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MILITARY STANDARD

SAMPLING PROCEDURES AND TABLES FOR INSPECTION BY VARIABLES FOR PERCENT DEFECTIVE

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
Washington 25, D. C.

Supply and Logistics 11 June 1957

Sampling Procedures and Tables for Inspection by
Variables for Percent Defective
MIL-STD-414

1. This standard has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy, and the Air Force, effective 11 June 1957.

2. In accordance with established procedure, the Standardization Division has designated the Chemical Corps, Bureau of Ordnance, and Air Force, respectively, as Army-Navy-Air Force custodians of this standard.

3. Recommended corrections, additions, or deletions should be addressed to the Standardization Division, Office of the Assistant Secretary of Defense (Supply and Logistics), Washington 25, D. C.

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INTRODUCTION

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

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

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

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

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

Operating Characteristic Curves in Table A-3 show the relationship between quality and percent of lots expected to be acceptable for the quality characteristic inspected. As stated, these Operating Characteristic Curves are based on the assumption that measurements are selected at random from a normal distribution.

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

Certain characteristics concerning the sampling plans in Sections B and C and those in Section D should be noted. Plans based on the estimate of unknown variability require fewer sample units for comparable assurance when the estimate of lot standard deviation is used than when the average range of the sample is used; on the other hand, plans using the average range of the sample require

simpler computations. Plans using known variability require considerably fewer sample units for comparable assurance than either of the plans when variability is unknown; however, the requirement of known variability is a stringent one. The user is advised to consult his technical agency before applying sampling plans using known variability.

Table B-8 provides values of the factor F to compute the maximum standard deviation MSD. The MSD serves as a guide for the magnitude of the estimate of lot standard deviation when using plans for the double specification limit case, based on the estimate of lot standard deviation of unknown variability. Similarly Table C-8 provides values of the factor f to compute the maximum average range MAR. The MAR serves as a guide for the magnitude of the average range of the sample when using plans for the double specification limit case, based on the average range of the sample of unknown variability. The estimate of lot standard deviation or average range of the sample, if it is less than the MSD or MAR, respectively, helps to insure, but does not guarantee, lot acceptability.

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

SECTION A

GENERAL DESCRIPTION OF SAMPLING PLANS

A1. SCOPE

A1.1 Purpose. This Standard establishes sampling plans and procedures for inspection by variables for use in Government procurement, supply and storage, and maintenance inspection operations. When applicable this Standard shall be referenced in the specification, contract, or inspection instructions, and the provisions set forth herein shall govern.

A1.2 Inspection. Inspection is the process of measuring, examining, testing, gaging, or otherwise comparing the "unit of product" (See A1.4) with the applicable requirements.

A1.3 Inspection by Variables. Inspection by variables is inspection wherein a specified quality characteristic (See A1.5) on a unit of product is measured on a continuous scale, such as pounds, inches, feet per second, etc., and a measurement is recorded.

A1.4 Unit of Product. The unit of product is the entity of product inspected in order to determine its measurable quality characteristic. This may be a single article, a pair, a set, a component of an end product, or the end product itself. The unit of product may or may not be the same as the unit of purchase, supply, production, or shipment.

A1.5 Quality Characteristic. The quality characteristic for variables inspection is that characteristic of a unit of product that is actually measured, to determine conformance with a given requirement.

A1.6 Specification Limits. The specification limit(s) is the requirement that a quality characteristic should meet. This requirement may be expressed as an upper specification limit; or a lower specification limit, called herein a single specification limit; or both upper and lower specification limits, called herein a double specification limit.

A1.7 Sampling Plans. A sampling plan is a procedure which specifies the number of units of product from a lot which are to be inspected, and the criterion for acceptability of the lot. Sampling plans designated in this Standard are applicable to the inspection of a single quality characteristic of a unit of product. These plans may be used whether procurement inspection is performed at the plant of a prime contractor, subcontractor or vendor, or at destination, and also may be used when appropriate in supply and storage, and maintenance inspection operations.

A2. CLASSIFICATION OF DEFECTS

A2.1 Method of Classifying Defects. A classification of defects is the enumeration of defects of the unit of product classified according to their importance. A defect is a deviation of the unit of product from requirements of the specifications, drawings, purchase descriptions, and any changes thereto in the contract or order. Defects normally belong to one of the following classes; however, defects may be placed in other classes.

A2.1.1 Critical Defects. A critical defect is one that judgment and experience indicate could result in hazardous or unsafe conditions for individuals using or maintaining the product; or, for major end items units of product, such as ships, aircraft, or tanks, a defect that could prevent performance of their tactical function.

A2.1.2 Major Defects. A major defect is a defect, other than critical, that could result in failure, or materially reduce the usability of the unit of product for its intended purpose.

A2.1.3 Minor Defects. A minor defect is one that does not materially reduce the usability of the unit of product for its intended purpose, or is a departure from established standards having no significant bearing on the effective use or operation of the unit.

A3. PERCENT DEFECTIVE

A3.1 Expression of Nonconformance. The extent of nonconformance of product shall be expressed in terms of percent defective.

A3.2 Percent Defective. The percent defective for a quality characteristic of a given lot of product is the number of units of product defective for that characteristic divided by the total number of units of product and multiplied by one hundred. Expressed as an equation: Percent defective =

$$\frac{\text{Number of defectives} \times 100}{\text{Number of units}}$$

A4. ACCEPTABLE QUALITY LEVEL

A4.1 Acceptable Quality Level. The acceptable quality level (AQL) is a nominal value expressed in terms of percent defective specified for a single quality characteristic. Certain numerical values of AQL ranging from .04 to 15.00 percent are shown in Table A-1. When a range of AQL values is specified, it shall be treated as if it were equal to the value of AQL for which sampling plans are furnished and which is included within the AQL range. When the specified AQL is a particular value other than those for which sampling plans are furnished, the AQL, which is to be used in applying the provisions of this Standard, shall be as shown in Table A-1.

A4.2 Specifying AQL's. The particular AQL value to be used for a single quality characteristic of a given product must be specified. In the case of a double specification limit, either an AQL value is specified for the total percent defective outside of both upper and lower specification limits, or two AQL values are specified, one for the upper limit and another for the lower limit.

A5. SUBMITTAL OF PRODUCT

A5.1 Lot. The term "lot" shall mean "inspection lot," i.e., a collection of units of product from which a sample is drawn and inspected to determine compliance with the acceptability criterion.

A5.1.1 Formation of Lots. Each lot shall, as far as is practicable, consist of units of product of a single type, grade, class, size, or composition manufactured under essentially the same conditions.

A5.2 Lot Size. The lot size is the number of units of product in a lot, and may differ from the quantity designated in the contract or order as a lot for production, shipment, or other purposes.

A6. LOT ACCEPTABILITY

A6.1 Acceptability Criterion. The acceptability of a lot of material submitted for inspection shall be determined by use of one of the sampling plans associated with a specified value of the AQL(s). This Standard provides sampling plans based on known and unknown variability. In the latter case two alternative methods are provided, one based on the estimate of lot standard deviation and the other on the average range of the sample. These are referred to as the standard deviation method and the range method. For the case of a single specification limit, the acceptability criterion is given in two forms. These are identified as Form 1 and Form 2.

