE — All the values given in the table above are based on Poisson distribution as an approximation to the binomial distribution.

Table 24 — Tables for sample size code letter M (individual plans)

Tables for sample size code letter N (individual plans)

Chart N — Operating characteristic curves for single sampling plans
(Curves for double and multiple sampling are matched as closely as practicable)



Quality of submitted product in percent nonconforming or in nonconformities per 100 units

NOTE — Values on curves are Acceptable Quality Levels (AQLs) for normal inspection.

Tabulated values for operating characteristic curves for single sampling plans

P_a	Acceptable quality levels (normal inspection)													
	0,025	0,10	0,15	0,25	0,40	0,65	1,0	1,5	2,5
	p (in percent nonconforming or nonconformities per 100 units)													
99,0	0,002 01	0,029 7	0,087 2	0,165	0,357	0,681	0,701	0,954	1,22	1,50	2,07	2,51
95,0	0,010 3	0,071 1	0,164	0,273	0,523	0,796	0,939	1,20	1,54	1,85	2,49	2,98
90,0	0,021 1	0,106	0,220	0,349	0,630	0,931	1,09	1,40	1,73	2,06	2,73	3,25
75,0	0,057 5	0,182	0,345	0,507	0,844	1,19	1,37	1,72	2,06	2,45	3,18	3,74
50,0	0,139	0,336	0,635	0,734	1,13	1,53	1,73	2,13	2,53	2,93	3,73	4,33
25,0	0,277	0,539	0,784	1,02	1,48	1,94	2,16	2,60	3,04	3,48	4,35	4,99
10,0	0,461	0,778	1,06	1,34	1,85	2,35	2,60	3,08	3,56	4,03	4,95	5,64
5,0	0,599	0,949	1,28	1,55	2,10	2,63	2,89	3,39	3,89	4,38	5,34	6,05
1,0	0,921	1,33	1,68	2,01	2,62	3,20	3,48	4,03	4,56	5,09	6,12	6,87
	0,040	0,15	0,25	0,40	0,65	1,0	1,5	2,5
	Acceptable quality levels (tightened inspection)													

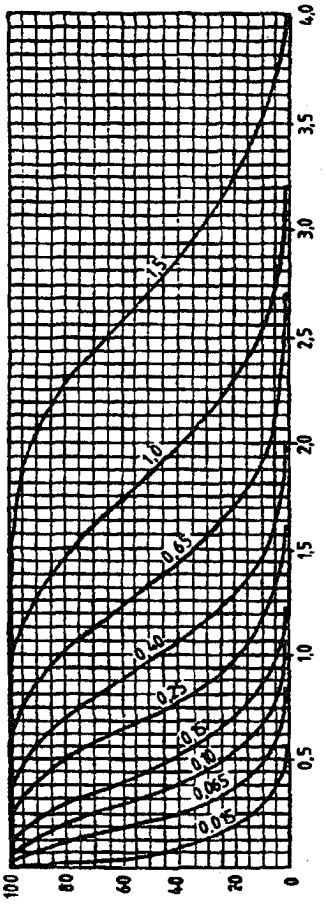
NOTE — All the values given in the table above are based on Poisson distribution as an approximation to the binomial distribution.

Table 25 — Tables for sample size code letter N (individual plans)

P

Tables for sample size code letter P (individual plans)

Chart P — Operating characteristic curves for single sampling plans
(Curves for double and multiple sampling are matched as closely as practicable)



NOTE — Values on curves are Acceptable Quality Levels (AQLs) for normal inspection.

Tabulated values for operating characteristic curves for single sampling plans

	Acceptable quality levels (normal inspection)													
	0,015	0,025	0,10	0,15	0,25	0,40	0,65	1,0	1,5
	p (in percent nonconforming or nonconformities per 100 units)													
99,0	0,001 26	0,018 6	0,054 5	0,103	0,223	0,353	0,438	0,596	0,762	0,935	1,29	1,67
95,0	0,008 41	0,044 4	0,102	0,171	0,327	0,498	0,597	0,771	0,961	1,16	1,56	1,98
90,0	0,013 2	0,056 5	0,138	0,218	0,394	0,582	0,679	0,878	1,09	1,29	1,71	2,09
75,0	0,036 0	0,120	0,216	0,317	0,527	0,745	0,855	1,08	1,30	1,53	1,99	2,34
50,0	0,088 6	0,210	0,334	0,459	0,709	0,959	1,09	1,33	1,58	1,83	2,33	2,71
25,0	0,173	0,337	0,490	0,639	0,928	1,21	1,35	1,63	1,90	2,17	2,72	3,12
10,0	0,286	0,496	0,665	0,836	1,16	1,47	1,62	1,93	2,22	2,52	3,09	3,52
5,0	0,374	0,593	0,787	0,969	1,31	1,64	1,80	2,12	2,43	2,74	3,34	3,78
1,0	0,576	0,830	1,05	1,26	1,64	2,00	2,18	2,52	2,85	3,18	3,82	4,29
	0,025	0,10	0,15	0,25	0,40	0,65	1,0	1,5
	Acceptable quality levels (tightened inspection)													

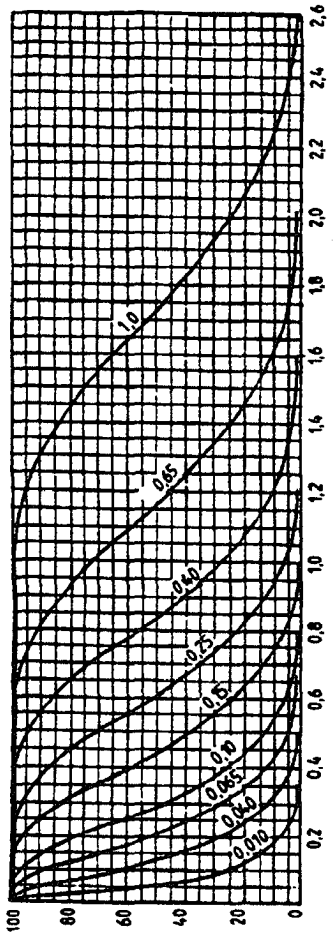
NOTE — All the values given in the table above are based on Poisson distribution as an approximation to the binomial distribution.

Table 26 — Tables for sample size code letter P (individual plans)

Q

Tables for sample size code letter Q (individual plans)

Chart Q — Operating characteristic curves for single sampling plans
(Curves for double and multiple sampling are matched as closely as practicable)



NOTE – Values on curves are Acceptable Quality Levels (AQLs) for normal inspection.

Tabulated values for operating characteristic curves for single sampling plans

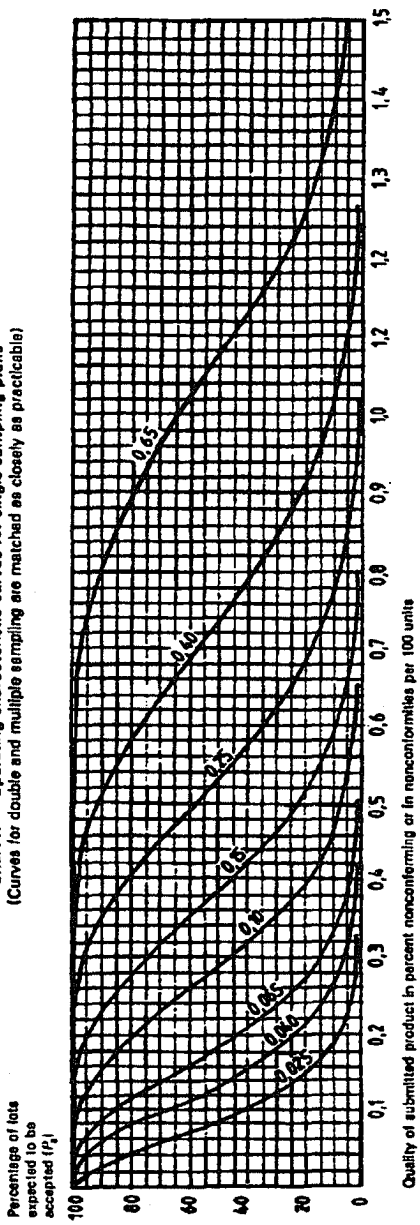
P_a	Acceptable quality levels (normal inspection)													
	0,010	0,040	0,065	0,10	0,15	0,25	0,40	0,65	1,0	1,5	2,5	4,0	6,5	10
	p, in percent nonconforming or nonconformities per 100 units													
99,0	0,000 804	0,011 9	0,034 9	0,065 9	0,143	0,232	0,281	0,382	0,489	0,598	0,828	1,01		
95,0	0,004 10	0,028 4	0,065 4	0,109	0,209	0,318	0,376	0,494	0,616	0,740	0,995	1,19		
90,0	0,008 43	0,042 5	0,088 2	0,140	0,262	0,372	0,435	0,562	0,692	0,824	1,09	1,30		
75,0	0,023 0	0,076 9	0,139	0,203	0,339	0,476	0,547	0,690	0,834	0,979	1,27	1,49		
50,0	0,055 6	0,134	0,214	0,294	0,454	0,614	0,694	0,853	1,01	1,17	1,49	1,73		
25,0	0,111	0,216	0,314	0,409	0,594	0,775	0,864	1,04	1,22	1,39	1,74	2,00		
10,0	0,184	0,311	0,426	0,534	0,742	0,942	1,04	1,23	1,42	1,61	1,98	2,26		
5,0	0,240	0,380	0,504	0,620	0,841	1,05	1,15	1,36	1,56	1,75	2,14	2,42		
1,0	0,368	0,531	0,672	0,804	1,05	1,28	1,39	1,61	1,83	2,04	2,45	2,75		
	0,015	0,065	0,10	0,15	0,25		0,40		0,65		1,0			
	Acceptable quality levels (tightened inspection)													

NOTE – All the values given in the table above are based on Poisson distribution as an approximation to the binomial distribution.

Table 27 — Tables for sample size code letter Q (individual plans)

Tables for sample size code letter R (individual plans)

Chart R — Operating characteristic curves for single sampling plans
(Curves for double and multiple sampling are matched as closely as practicable)



Quality of submitted product in percent nonconforming or in nonconformities per 100 units

NOTE — Values on curves are Acceptable Quality Levels (AQLs) for normal inspection.