A6.2 Choice of Sampling Plans. Sampling plans and procedures are provided in Section B if variability is unknown and the standard deviation method is used, in Section C if variability is unknown and the range method is used, and in Section D if variability is known. Unless otherwise specified, unknown variability, standard deviation method sampling plans, and the acceptability criterion of Form 2 (for the single specification limit case) shall be used.

A7. SAMPLE SELECTION

A7.1 Determination of Sample Size. The sample size is the number of units of product drawn from a lot. Relative sample sizes are designated by code letters. The sample size code letter depends on the inspection level and the lot size. There are five inspection levels: I, II, III, IV, and V. Unless otherwise specified inspection level IV shall be used. The sample size code letter applicable to the specified inspection level and for lots of given size shall be obtained from Table A-2.

NOTICE—Special Reservation for Critical Characteristics. The Government reserves the right to inspect every unit submitted by the supplier for critical characteristics, and to reject the remainder of the lot immediately after a defect is found. The Government also reserves the right to sample for critical defects every lot submitted by the supplier and to reject any lot if a sample drawn therefrom is found to contain one or more critical defects.

A7.2 Drawing of Samples. A sample is one or more units of product drawn from a lot. Units of the sample shall be selected without regard to their quality.

A8. ESTIMATION OF PROCESS AVERAGE AND SEVERITY OF INSPECTION

Procedures for estimating the process average and criteria for tightened and reduced inspection based on the inspection results of preceding lots are provided in Part III of Sections B, C, and D.

A9. SPECIAL PROCEDURE FOR APPLICATION OF MIXED VARIABLES-ATTRIBUTES SAMPLING PLANS

A9.1 Applicability. A mixed variables and attributes sampling plan may be used under either of the two following conditions: (NOTE: No Operating Characteristic Curves

are provided for the mixed variables-attributes sampling plans herein and that those in Table A-3 are not applicable.)

Condition A. Ample evidence exists that the product submitted for inspection is selected by the supplier to meet the specification limit(s) by a screening process from a larger quantity of product which is not being produced within the specification limit(s).

Condition B. Other conditions exist that warrant the use of a variables-attributes sampling plan.

A9.2 Definitions.

A9.2.1 Inspection by Attributes. Inspection by attributes is inspection wherein the unit of product is classified simply as defective or nondefective with respect to a given requirement or set of requirements.

A9.2.2 Mixed Variables-Attributes Inspection. Mixed variables-attributes inspection is inspection of a sample by attributes, in addition to inspection by variables already made of a previous sample, before a decision as to acceptability or rejectability of a lot can be made.

A9.3 Selection of Sampling Plans. The mixed variables-attributes sampling plan shall be selected in accordance with the following:

A9.3.1 Select the variables sampling plan in accordance with Section B, C, or D.

A9.3.2 Select the attributes sampling plan from MIL-STD-105, paragraph 10, using a single sampling plan and tightened inspection. The same AQL value(s) shall be used for the attributes sampling plan as used for the variables plan of paragraph A9.3.1. (Additional sample items may be drawn, as necessary, to satisfy the requirements for sample size of the attributes sampling plan. Count as a defective each sample item falling outside of specification limit(s).)

A9.4 Determination of Acceptability. A lot meets the acceptability criterion if one of the following conditions is satisfied:

Condition A. The lot complies with the appropriate variables acceptability criterion of Section B, C, or D.

Condition B. The lot complies with the acceptability criterion of paragraph 11.1.2 of MIL-STD-105.

A9.4.1 If Condition A is not satisfied, proceed in accordance with the attributes sampling plan to meet Condition B.

A9.4.2 If Condition B is not satisfied, the lot does not meet the acceptability criterion.

A9.5 Severity of Inspection. The procedures for severity of inspection referred to in paragraph A8 are not applicable for mixed variables-attributes inspection.

TABLE A-1

AQL Conversion Table

For specified AQL values falling within these ranges	Use this AQL value
—— to 0.049	0.04
0.050 to 0.069	0.065
0.070 to 0.109	0.10
0.110 to 0.164	0.15
0.165 to 0.279	0.25
0.280 to 0.439	0.40
0.440 to 0.699	0.65
0.700 to 1.09	1.0
1.10 to 1.64	1.5
1.65 to 2.79	2.5
2.80 to 4.39	4.0
4.40 to 6.99	6.5
7.00 to 10.9	10.0
11.00 to 16.4	15.0

TABLE A-2

Sample Size Code Letters[1]

Lot Size	Inspection Levels				
	I	II	III	IV	V
3 to 8	B	B	B	B	C
9 to 15	B	B	B	B	D
16 to 25	B	B	B	C	E
26 to 40	B	B	B	D	F
41 to 65	B	B	C	E	G
66 to 110	B	B	D	F	H
111 to 180	B	C	E	G	I
181 to 300	B	D	F	H	J
301 to 500	C	E	G	I	K
501 to 800	D	F	H	J	L
801 to 1,300	E	G	I	K	L
1,301 to 3,200	F	H	J	L	M
3,201 to 8,000	G	I	L	M	N
8,001 to 22,000	H	J	M	N	O
22,001 to 110,000	I	K	N	O	P
110,001 to 550,000	I	K	O	P	Q
550,001 and over	I	K	P	Q	Q

[1] Sample size code letters given in body of table are applicable when the indicated inspection levels are to be used.

TABLE A-3

Operating Characteristic Curves for Sampling Plans of Sections B, C, and D

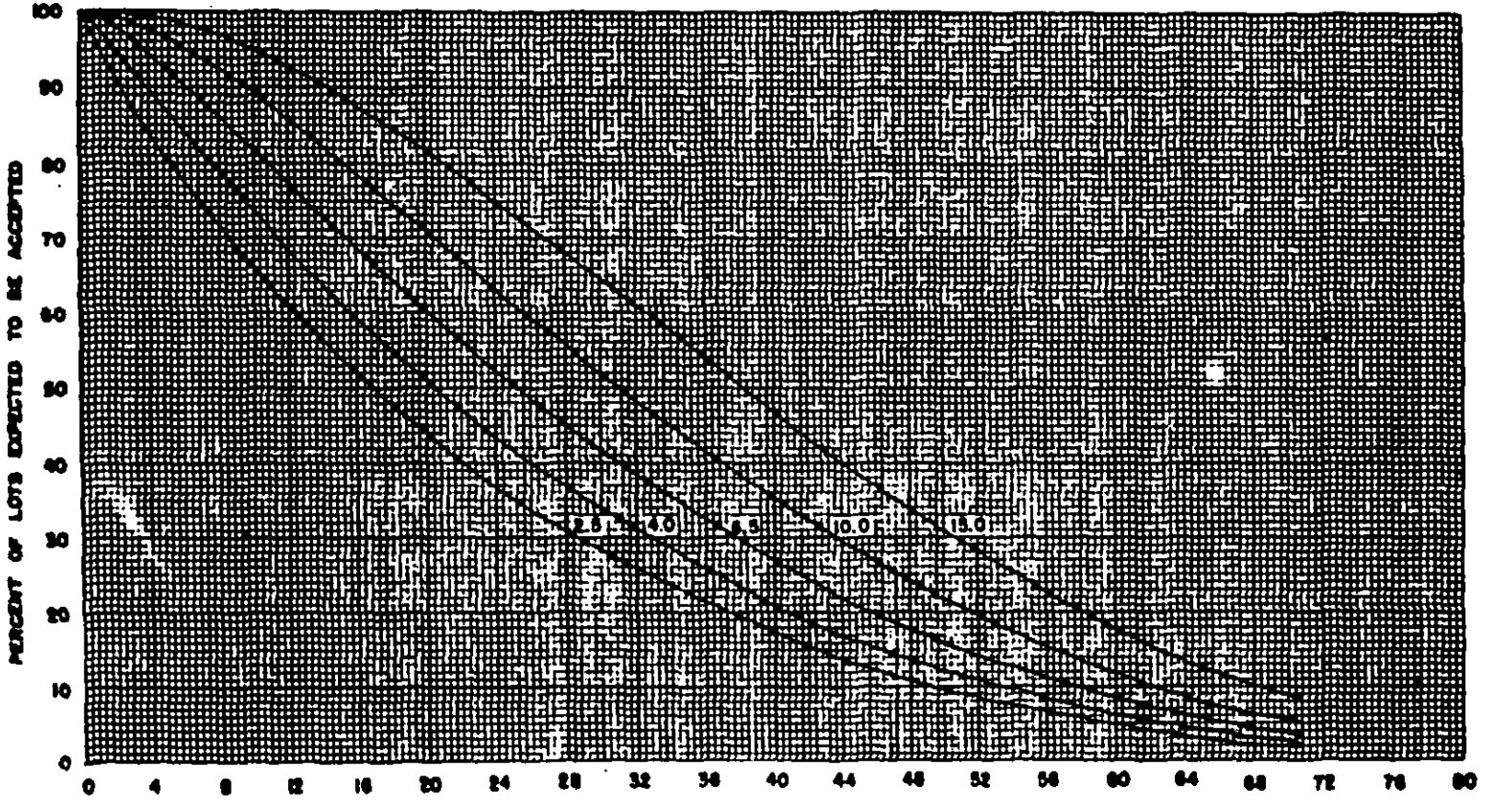
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

B

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are obtained at random from a normal distribution.

QUALITY OF SUBMITTED LOTS (In percent defective)

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

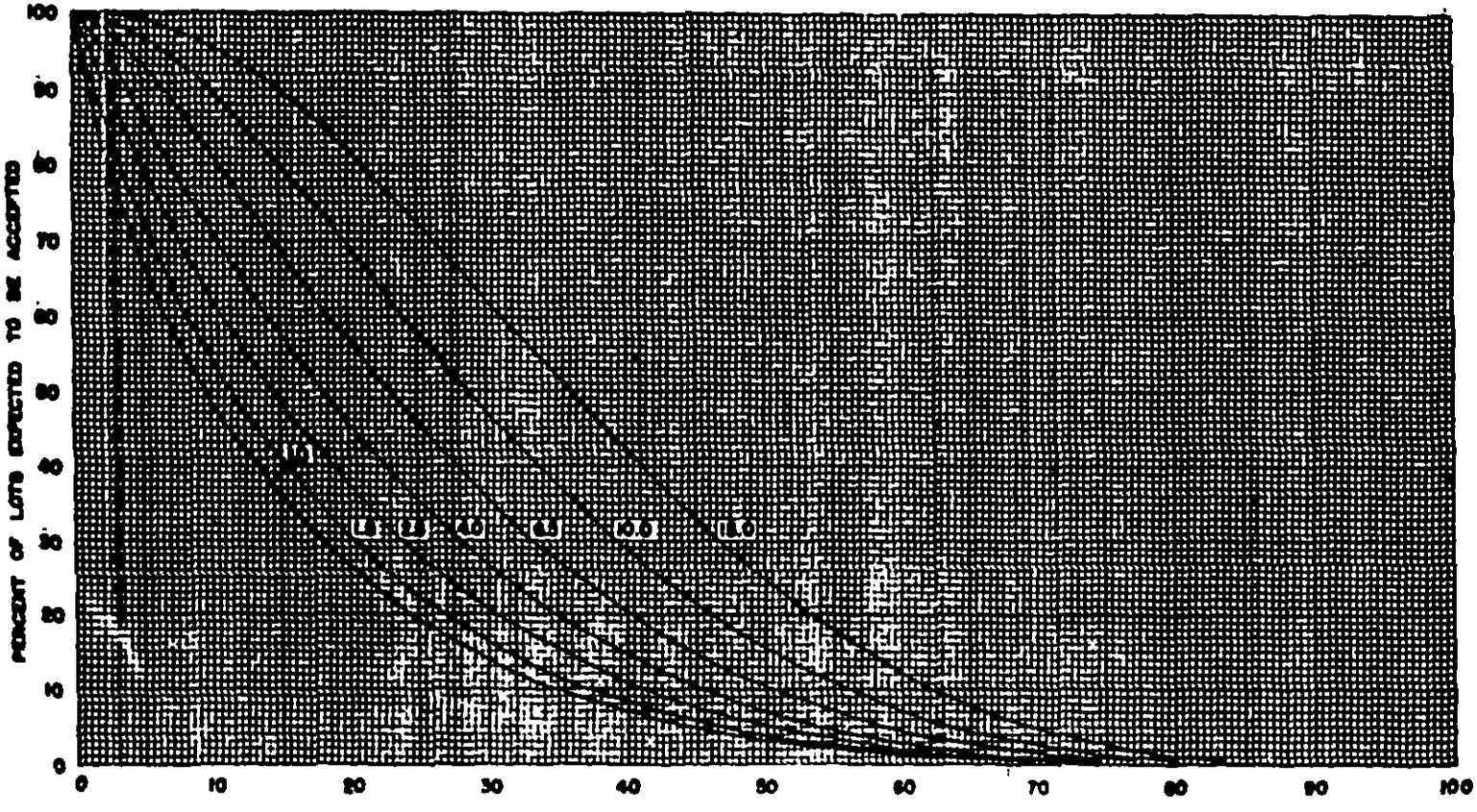
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