Tabulated values for operating characteristic curves for single sampling plans

P_a	Acceptable quality levels (normal inspection)											
	0,026	0,040	0,065	0,10	0,15	X	0,25	X	0,40	X	0,65	
	p (in percent nonconforming or nonconformities per 100 units)											
99,0	0,007 43	0,021 8	0,041 2	0,083 2	0,145	0,175	0,239	0,305	0,374	0,517	0,629	
95,0	0,017 8	0,040 9	0,068 3	0,131	0,199	0,235	0,309	0,304	0,462	0,622	0,745	
90,0	0,026 6	0,065 1	0,097 2	0,168	0,233	0,272	0,351	0,432	0,515	0,684	0,812	
75,0	0,048 1	0,086 4	0,127	0,211	0,288	0,342	0,431	0,521	0,612	0,795	0,934	
50,0	0,083 9	0,134	0,181	0,264	0,333	0,433	0,533	0,633	0,733	0,933	1,08	
25,0	0,135	0,196	0,255	0,371	0,484	0,540	0,651	0,761	0,870	1,09	1,26	
10,0	0,194	0,266	0,334	0,464	0,589	0,650	0,770	0,889	1,01	1,24	1,41	
5,0	0,237	0,315	0,388	0,526	0,657	0,722	0,848	0,972	1,09	1,33	1,51	
1,0	0,332	0,420	0,502	0,655	0,800	0,870	1,02	1,14	1,27	1,53	1,72	
	0,040	0,065	0,10	0,15	X	0,25	X	0,40	X	0,65	X	
	Acceptable quality levels (tightened inspection)											

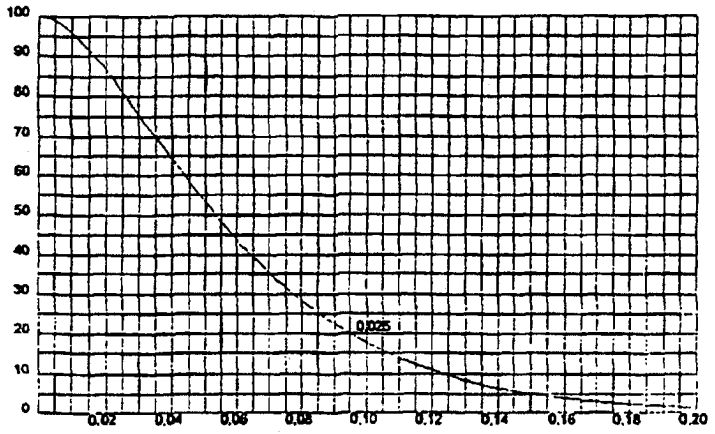
NOTE — All the values given in the table above are based on Poisson distribution as an approximation to the binomial distribution.

Table 28 — Tables for sample size code letter R (individual plans)

Tables for sample size code letter S (individual plans)

Chart S - Operating characteristic curve for single sampling plans

(Curves for double and multiple sampling are matched as closely as practicable)



NOTE - Values on curve are Acceptable Quality Level (AQL) for tightened inspection

Tabulated values for operating characteristic curve for single sampling plan

Pa	Acceptable quality levels (normal inspection)	
	X	X
	p (in percent nonconforming)	p (in nonconformities per 100 units)
99.0	0.00472	0.00472
95.0	0.0113	0.0113
90.0	0.0169	0.0169
75.0	0.0305	0.0305
50.0	0.0533	0.0533
25.0	0.0855	0.0855
10.0	0.123	0.123
5.0	0.151	0.151
1.0	0.211	0.211
	0.025	0.025
	Acceptable quality levels (tightened inspection, in percent)	

NOTE - Binomial distribution used for percent nonconforming computations. Poisson for nonconformities per 100 units.

Table 29 — Tables for sample size code letter S (individual plans)

12.2 Sequential sampling using ISO 8422

The purpose of 12.2 is to provide sequential sampling procedures that correspond to the single sampling plans discussed in 12.1. The sequential plans discussed here match, as closely as possible, the plans described in 12.1. The sampling schemes again are indexed by *AQL* and sample size code letter. The procedure for selecting these indexes is the same as that described in 12.1.

The sampling plans described here are for use in situations where

— there is a continuing series of lots, and

— inspection is by attributes for either percent nonconforming or number of nonconformities per 100 images.

The sampling plans are based on the assumption that nonconformities occur randomly and with statistical independence.

In the case of inspection of isolated lots, the procedures in 11.2, Item-by-item single sampling procedures, should be used. Those procedures require selecting the following risks:

— rejecting lots with an acceptable level

— accepting lots with an unacceptable quality level

The principles of sequential sampling by attributes were discussed in 11.2.1. The definitions and symbols used here are the same as those used in 11.2.1. Presented here are the values of the sequential sampling parameters that result in operating characteristic curves approximately the same as those of the single sampling plans described in 12.1 for the same *AQL* and sample size code letters.

12.2.1 Operation of the procedure

For each value, n_{cum}, of the cumulative sample size that is less than the curtailment number n_t, the acceptance number, A, is found by rounding the quantity $gn_{cum} - h_A$ down to the nearest integer (see the example that follows).

The rejection number, R, is found by rounding the quantity $gn_{cum} + h_R$ up to the nearest integer (see the example that follows).

Values of h_A, h_R, and g for normal inspection are given in table 30, indexed by *AQL* and sample size code letter. Values of the same parameters for tightened inspection are given in table 31.

Curtailment values for the normal and tightened inspection plans of tables 30 and 31 are provided in tables 32 and 33, along with the acceptance number, A_t, for the curtailment sample size.

The rejection number for the curtailment value of the cumulative sample size, R_t, is one more than the acceptance number, A_t.

An example follows.

For the sequential sampling plan with AQL = 2.5% and sample size code letter J, table 30 gives the following values for normal inspection:

— $h_A = 1.910$

— $h_R = 1.650$

— $g = 0.0706$

The corresponding single sampling plan from table 32 is 80.

The curtailment value from table 32 is 120 with an acceptance number of 8 and a rejection number of 9 (8 +1), for the curtailment sample size.

The value of the acceptance number, A, is

$$A = gn_{cum} - h_A$$

$$A = 0.0706n_{cum} - 1.910$$

rounded down to the nearest integer (see table 34).

The value of the rejection number, R, is

$$R = gn_{cum} + h_R$$

$$R = 0.0706n_{cum} + 1.650$$

rounded up to the nearest integer (see table 34).

The rejection number cannot exceed the curtailment rejection number, R_t and the acceptance number cannot be less than zero.

The acceptance and rejection numbers corresponding to the cumulative sample sizes 1,2,..., 120 are calculated from these expressions by successively inserting the values of n_{cum} in the expressions and rounding appropriately. The results are indicated in table 34.

The example also can be presented graphically, if desired. Figure 4, Example graph for sequential sampling using ISO 8422, illustrate graphically the same information that is in table 34.

To use the graph, do the following:

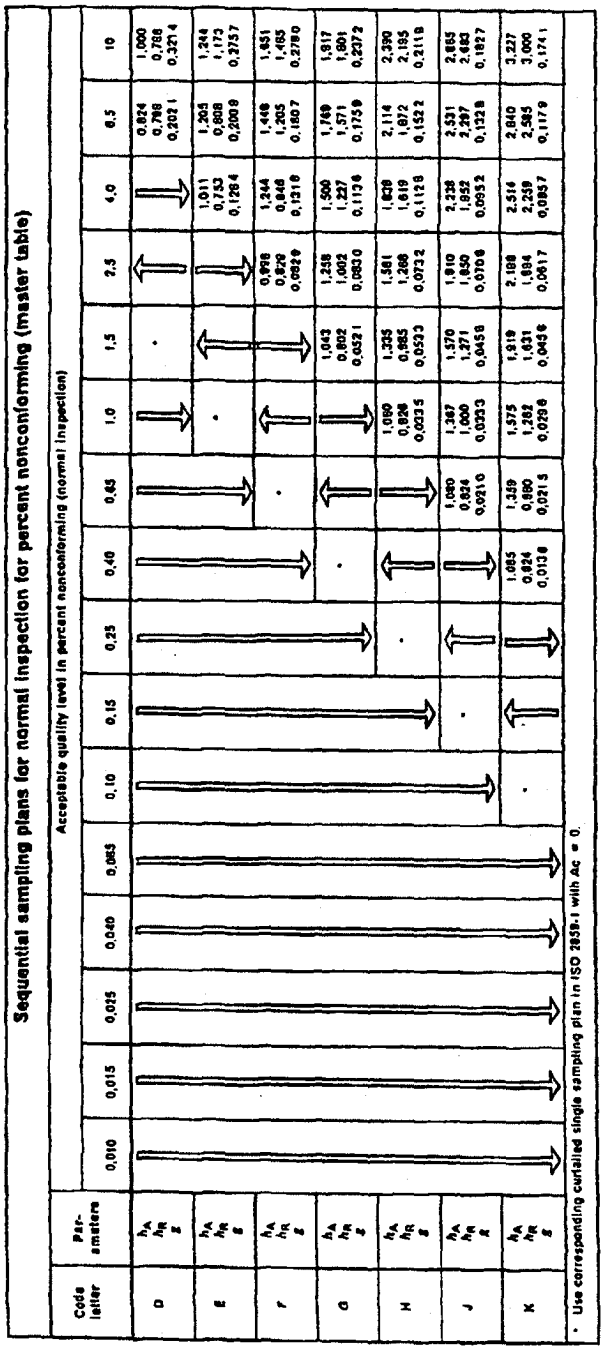
A. Start inspection at the origin.

B. For each image inspected, move one unit to the right.

C. If an image is nonconforming, also move up one unit.

D. Check if the lower or upper decision line is crossed.
   — If the plot crosses the lower decision line, the lot can be accepted.
   — If the plot crosses the upper line, the lot is rejected.