C

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

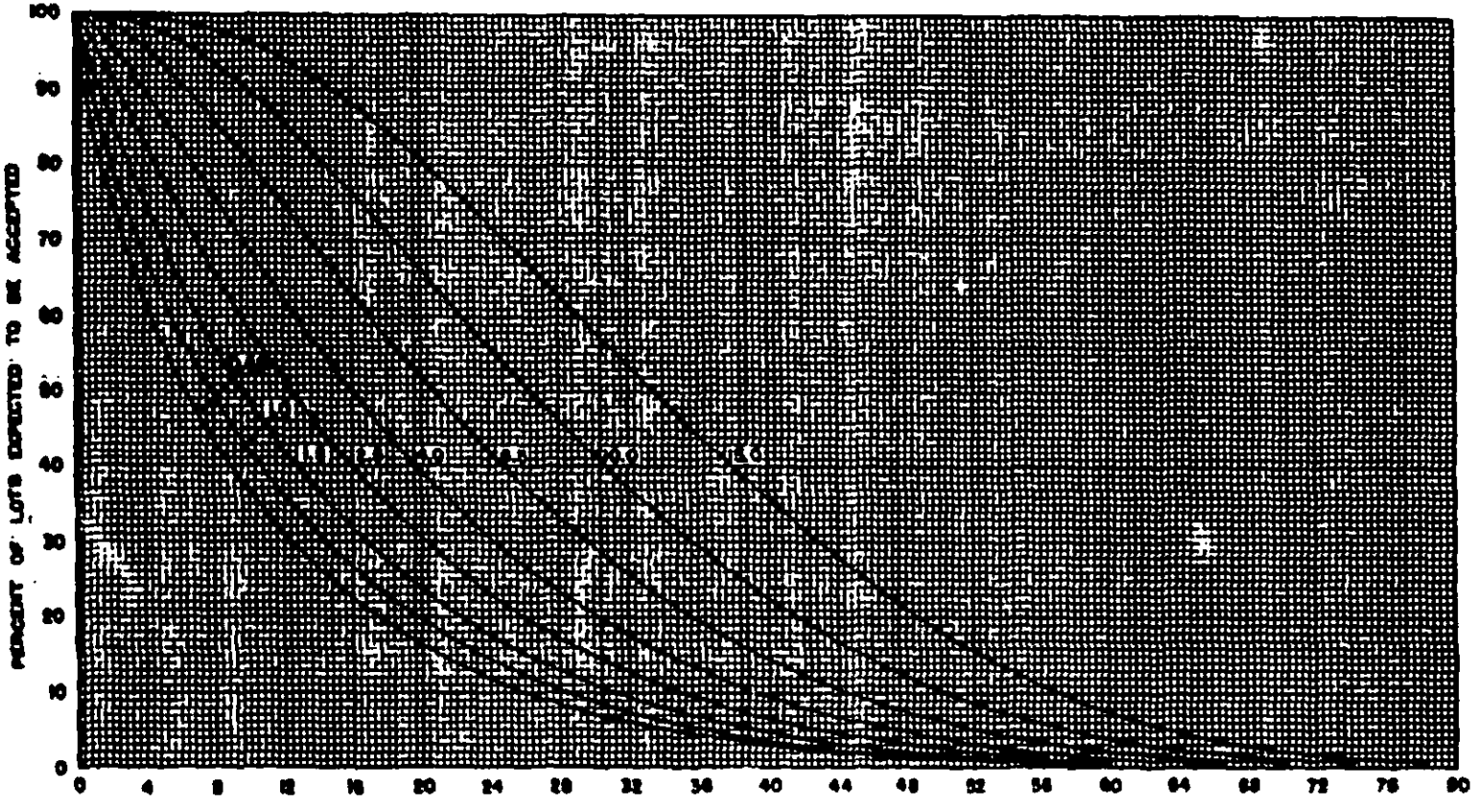
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

D

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

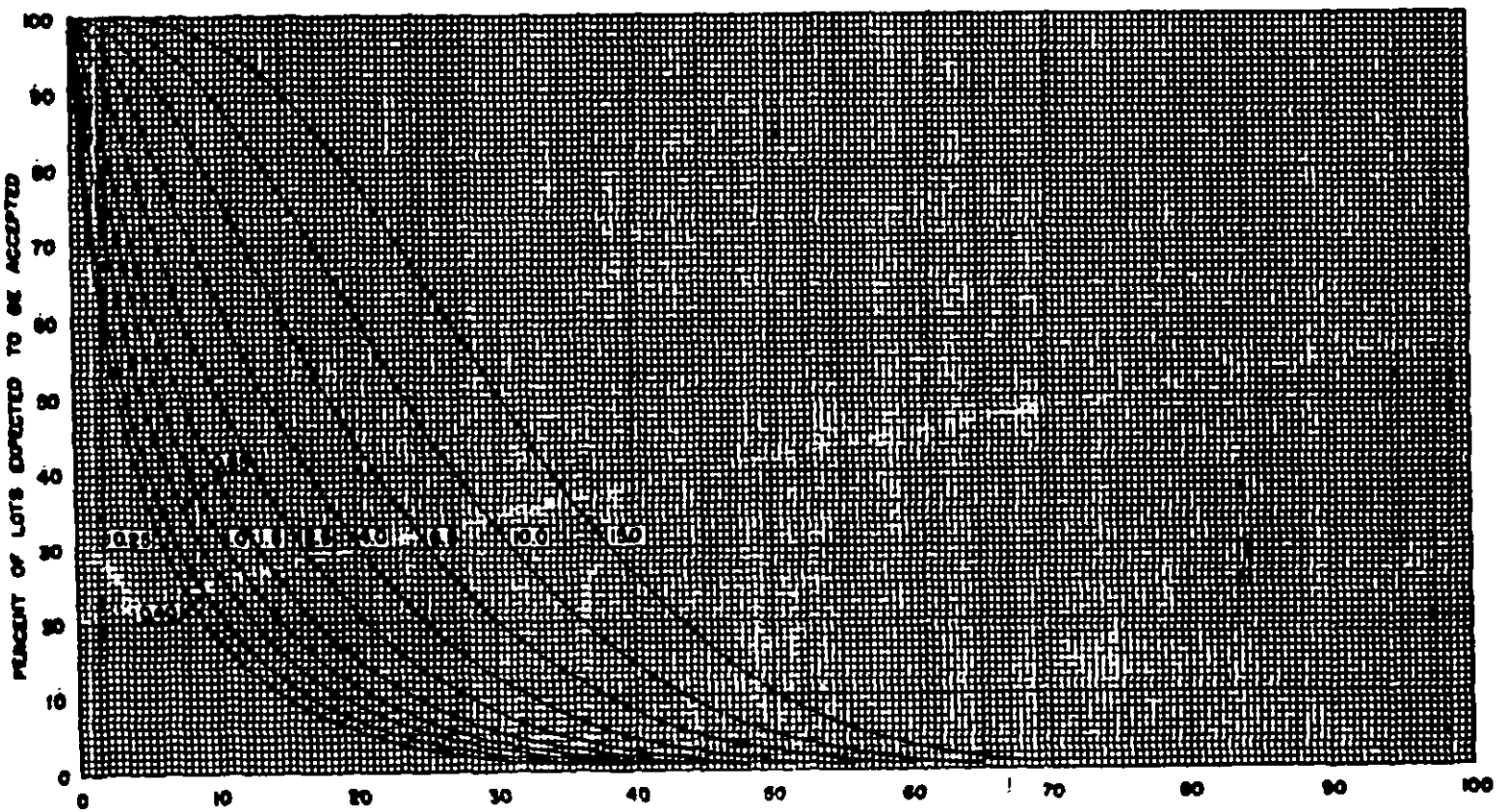
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