E. Continue sampling one image at a time as long as the plot is between the two lines.



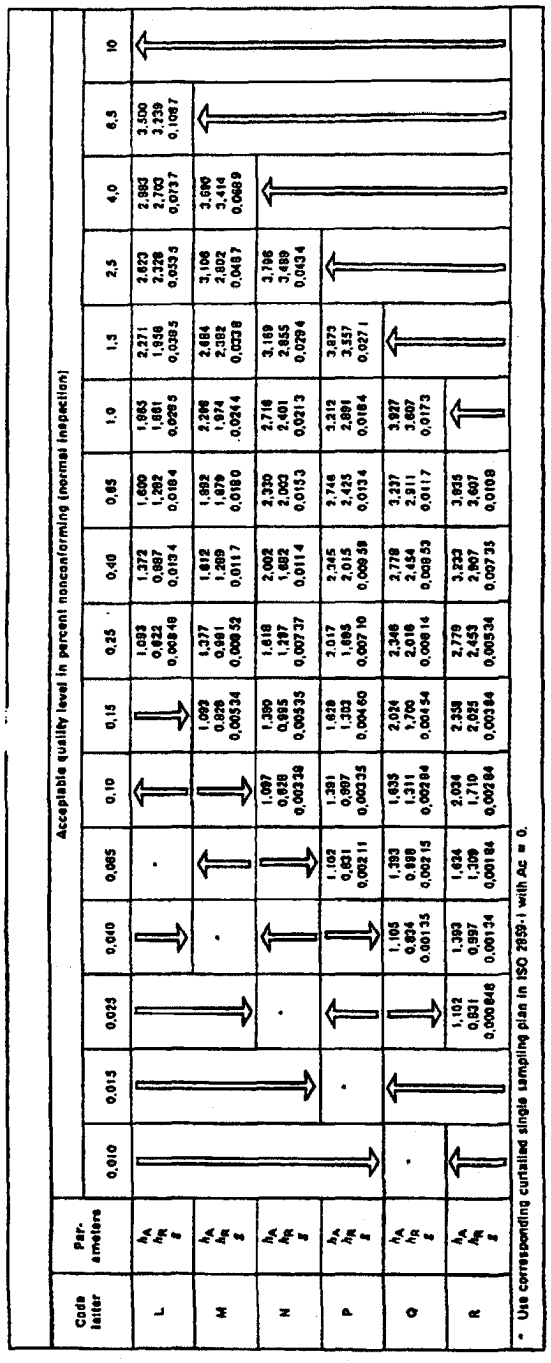
Sequential sampling plans for normal inspection for percent nonconforming (master table)

Acceptable quality level in percent nonconforming (normal inspection)

Code letter	Parameters	0,010	0,015	0,025	0,040	0,065	0,10	0,15	0,25	0,40	0,65	1,0	1,5	2,5	4,0	6,5	10
D	h_A															0,824	1,000
	h_R															0,788	0,788
	g															0,2021	0,3214
E	h_A														1,011	1,205	1,344
	h_R														0,733	0,808	1,173
	g														0,1284	0,2009	0,3757
F	h_A													0,998	1,244	1,448	1,851
	h_R													0,829	0,846	1,205	1,495
	g													0,0629	0,1316	0,1907	0,2790
G	h_A												1,043	1,238	1,500	1,769	1,917
	h_R												0,802	1,002	1,227	1,571	1,801
	g												0,0321	0,0830	0,1134	0,1759	0,2272
H	h_A											1,080	1,335	1,581	1,839	2,114	2,390
	h_R											0,826	0,985	1,266	1,619	1,872	2,195
	g											0,0235	0,0533	0,0732	0,1128	0,1522	0,2118
J	h_A										1,080	1,367	1,570	1,810	2,238	2,531	2,855
	h_R										0,824	1,000	1,271	1,650	1,952	2,297	2,665
	g										0,0210	0,0353	0,0458	0,0706	0,0932	0,1328	0,1827
K	h_A									1,085	1,359	1,575	1,819	2,188	2,514	2,840	3,227
	h_R									0,824	0,980	1,282	1,631	1,984	2,259	2,585	3,000
	g									0,0138	0,0215	0,0298	0,0436	0,0617	0,0857	0,1179	0,1741

* Use corresponding curtailed single sampling plan in ISO 2859-1 with Ac = 0.

Table 30 — Sequential sampling plans for normal inspection for percent nonconforming (Master table)



Code letter	Parameters	Acceptable quality level in percent nonconforming (normal inspection)																					
		0,010	0,015	0,025	0,040	0,065	0,10	0,15	0,25	0,40	0,65	1,0	1,5	2,5	4,0	6,5	10
L	h_A	⇩	⇩	⇩	⇩	·	⇩	⇩	1,093	1,372	1,600	1,965	2,271	2,623	2,883	3,500	⇦
	h_R								0,822	0,887	1,282	1,681	1,936	2,328	2,700	3,239	
	g								0,00840	0,0134	0,0184	0,0285	0,0395	0,0535	0,0737	0,1087	
M	h_A			⇩	⇩	⇩	·	⇩	1,377	1,812	1,982	2,298	2,684	3,106	3,690	⇦	
	h_R								0,991	1,289	1,676	1,974	2,382	2,802	3,414		
	g								0,00852	0,0117	0,0160	0,0244	0,0338	0,0467	0,0689		
N	h_A				⇩	⇩	⇩	·	1,818	2,002	2,330	2,716	3,169	3,796	⇦		
	h_R								1,297	1,682	2,003	2,401	2,855	3,489			
	g								0,00737	0,0114	0,0153	0,0213	0,0294	0,0434			
P	h_A					⇩	⇩	⇩	2,017	2,045	2,746	3,212	3,873	⇦			
	h_R								1,885	2,015	2,425	2,891	3,557				
	g								0,00710	0,00958	0,0134	0,0184	0,0271				
Q	h_A	⇩	⇩	⇩	⇩	⇩	⇩	⇩	2,346	2,778	3,237	3,927	⇦				
	h_R								2,016	2,454	2,911	3,607					
	g								0,00814	0,00853	0,0117	0,0173					
R	h_A	⇩	⇩	⇩	⇩	⇩	⇩	⇩	2,779	3,223	3,835	⇦					
	h_R								2,453	2,967	3,607						
	g								0,00534	0,00735	0,0108						

* Use corresponding curtailed single sampling plan in ISO 2859-1 with Ac = 0.

Table 30 — Sequential sampling plans for normal inspection for percent nonconforming (Master table) (concluded)

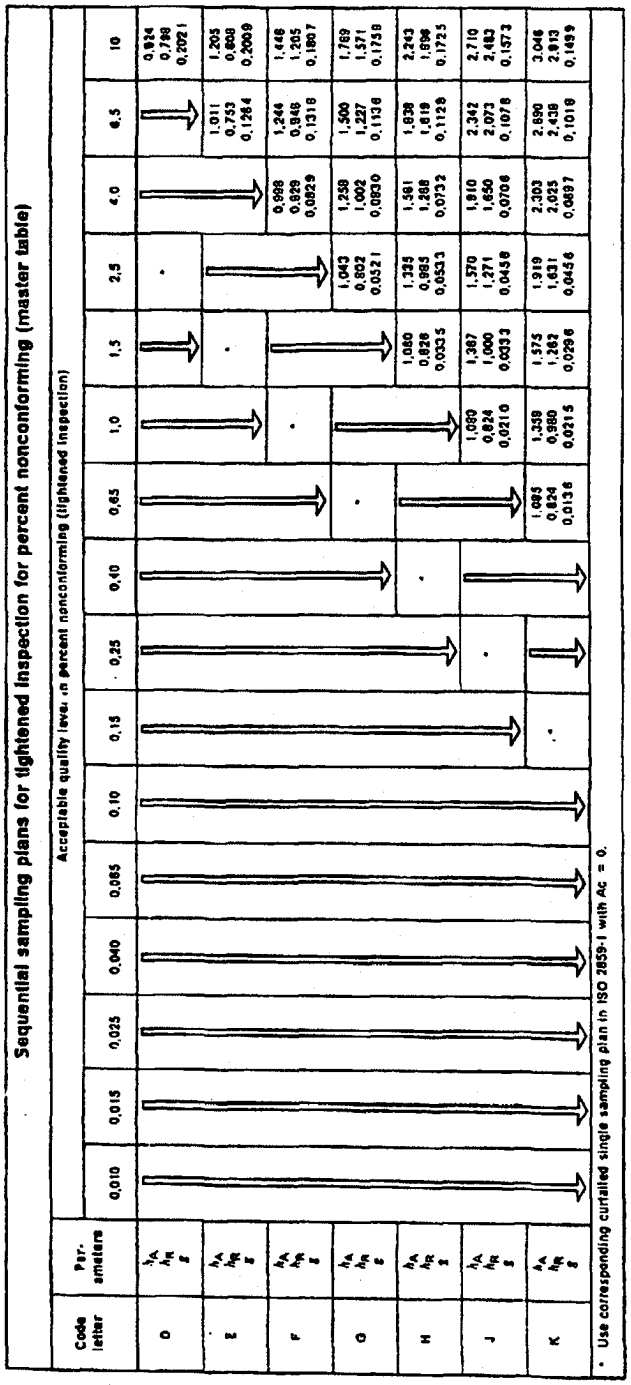


Table 31 — Sequential sampling plans for tightened inspection for percent nonconforming (Master table)