E

(Curves for sampling plans based on range method are known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

QUALITY OF SUBMITTED LOTS (In percent defective)

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

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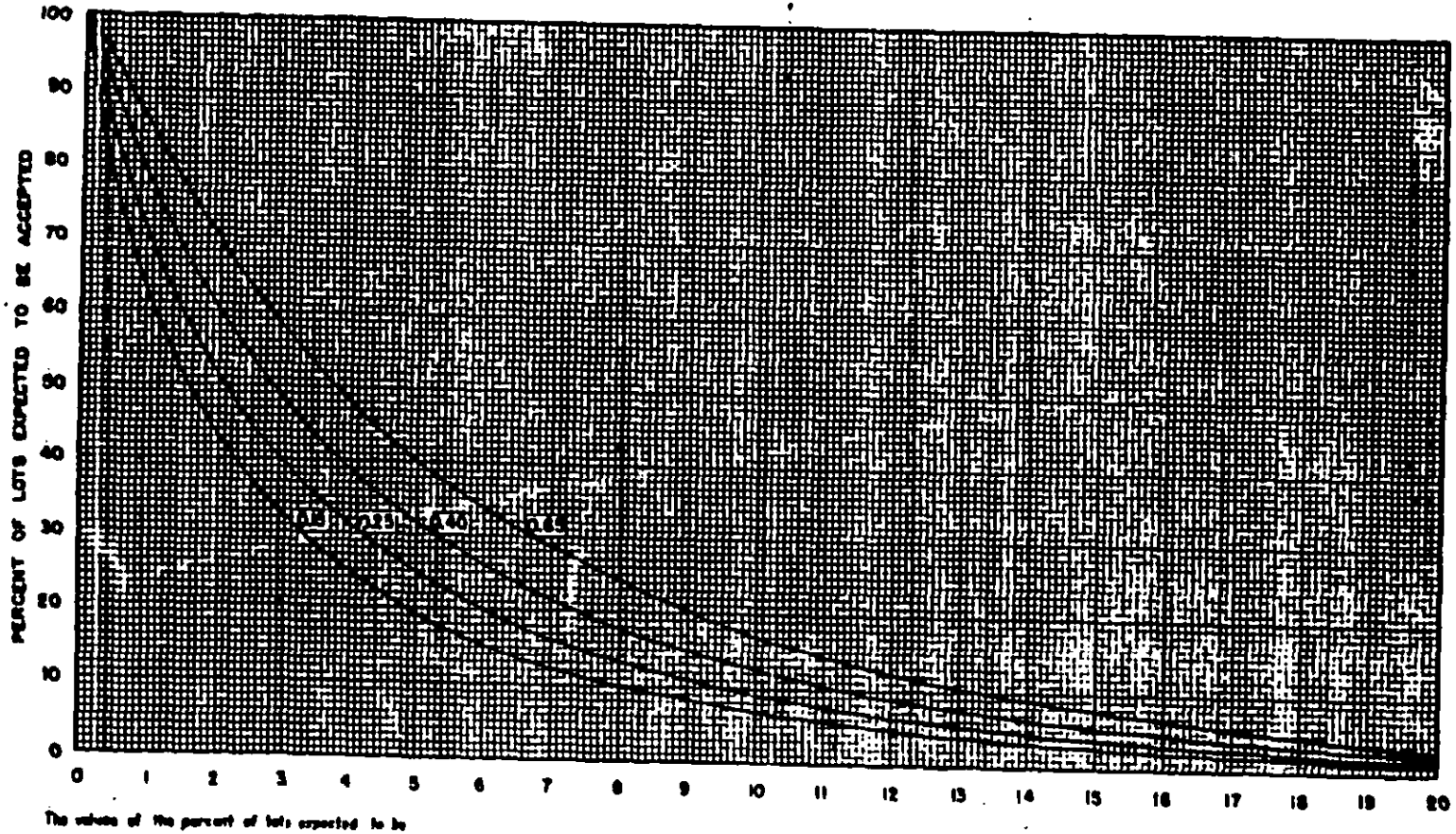
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

F

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

QUALITY OF SUBMITTED LOTS (in percent defective)

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

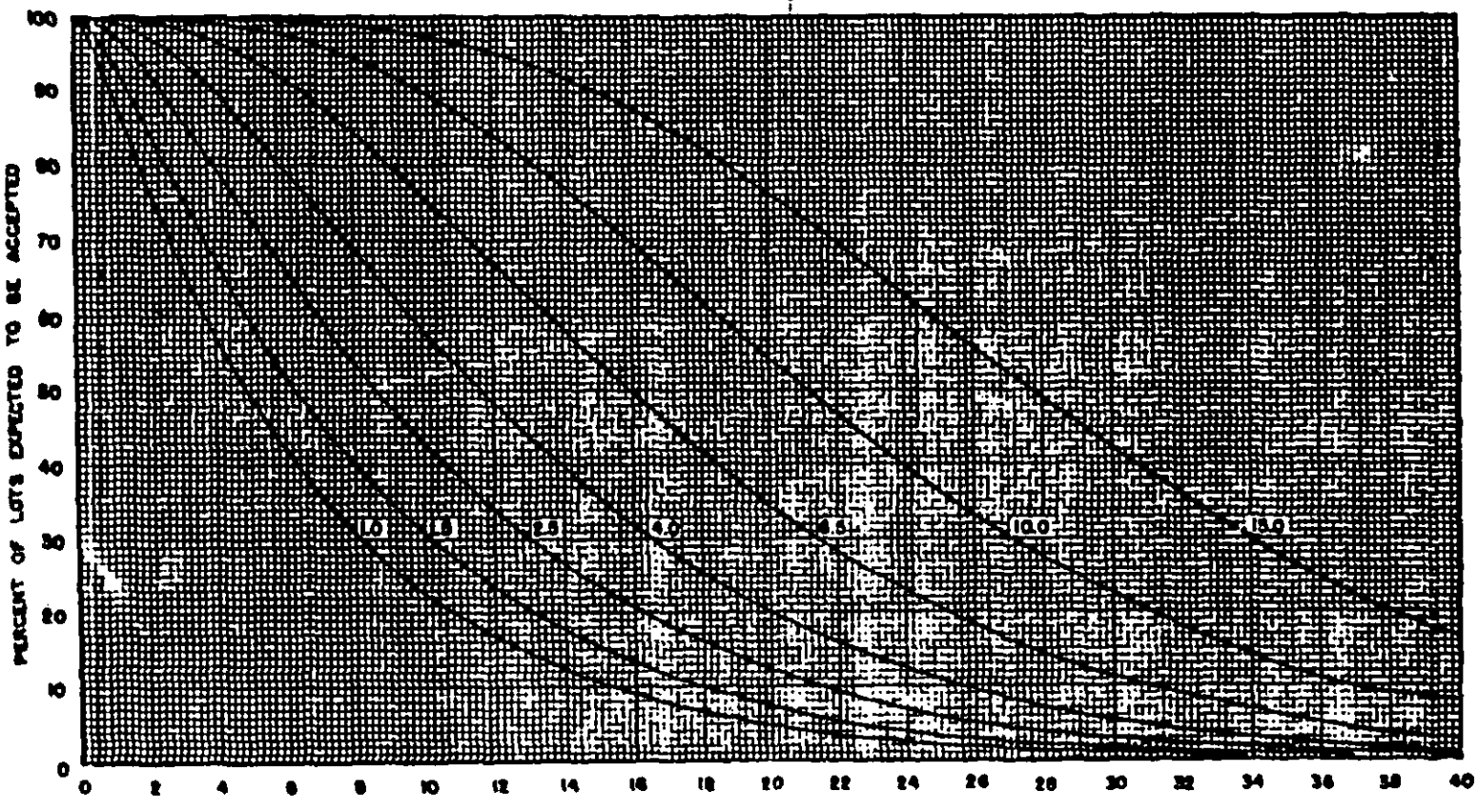
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