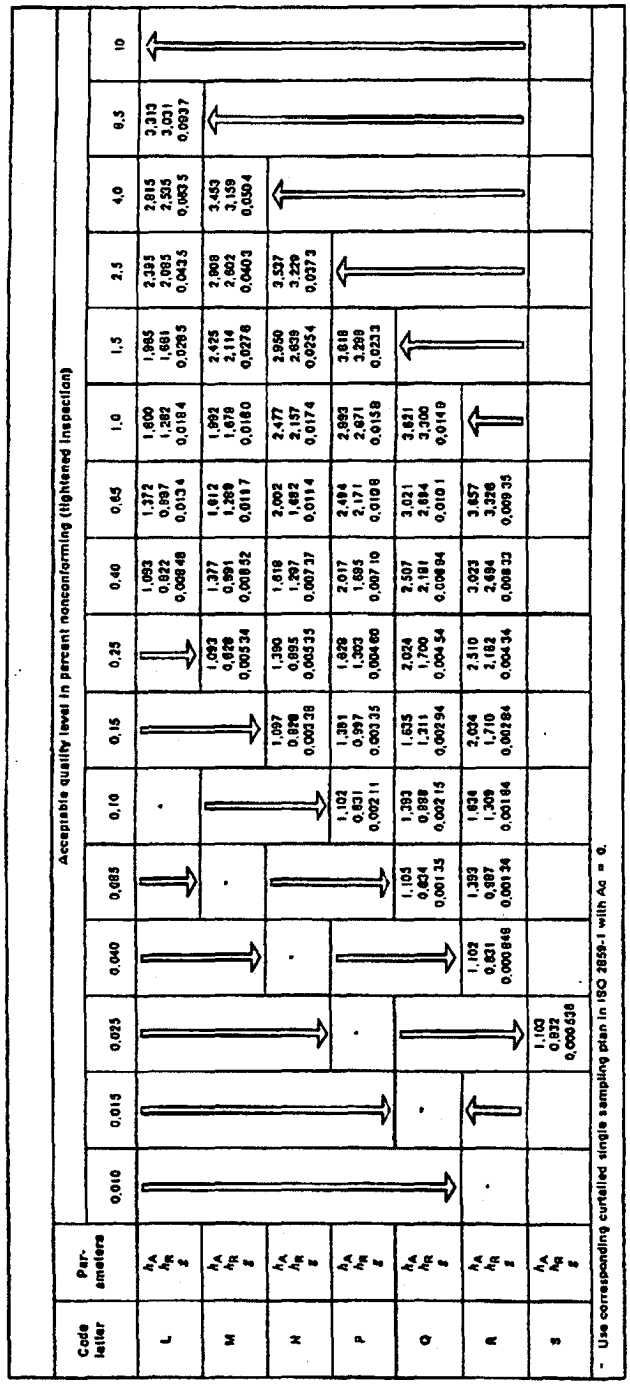
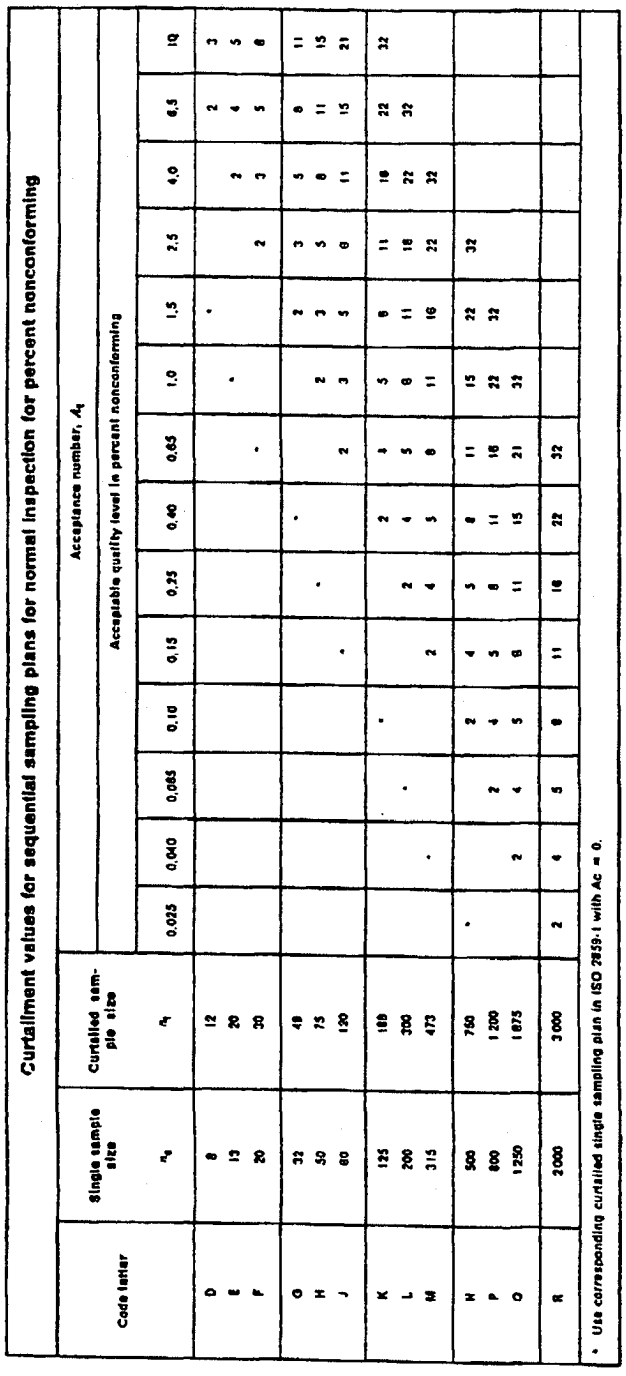


Table 31 — Sequential sampling plans for tightened inspection for percent nonconforming (Master table) (concluded)

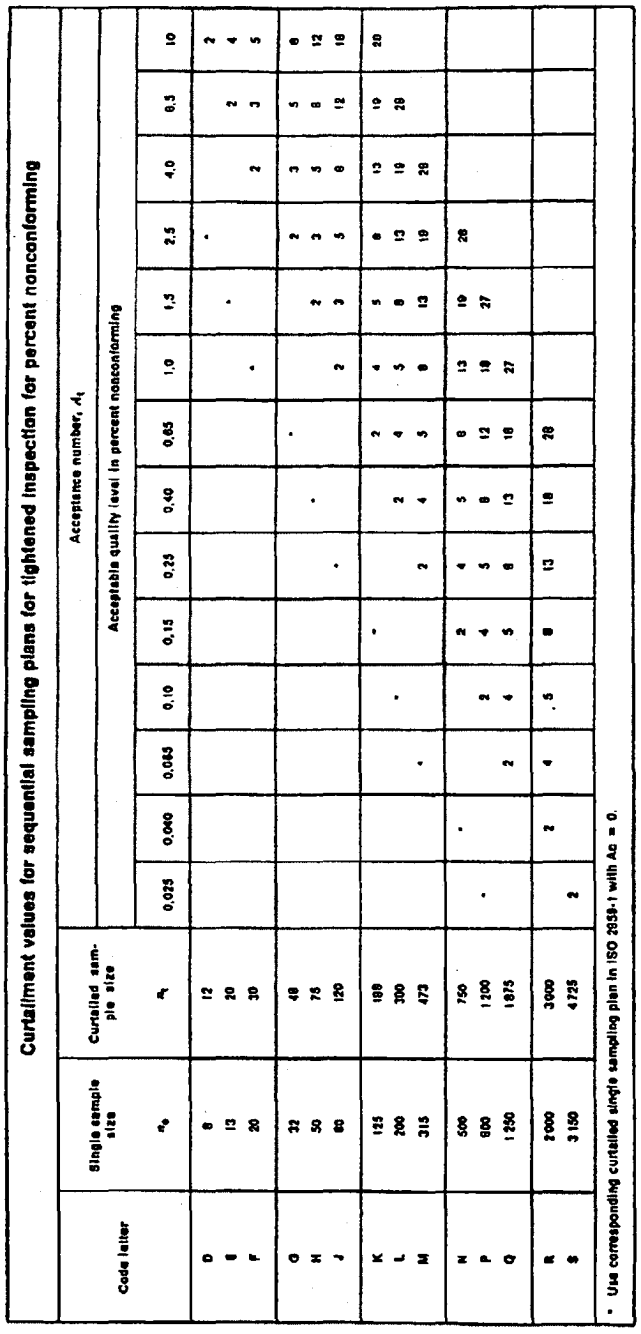


Curtailment values for sequential sampling plans for normal inspection for percent nonconforming

Code letter	Single sample size	Curtailed sample size	Acceptance number, A_q	Acceptable quality level in percent nonconforming														
				0.025	0.040	0.065	0.10	0.15	0.25	0.40	0.65	1.0	1.5	2.5	4.0	6.5	10
D	8	12										•				2	3
E	13	20													2	4	5
F	20	30									•			2	3	5	8
G	32	48								•		2	2	3	5	8	11
H	50	75							•			3	3	5	8	11	15
J	80	120						•			2	3	5	8	11	15	21
K	125	188					•			2	4	5	8	11	18	22	32
L	200	300				•			2	4	5	8	11	18	22	32	
M	315	473			•			2	4	5	8	11	16	22	32		
N	500	750		•			2	4	5	8	11	15	22	32			
P	800	1 200				2	4	5	8	11	16	22	32				
Q	1250	1 875			2	4	5	8	11	15	21	32					
R	2000	3 000		2	4	5	8	11	16	22	32						

• Use corresponding curtailed single sampling plan in ISO 2859-1 with Ac = 0.

Table 32 — Curtailment values for sequential sampling plans for normal inspection for percent nonconforming



Curtailment values for sequential sampling plans for tightened inspection for percent nonconforming

Code letter	Single sample size	Curtailed sample size	Acceptance number, A_t														
			Acceptable quality level in percent nonconforming														
			0.025	0.040	0.065	0.10	0.15	0.25	0.40	0.65	1.0	1.5	2.5	4.0	6.5	10
D	8	12											*			2
E	13	20									*				2	4
F	20	30												2	3	5
G	32	48								*			2	3	5	8
H	50	75										2	3	5	8	12
J	80	120						*			2	3	5	8	12	18
K	125	188					*			2	4	5	8	13	19	28
L	200	300				*			2	4	5	8	13	19	28	
M	315	473			*			2	4	5	8	13	19	28		
N	500	750		*			2	4	5	8	13	19	28			
P	800	1 200	*			2	4	5	8	12	18	27				
Q	1 250	1 875			2	4	5	8	13	18	27					
R	2 000	3 000		2	4	5	8	13	18	28						
S	3 150	4 725	2													

* Use corresponding curtailed single sampling plan in ISO 2859-1 with Ac = 0.

Table 33 — Curtailment values for sequential sampling plans for tightened inspection for percent nonconforming

Cumulative Sample Size n_{cum}	Acceptance Number $gn_{cum} - h_A$	Rounded Acceptance Number A	Rejection Number $gn_{cum} + h_R$	Rounded Rejection Number R
1	-1.839	*	1.721	**
2	-1.769	*	1.791	2
3	-1.698	*	1.862	2
4	-1.628	*	1.932	2
5	-1.557	*	2.003	3
..	....	..	.....	..
20	-0.498*	*	3.062	4
..	....	..	.....	..
28	0.067	0	3.627	4
..	....	..	.....	..
34	0.490	0	4.050	5
..	....	..	.....	..
42	1.055	1	4.615	5
..	....	..	.....	..
48	1.479	1	5.039	6
..	....	..	.....	..
56	2.044	2	5.604	6
..	....	..	.....	..
63	2.538	2	6.098	7
..	....	..	.....	..
70	3.032	3	6.592	7
..	....	..	.....	..
76	3.456	3	7.016	8
..	....	..	.....	..
84	4.020	4	7.580	8
..	....	..	.....	..
90	4.444	4	8.004	9
..	....	..	.....	..
98	5.009	5		9
..	....	..		..
113	6.068	6		9
..		..		..
119		6		..
120		8		9

Table 34 — Example sequential plan

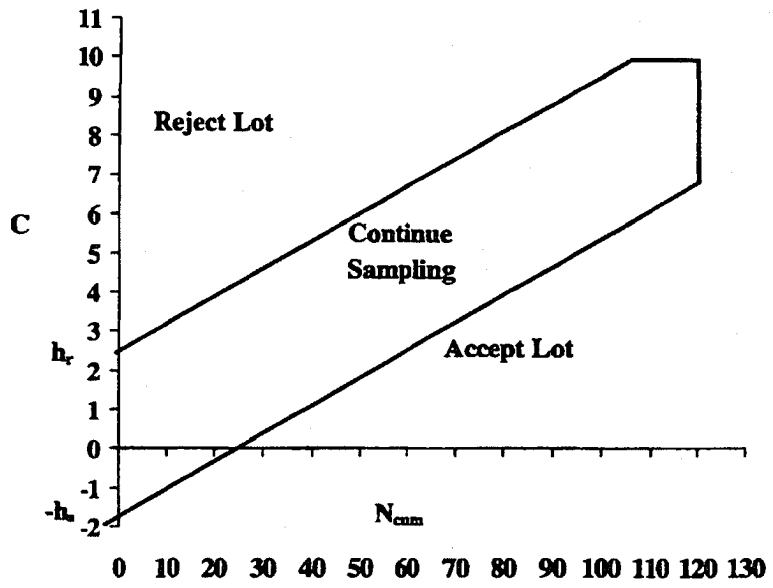


Figure 4 — Example graph for sequential sampling using ISO 8422

12.2.2 Switching rules and operating characteristic curves

With the exception that reduced inspection is not possible with the sequential plans given in this technical report, the switching rules provided in 12.1.2 apply. The operating characteristic curves provided in 12.1.5 also apply to the sequential sampling plans provided.

12.2.3 Average sample size

The average sample size is the average of the various sample sizes that can occur before a decision to accept or reject a lot is made. The average sample size for four values of the process average are given in table 35 for normal inspection and in table 36 for tightened inspection.

In the tables, 0.00 means no nonconforming images exist in the lot being inspected. The symbol p_A refers to the quality level, in terms of percent nonconforming, or nonconformities per 100 images, that would lead to 90% of the lots being accepted by the sampling plan. The symbol p_R refers to the quality level that would lead to 10% of the lots being accepted by the sequential sampling plan. The symbol g refers to the parameter g of the sampling plan. When the quality is equal to $100g$ (in terms of percent nonconforming or number of nonconformities per 100 images), the average sample size is at its highest level. Values of the average sample size for quality levels not given in the tables can be found by interpolation.

Average sample size for sequential sampling plans for normal inspection for percent nonconforming															
Code letter	Quality level, p (proportion nonconforming)	Acceptable quality level in percent nonconforming (normal inspection)													
		0,025	0,040	0,065	0,10	0,15	0,25	0,40	0,65	1,0	1,5	2,5	4,0	6,5	10
D	0,00													5	4
	P_A													6,0	5,9
	g													6,5	6,6
	P_R													4,1	4,6
E	0,00												8	6	5
	P_A												9,8	8,6	8,3
	g												10,3	9,4	9,9
	P_R												6,4	6,4	6,7
F	0,00											13	10	8	6
	P_A											15,5	13,8	13,3	12,5
	g											15,6	14,7	15,4	15,4
	P_R											9,2	9,4	10,0	10,6
G	0,00										21	16	14	11	9
	P_A										24,8	22,2	21,5	20,4	19,1
	g										24,7	23,6	24,0	24,2	23,5
	P_R										14,4	14,8	15,3	16,0	16,0
H	0,00									32	26	22	17	14	12
	P_A									37,8	35,6	33,7	31,6	30,8	29,6
	g									37,7	37,2	37,2	37,0	37,2	37,2
	P_R									21,9	22,9	23,0	23,9	24,7	25,4
J	0,00								52	41	35	28	24	20	16
	P_A								61,2	56,4	53,9	51,1	50,0	48,3	46,7
	g								60,7	58,7	59,1	59,1	59,3	58,2	58,9
	P_R								34,8	35,9	36,6	37,8	38,8	39,6	40,2
K	0,00							80	64	54	43	36	30	25	19
	P_A							93,6	87,2	81,6	76,6	73,2	69,8	65,4	60,1
	g							92,7	90,2	89,1	87,6	86,1	84,4	81,0	76,3
	P_R							52,8	54,7	54,6	55,4	55,6	55,5	54,3	52,3

Table 35 — Average sample size for sequential sampling plans for normal inspection for percent nonconforming

Code letter	Quality level, p (proportion nonconforming)	Acceptable quality level in percent nonconforming (normal inspection)													
		0,025	0,040	0,065	0,10	0,15	0,25	0,40	0,65	1,0	1,5	2,5	4,0	6,5	10
L	0,00						129	103	87	69	59	50	41	33	
	p_A						152	141	133	125	120	116	109	103	
	g						150	145	145	143	141	139	134	130	
	p_R						84,9	87,8	88,1	89,9	90,3	91,1	89,2	88,1	
M	0,00					205	162	138	111	95	80	67	54		
	p_A					241	221	211	200	192	186	179	171		
	g					237	227	229	229	225	224	221	215		
	p_R					135	137	139	143	144	146	146	145		
N	0,00				326	260	220	177	152	128	108	88			
	p_A				383	354	335	317	311	298	289	280			
	g				377	365	363	362	364	358	355	351			
	p_R				213	220	220	226	232	233	235	236			
P	0,00			522	415	354	285	245	206	175	143				
	p_A			613	566	540	513	499	481	470	458				
	g			605	583	586	584	584	577	577	574				
	p_R			342	351	355	365	372	375	380	385				
Q	0,00		820	649	556	446	383	326	276	227					
	p_A		965	886	850	804	779	765	742	728					
	g		952	912	924	916	910	919	909	912					
	p_R		539	549	559	573	580	596	599	611					
R	0,00	1 303	1 040	889	716	615	521	440	363						
	p_A	1 531	1 419	1 357	1 293	1 252	1 221	1 178	1 159						
	g	1 508	1 461	1 473	1 475	1 484	1 465	1 441	1 449						
	p_R	853	879	892	921	932	949	949	970						

NOTES

1 Values of p_A ($P_a = 0,90$) and p_R ($P_a = 0,10$) are shown in table X of ISO 2859-1:1989.

2 Average sample size for $p = 1,0$ (100 % nonconforming) is an integer immediately above $h_R/(1 - g)$

Table 35 — Average sample size for sequential sampling plans for normal inspection for percent nonconforming (concluded)

Average sample size for sequential sampling plans for tightened inspection for percent nonconforming															
Code letter	Quality level, p (proportion nonconforming)	Acceptable quality level in percent nonconforming (tightened inspection)													
		0,025	0,040	0,065	0,10	0,15	0,25	0,40	0,65	1,0	1,5	2,5	4,0	6,5	10
D	0,00														5
	P_A														6,0
	g														6,5
	P_R														4,1
E	0,00													8	6
	P_A													9,8	8,6
	g													10,3	9,4
	P_R													6,4	6,4
F	0,00												13	10	8
	P_A												15,5	13,8	13,3
	g												15,6	14,7	15,4
	P_R												9,2	9,4	10,0
G	0,00											21	16	14	11
	P_A											24,8	22,2	21,5	20,4
	g											24,7	23,6	24,0	24,2
	P_R											14,4	14,8	15,3	16,0
H	0,00										32	26	22	17	13
	P_A										37,8	35,6	33,7	31,6	30,4
	g										37,7	37,2	37,2	37,0	37,2
	P_R										21,9	22,9	23,0	23,9	24,9
J	0,00									52	41	35	28	22	18
	P_A									61,2	56,4	53,9	51,1	49,3	47,0
	g									60,7	58,7	59,1	59,1	59,6	58,4
	P_R									34,8	35,9	36,6	37,8	39,3	39,4
K	0,00								80	64	54	43	34	27	21
	P_A								93,8	87,2	81,8	76,6	71,8	67,5	61,2
	g								92,7	90,2	89,1	87,8	85,3	82,7	76,8
	P_R								52,8	54,7	54,6	55,4	55,5	55,0	52,3

Table 36 — Average sample size for sequential sampling plans for tightened inspection for percent nonconforming

Code letter	Quality level, p (proportion nonconforming)	Acceptable quality level in percent nonconforming (tightened inspection)													
		0,025	0,040	0,065	0,10	0,15	0,25	0,40	0,65	1,0	1,5	2,5	4,0	6,5	10
L	0,00							129	103	87	69	56	45	36	
	P_A							152	141	133	125	119	112	105	
	g							150	145	145	143	141	137	131	
	P_R							84,9	87,8	88,1	89,9	90,8	90,6	88,5	
M	0,00						205	162	138	111	88	73	59		
	P_A						241	221	211	200	188	182	174		
	g						237	227	229	229	223	222	217		
	P_R						135	137	139	143	144	146	146		
N	0,00					326	260	220	177	143	117	95			
	P_A					383	354	335	317	307	294	283			
	g					377	365	383	362	363	357	352			
	P_R					213	220	220	226	233	234	235			
P	0,00				522	415	354	285	231	190	155				
	P_A				613	566	540	513	496	478	465				
	g				605	583	586	584	586	580	578				
	P_R				342	351	355	365	376	380	386				
Q	0,00			820	649	556	446	361	299	243					
	P_A			965	886	850	804	774	754	723					
	g			952	912	924	916	916	916	897					
	P_R			539	549	559	573	587	600	597					
R	0,00		1 303	1 040	889	716	579	478	392						
	P_A		1 531	1 419	1 357	1 293	1 242	1 203	1 168						
	g		1 508	1 461	1 473	1 475	1 467	1 460	1 449						
	P_R		853	879	892	921	940	954	964						
S	0,00	2 059													
	P_A	2 419													
	g	2 384													
	P_R	1 347													

NOTES

1 Values of p_A ($P_a = 0,80$) and p_R ($P_a = 0,10$) are shown in table X of ISO 2859-1:1989.

2 Average sample size for $p = 1,0$ (100 % nonconforming) is an integer immediately above $h_R/(1 - g)$

Table 36 — Average sample size for sequential sampling plans for tightened inspection for percent nonconforming (concluded)

13 Examples

This clause provides specific examples of how to use this report. The examples may or may not be similar to actual user situations.