F (Continued)

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

QUALITY OF SUBMITTED LOTS (In percent defective)

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

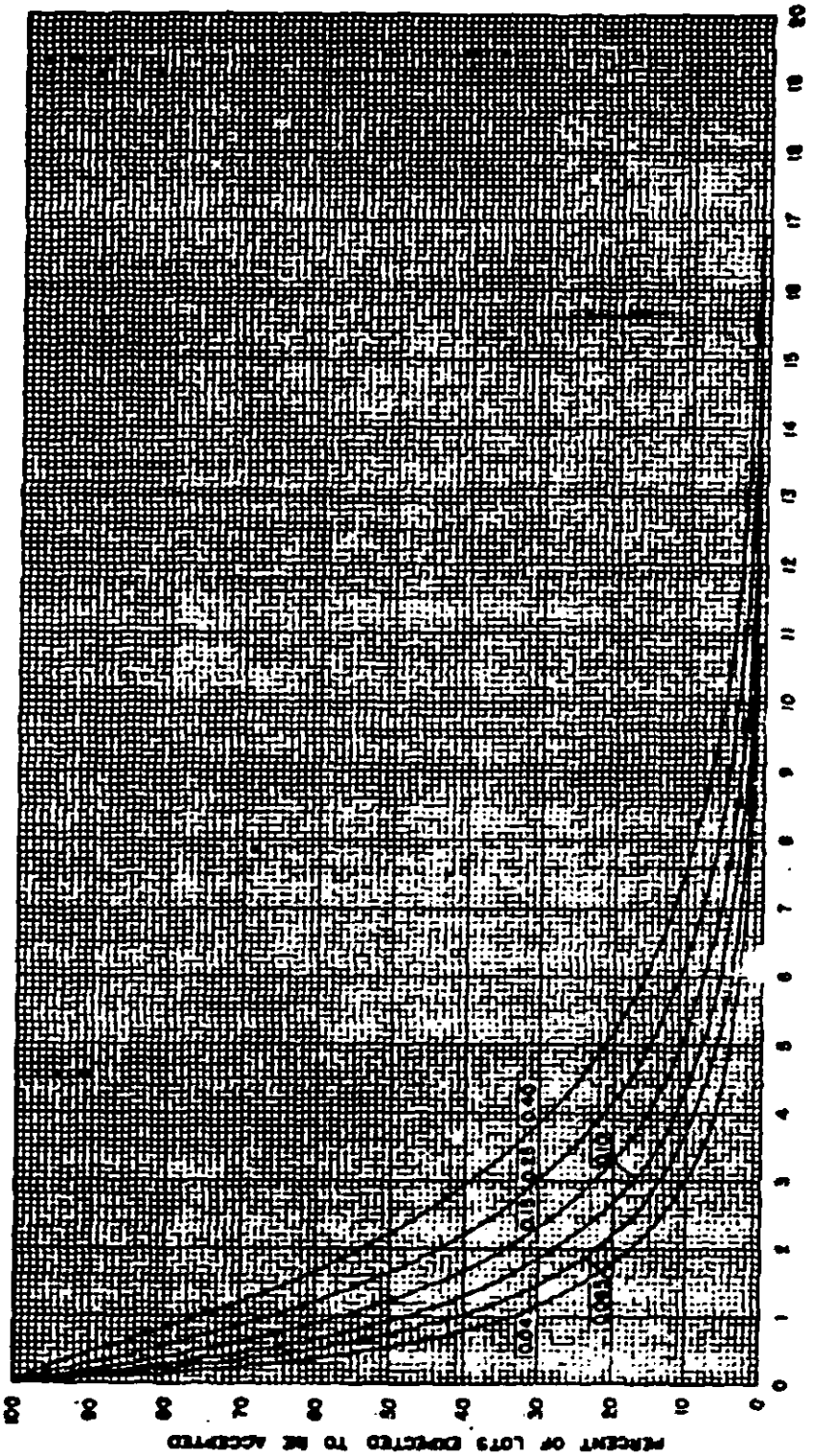
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

G

(Curves for sampling plans based on range method and known variability are essentially equivalent.)



The values of the percent of lots expected to be accepted are valid only when measurements are obtained at random from a normal distribution.

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

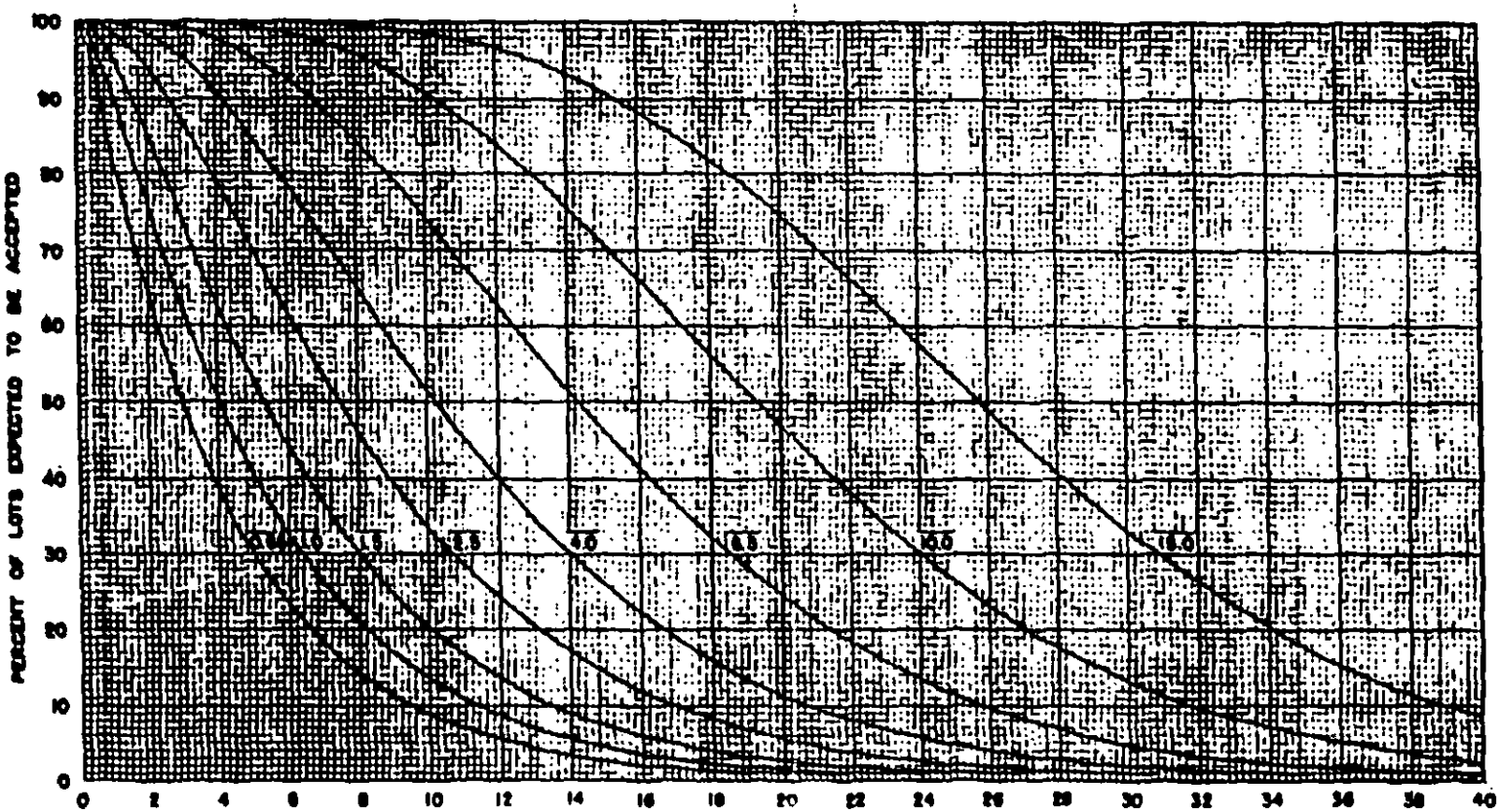
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

G (Continued)

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

QUALITY OF SUBMITTED LOTS (In percent defective)

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

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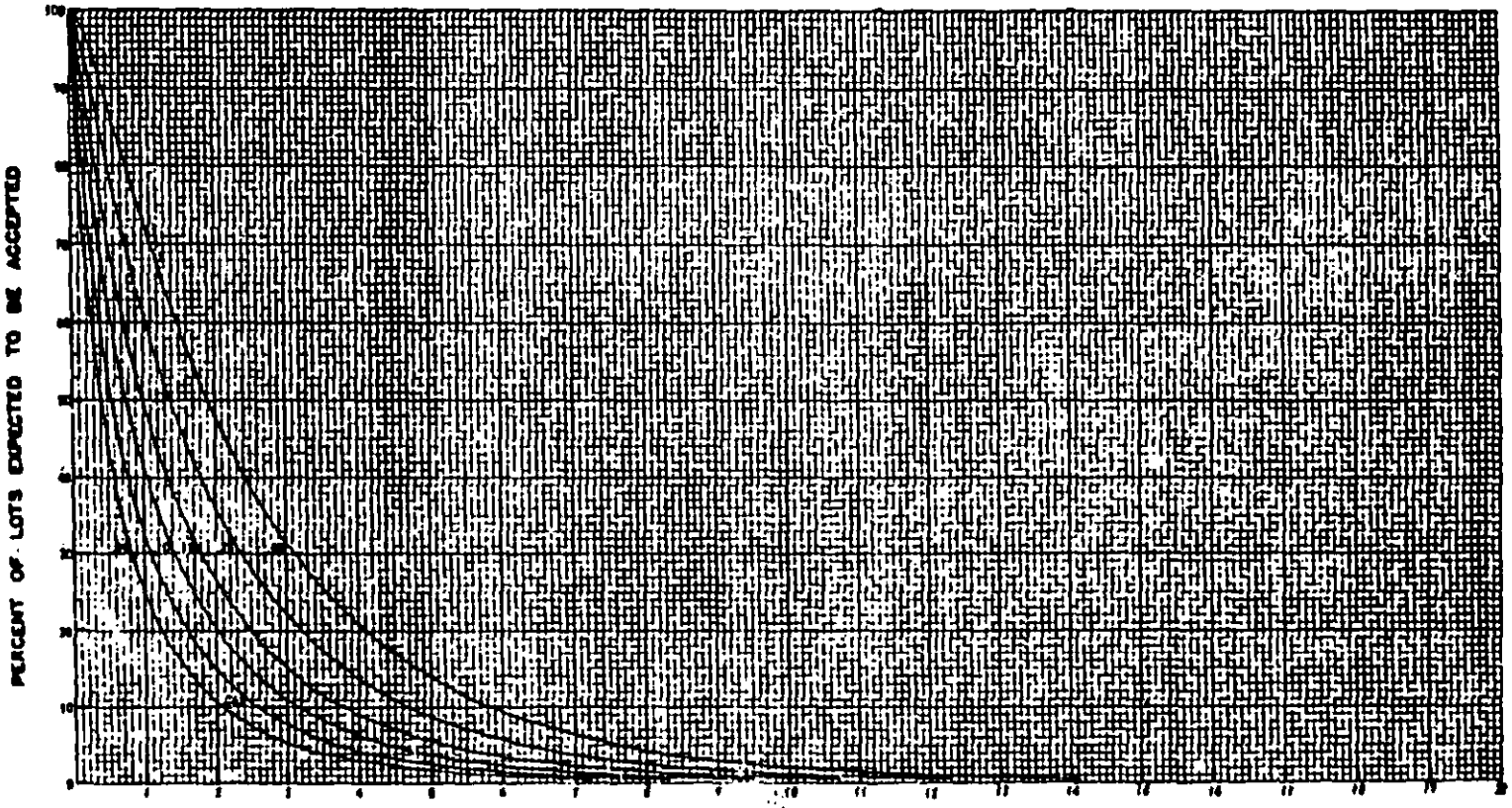
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

H

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

QUALITY OF SUBMITTED LOTS (in percent defective)