13.1 Example one: Film conversion/isolated lots (clause 11)

Film is supplied by the vendor in rolls of 2000 images. A total of 10 rolls is supplied in separate shipments. Each roll is to be sampled. Since 10 rolls are not enough to be considered a continuing series of lots, we treat each roll separately using the procedures of clause 11. First in 13.1.1, we will use the single sampling procedures from 11.1. Then in 13.1.2, we will use the sequential procedures of 11.2.

13.1.1 Single sampling

The film attributes to be inspected are found in table 2, Some film attributes, of clause 9. These attributes are classified as class A or B according to their seriousness.

A. We must first choose producer's and consumer's risk qualities for each class of nonconformity. This is done in the following table. Recall that we are using 5% for producer's risk and 10% for consumer's risk.

Class	*PRQ*	*CRQ*
A	1%	4%
B	4%	10%

Table 37 — Example one: risk qualities

B. Next, we use table 3, Values for single sample plans, to find the sampling plan for class A attributes.

$CRQ/PRQ = 0.04/0.01 = 4.0 \qquad Ac = 4$

$n \times CRQ = 7.994$

$n = 7.994/0.04 = 200$

$n \times PRQ = 1.970$

or $n = 1.970/0.01 = 197$

C. We choose the higher n possibility. Therefore, we might use the plan $n = 200, Ac = 4$. Alternatively, we could have used the nomograph in figure 1. This would result in the same plan.

D. Next, we use table 3 to find the sampling plan for class B attributes.

$CRQ/PRQ = 0.10/0.04 = 2.5 \qquad Ac = 10$

$n \times CRQ = 15.407$

$n = 15.407/0.10 = 154$

$n \times PRQ = 6.169$

or $n = 6.169/0.04 = 154$

The sampling plan is $n = 154$, $Ac = 10$. Again, the nomograph in figure 1 gives us the same plan.

E. We review the sampling plans for each class and determine the following:

— class A is $n = 200, Ac = 4$.

— class B is $n = 154, Ac = 10$.

Because the largest sample size found was 200, we should select 200 images from the roll. For class B nonconformities, 154 of these would be inspected; for class A, all 200 would be inspected. We would accept a roll if we find

— no more than 4 of the 200 images contain class A nonconformities, and

— no more than 10 of the 154 images contain Class B nonconformities

Otherwise, we would reject the roll.

13.1.2 Sequential sampling

For the same situation as in 13.1, we have decided to use the sequential sampling procedure of 11.2, Item-by-item sequential sampling plans. We again have rolls of 2000 images and the same producer's and consumer's risk qualities shown in table 37 — 5% producer's risk and 10% consumer's risk — for the two classes of nonconforming images.

A. After we decide to use the sequential sampling procedure, we use table 5 to find the parameters for the three plans. These are found in table 38.

Class	h_A	h_B	g	n_t	A_t	R_t
A	1.589	2.040	0.0217	300	6	7
B	2.295	2.947	0.0658	231	15	16

Table 38 — Parameters for sequential plans

B. Then, we construct tables similar to tables 39 and 40.

n_{cum}	A	R	n_{cum}	A	R
1	*	**	137	1	6
2	*	**	166	2	6
3	*	3	183	2	7
4	*	3	212	3	7
45	*	4	258	4	7
74	0	4	299	4	7
91	0	5	300	6	7
120	1	5			

Table 39 — Class A sequential plan

n_{cum}	A	R	n_{cum}	A	R
1	*	**	111	5	11
2	*	**	123	5	12
3	*	**	127	6	12
4	*	4	138	6	13
17	*	5	142	7	13
32	*	6	153	7	14
35	0	6	157	8	14
47	0	7	168	8	15
51	1	7	172	9	15
62	1	8	184	9	16
66	2	8	187	10	16
77	2	9	203	11	16
81	3	9	218	12	16
92	3	10	230	12	16
96	4	10	231	15	16
108	4	11			

Table 40 — Class B sequential plan

C. Because there are no fixed sample sizes in this case, we would start inspecting both classes of nonconformities.

D. Finally, we would
- stop inspecting if either of the classes reached its rejection value, *R*
- stop inspecting for either class when its cumulative count, *c*, reaches its acceptance number, *A*
- accept a roll only after both classes have reached their respective values of *A* (i.e., we cannot accept a roll until both classes have reached their respective values of *A*)

13.2 Example two: EIM/series of lots

Electronic images are submitted on magnetic or optical disks with 2000 images per disk. Fifty disks are to be submitted in separate shipments. That is, we have 50 lots (disks) of 2000 images each.

13.2.1 Single sampling

Because we have a continuing series of disks or lots we use the sampling methods of clause 12.

A. The first thing we must do is choose the acceptable quality level (*AQL*) for each class of nonconformities. We use the classifications in table 1, Some EIM attributes, in clause 9.

The class A nonconformities are given an *AQL* of 1% and those in class B an *AQL* of 4%.

B. We can choose either
- the single sampling methods in 12.1, or
- the sequential methods of 12.2.

The single sampling approach will be used here and the sequential method will be used in 13.2.2.

C. Next, we consult table 7, Sample size code letters. The lot size is 2000 and table 7 indicates that for inspection level II we must use sample size code letter K.

D. Then from tables 8, 9, and 10, we find the sampling plans for normal, tightened, and reduced inspection, respectively, for each selected *AQL*. These results are shown in table 41, Single sampling plans for each class.

E. For the first disk submitted, we would select a sample of 125 images to be inspected on normal inspection.

F. We would accept the disk if there are no more than the following number of nonconforming images in the sample:
- 3 class A nonconforming images. (A class A nonconforming image has one or more class A nonconformities.)
- 10 class B nonconforming images. (A class B nonconforming image has one or more class B nonconformities and no class A nonconformities.)

G. Next, we would follow the inspection guidelines outlined in table 42.

		Normal		Tightened		Reduced	
Class	*AQL*	*n*	*Ac*	*n*	*Ac*	*n*	*Ac*
A	1%	125	3	125	2	50	2
B	4%	125	10	125	8	50	6

Table 41 — Single sampling plans for each class

If we...	Then we...
reject 2 disks out of any 5 inspected	switch to tightened inspection, and remain on tightened inspection until we have accepted 5 disks in succession
accept 10 consecutive disks under normal inspection using an acceptance number of 2 for class A and 7 for class B	can switch to reduced inspection with its corresponding smaller sample size for each class
reject a lot while on reduced inspection	switch back to normal inspection for the next disk
reject as many as 5 disks while on tightened inspection	should discontinue inspection of the entire shipment of 50 disks

Table 42 — Inspection guidelines (from table 11)

13.2.2 Sequential sampling

As an alternative to the single sampling procedure in 13.2.1, we could use the sequential procedure of 12.2. To illustrate this procedure, we would do the following:

A. Again, we will assume the *AQL* values used in 13.2.1 for each class — 1% for class A and 4% for class B.

B. Using tables 30, 31, and 32, we find the plan parameters indicated in table 43. Recall that we are using code letter K from table 7.

C. We might again develop tables, such as tables 44 and 45, using these parameters to assist in the use of these plans.

D. As before, we start inspection with the two normal plans. The switching rules are carried out as in 13.2.1, except there are no reduced inspection plans with sequential sampling. Table 46 outlines the inspection guidelines for sequential sampling.

	Acceptable Quality Level (*AQL*)	Acceptable Parameter (h_A)	Rejection Parameter (h_R)	Slope of Decision Lines (*g*)	Curtailment Numbers		
					n_t	A_t	R_t
Normal Inspection							
Class A	1%	1.575	1.262	0.0296	188	5	6
Class B	4%	2.514	2.259	0.0857	188	16	17
Tightened Inspection							
Class A	1%	1.359	0.980	0.0215	188	4	5
Class B	4%	2.303	2.025	0.0697	188	13	14

Table 43 — Parameters for sequential plans

Normal Inspection			Tightened Inspection		
n_{cum}	A	R	n_{cum}	A	R
1	*	**	1	*	**
2	*	2	2	*	2
25	*	3	48	*	3
54	0	3	64	0	3
59	0	4	94	0	4
87	1	4	110	1	4
93	1	5	141	1	5
121	2	5	157	2	5
127	2	6	187	2	5
155	3	6	188	4	5
187	3	6			
188	5	6			

Table 44 — Class A sequential plans (example two)

Normal Inspection			Tightened Inspection		
n_{cum}	A	R	n_{cum}	A	R
1	*	**	1	*	**
2	*	**	2	*	**
3	*	3	3	*	3
9	*	4	14	*	4
21	*	5	29	*	5
30	0	5	34	0	5
32	0	6	43	0	6
42	1	6	48	1	6
44	1	7	58	1	7
53	2	7	62	2	7
56	2	8	72	2	8
65	3	8	77	3	8
67	3	9	86	3	9
77	4	9	91	4	9
79	4	10	101	4	10
88	5	10	105	5	10
91	5	11	115	5	11
100	6	11	120	6	11
102	6	12	129	6	12
112	7	12	134	7	12
114	7	13	144	7	13
123	8	13	148	8	13
126	8	14	158	8	14
135	9	14	163	9	14
138	9	15	177	10	14
147	10	15	187	10	14
149	10	16	188	13	14
158	11	16			
161	11	17			
170	12	17			
182	13	17			
187	13	17			
188	16	17			

Table 45 — Class B sequential plans (example two)

If we...	Then we...
reject 2 out of 5 or fewer consecutive lots for class A or class B nonconforming images	switch to tightened inspection for both classes
accept 5 consecutive disks while on tightened inspection	switch back to normal inspection plans
reject a total of 5 disks while on tightened inspection	discontinue sampling inspection under this procedure

Table 46 — Inspection guidelines for sequential sampling (from table 11)

Annex A
Sampling Costs

To illustrate the type of decisions that must be made regarding the two types of attributes plans — single and sequential plans — consider the cost model provided in the following equation.

$$C = a + bn^* + cn_a,$$

where:

C is the total cost;

n^* is the maximum sample size;

n_a is the average sample size when the quality level is at the producer's risk quality (PRQ);

a is the overhead cost;

b is the cost of selecting the sample (per image);

c is the cost of inspection (per image).

To illustrate the use of this equation, assume the overhead cost, a, to be as follows:

— single $0.20

— sequential $0.50

Now assume the following:

— The cost of selecting the sample is $0.002 per image.

— The cost of inspection is $0.02 per image.

— We are dealing with batches of 10,000 images.

— The PRQ is 0.015 (i.e., 1.5% nonconforming).

If the consumer's risk quality (CRQ) is 0.05 (i.e., 5% nonconforming), the producer's risk is set at 5%, and the consumer's risk is 10%, the plans in table A1 would be equivalent in their protection.

Type Plan	Plan Parameters
Single	$n = 410, Ac = 10$
Sequential	$R = 2.4075 + 0.0292n$ $A = -3.6720 + 0.0292n$

Table A1 — Equivalent plans

For these plans, table A2 illustrates the values of n^* and n_a for $PRQ = 0.015$. The resulting total costs are shown in the last column of the table.

Type Plan	n^*	n_a	Cost
Single	410	410	$9.22
Sequential	725	237	$6.69

Table A2 — Cost comparison 1

In this case, the most economical plan is the sequential plan. Remember that both plans satisfy our requirements regarding risks. If, on the other hand, the unit cost of selecting a sample is increased to $0.10 and the inspection cost per image is reduced to $0.01, the model would give the results displayed in table A3, Cost comparison 2.

Type Plan	Cost
Single	$45.30
Sequential	$75.37

Table A3 — Cost comparison 2

For this illustration, we see that the single sampling plan is the lowest cost plan. These two extreme examples serve to illustrate the fact that high costs of selecting sample units and low inspection costs lead to the decision to use single sampling plans. An additional advantage of such plans is their simplicity.

Annex B
Flowcharting inspection procedures using applicable ANSI standards and specifications and a sampling system (based on the example provided in clause 7 of this technical report)

This publication provides a more statistically valid method for selecting the number of images that should be inspected. It replaces the random image inspection scheme described in MS23. That publication recommends a detailed visual image examination criteria for roll films where approximately 0.5% or 10 images would be viewed with a magnifier. MS23 does not establish an acceptance–rejection criteria but does describe what the attributes are and how to inspect. Employing a statistical plan may establish a sample that will accurately determine the product quality based on the needs of the user. However, there is a need to understand

— the inspection criteria listed in various ANSI standards and guidelines
— the inspection tools to use to be qualified to inspect the film

Also, a sampling plan is not a replacement for specific inspection procedures developed by film technologists.

Micrographic methodology can use 100% inspection of specific criteria target images. Often, this level of inspection is a "Go, No–Go," or a circuit breaker that would increase inspection if certain quality conditions were not met. Unfortunately, quality criteria in the form of specific resolution and density readings are usually based on the assumption that all of the material in a film batch is of equal quality or that the necessary "Go, No–Go," acceptance criteria have been established through an examination of the source documents. A sampling plan probably will indicate conditions where MS23 image capture inspection methods may be unsatisfactory.

Three major micrographic technology quality criteria are

— resolution, which is the ability of the system to capture or film the smallest necessary character at the first generation at significant quality at the user level. This is done by using a quality index chart (MS1, MS23, MS43, and implied in MS32). Readings are made of filmed resolution target arrays.

— background density, which represents an arbitrary relationship between the data on the page and its background. Background density is determined by comparing the documents to be filmed to applicable Background Density Groups (MS32, MS43, and MS32). Specific targets, usually in the form of reading the density using a calibrated densitometer, are used.

— inspection for lost data. This class A attribute is evaluated by passing the film over a light box and noting any unusual condition.

Unlike the sampling plan, the technology inspections are 100%.

The flow chart, illustrated in figure B1, Technical inspection and sampling plans, is based on the use of micrographic standards to establish fundamental film attributes based on the selected microform, technical inspection, and a sampling technique described in clause 7 of this technical report.

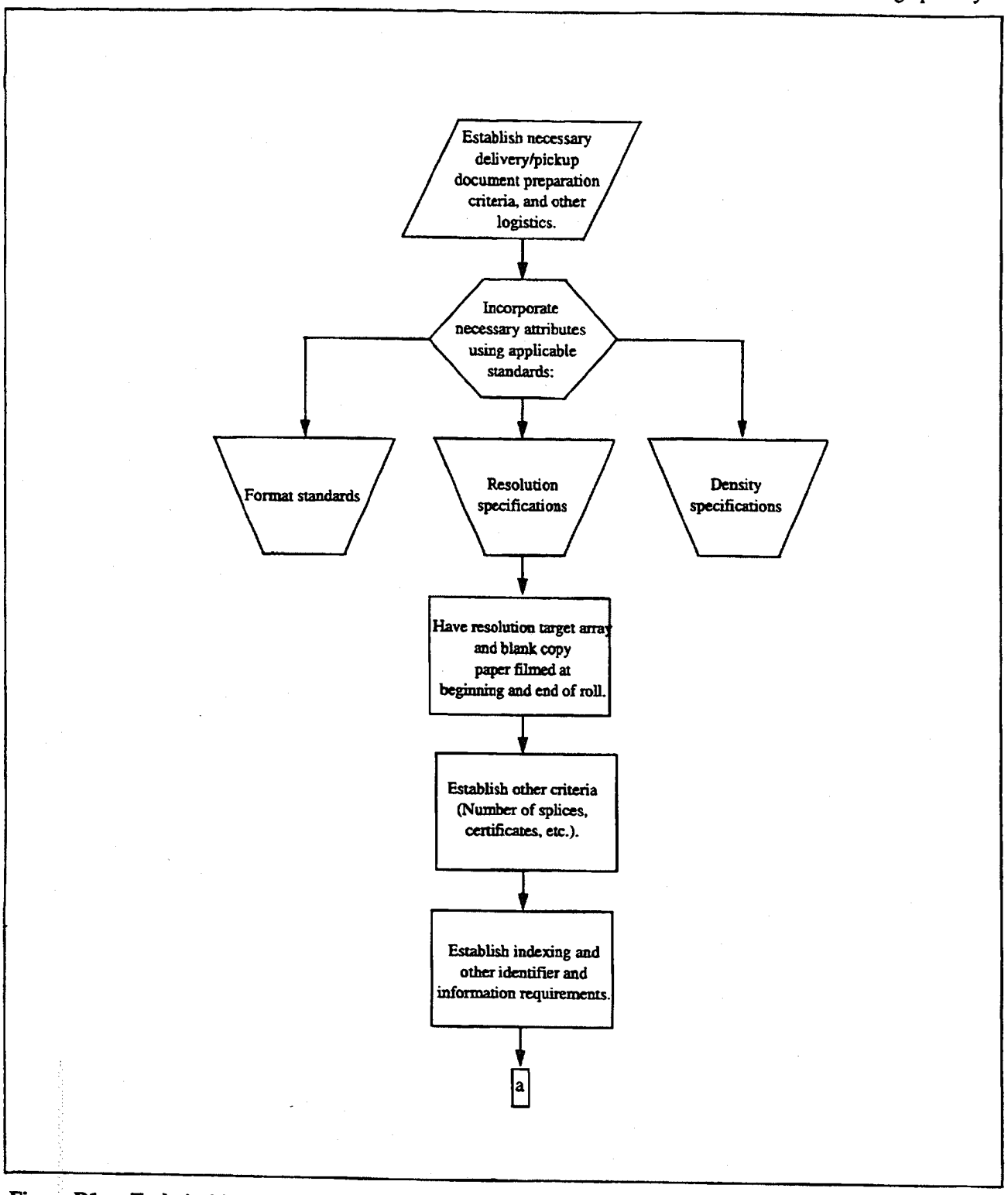


Figure B1 — Technical inspection and sampling plans (sample of micrographic plan)

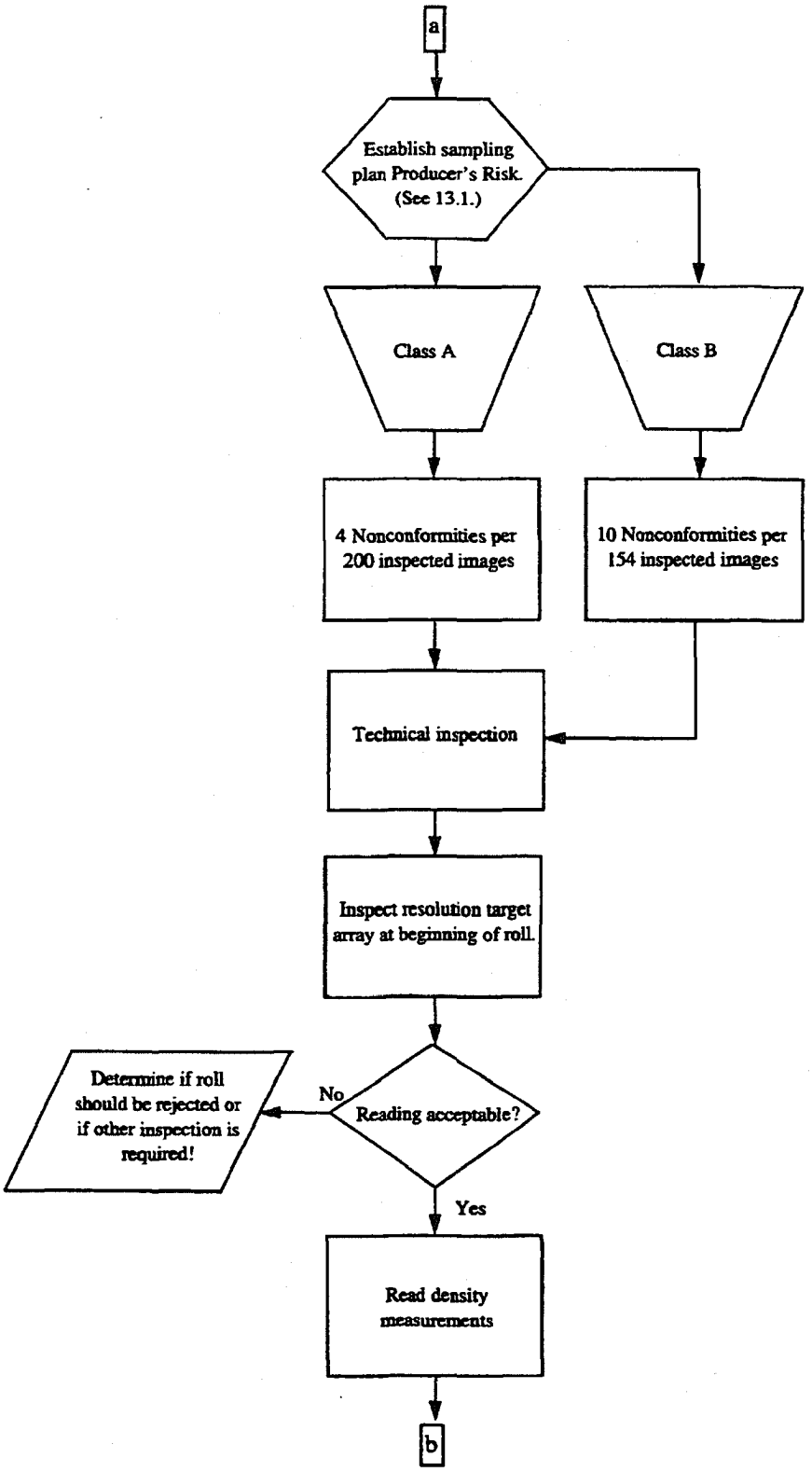


Figure B1 — Technical inspection and sampling plans (sample of micrographic plan) (continued)

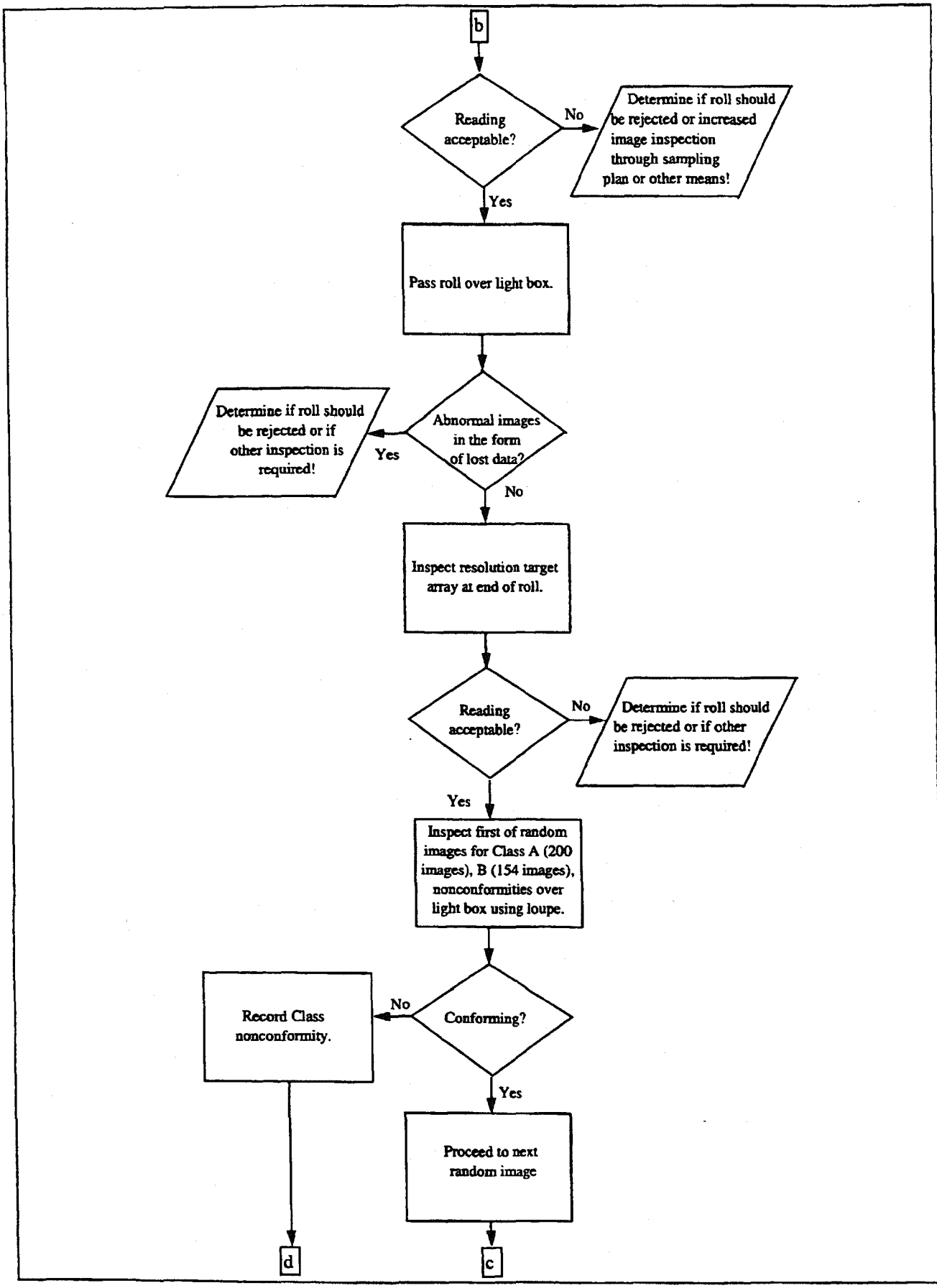


Figure B1 — Technical inspection and sampling plans (sample of micrographic plan) (continued)

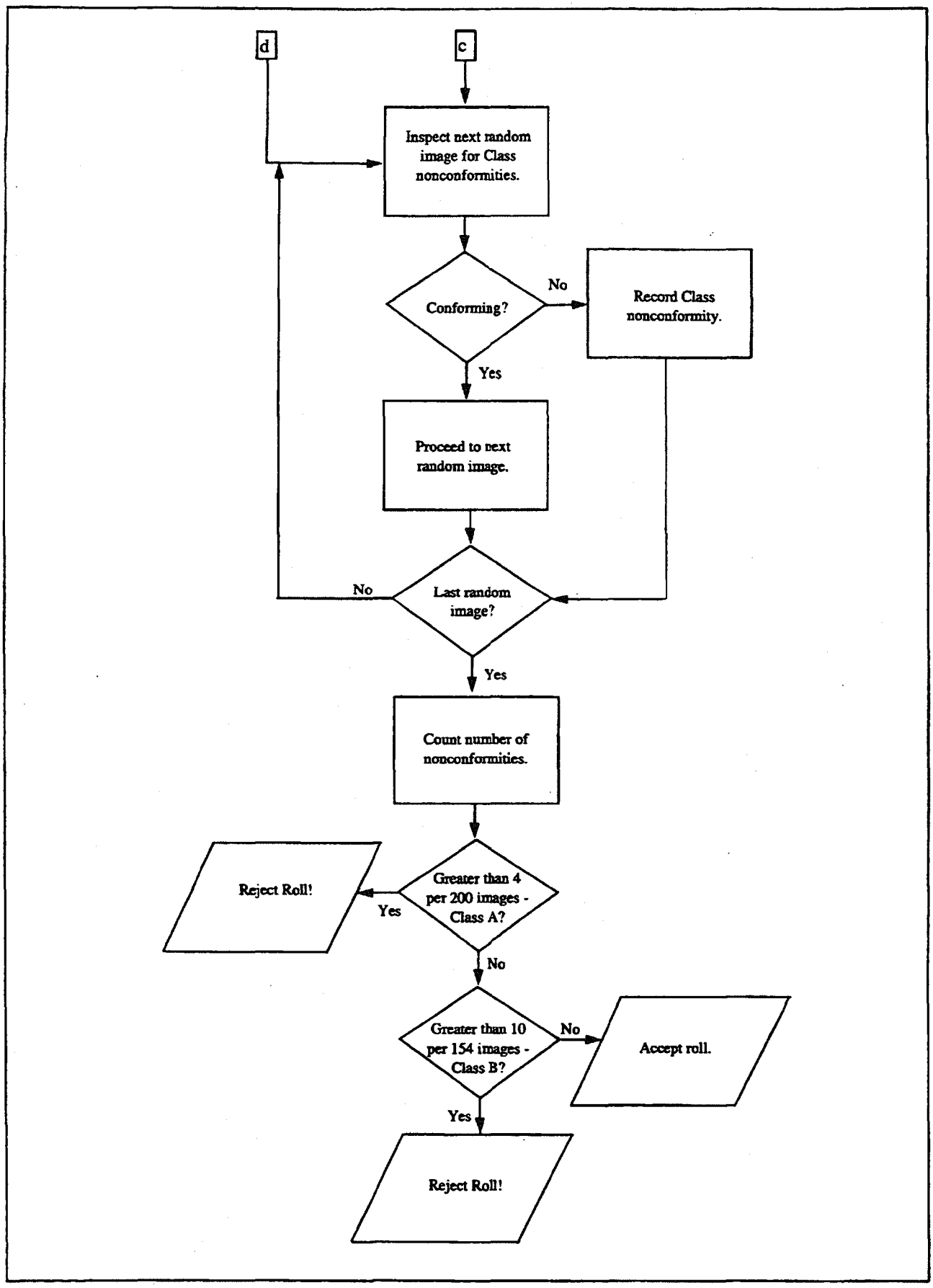


Figure B1 — Technical inspection and sampling plans (sample of micrographic plan) (concluded)