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

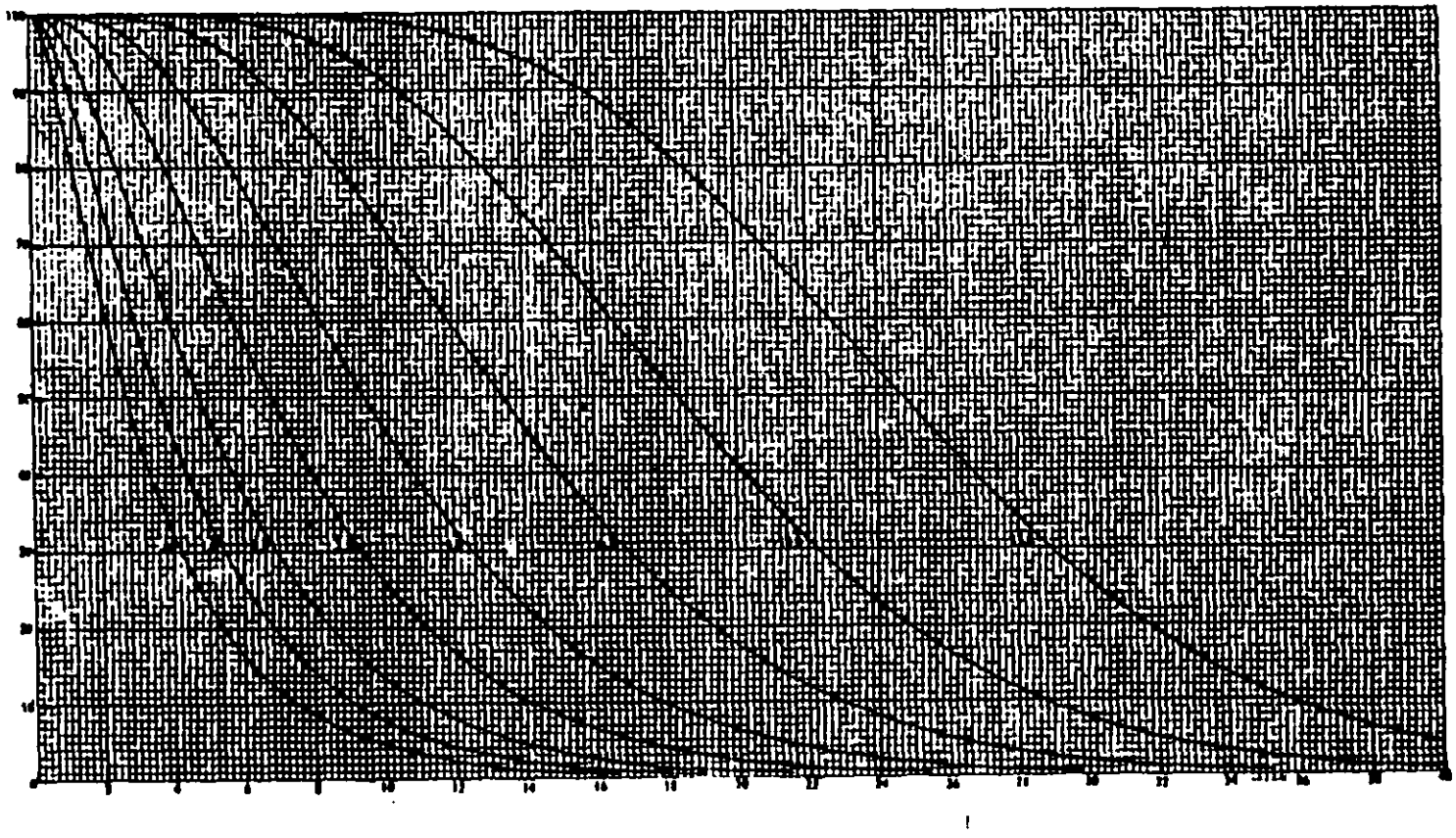
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

H (Continued)

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

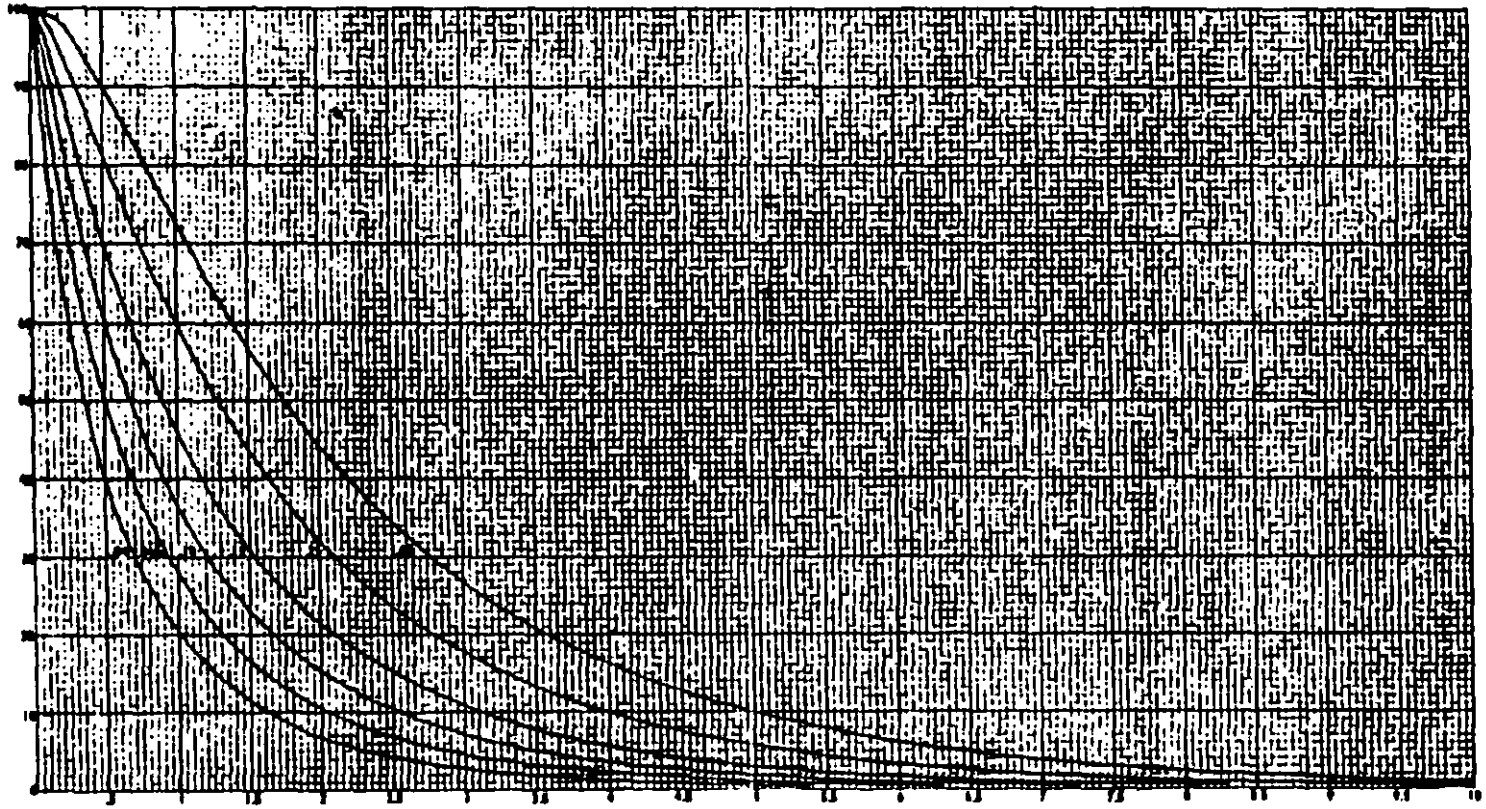
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

I

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are obtained at random from a normal distribution.

QUALITY OF SUBMITTED LOTS (in percent defective)

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

I (Continued)

(Curves for sampling plans based on range method and known variability are essentially equivalent)

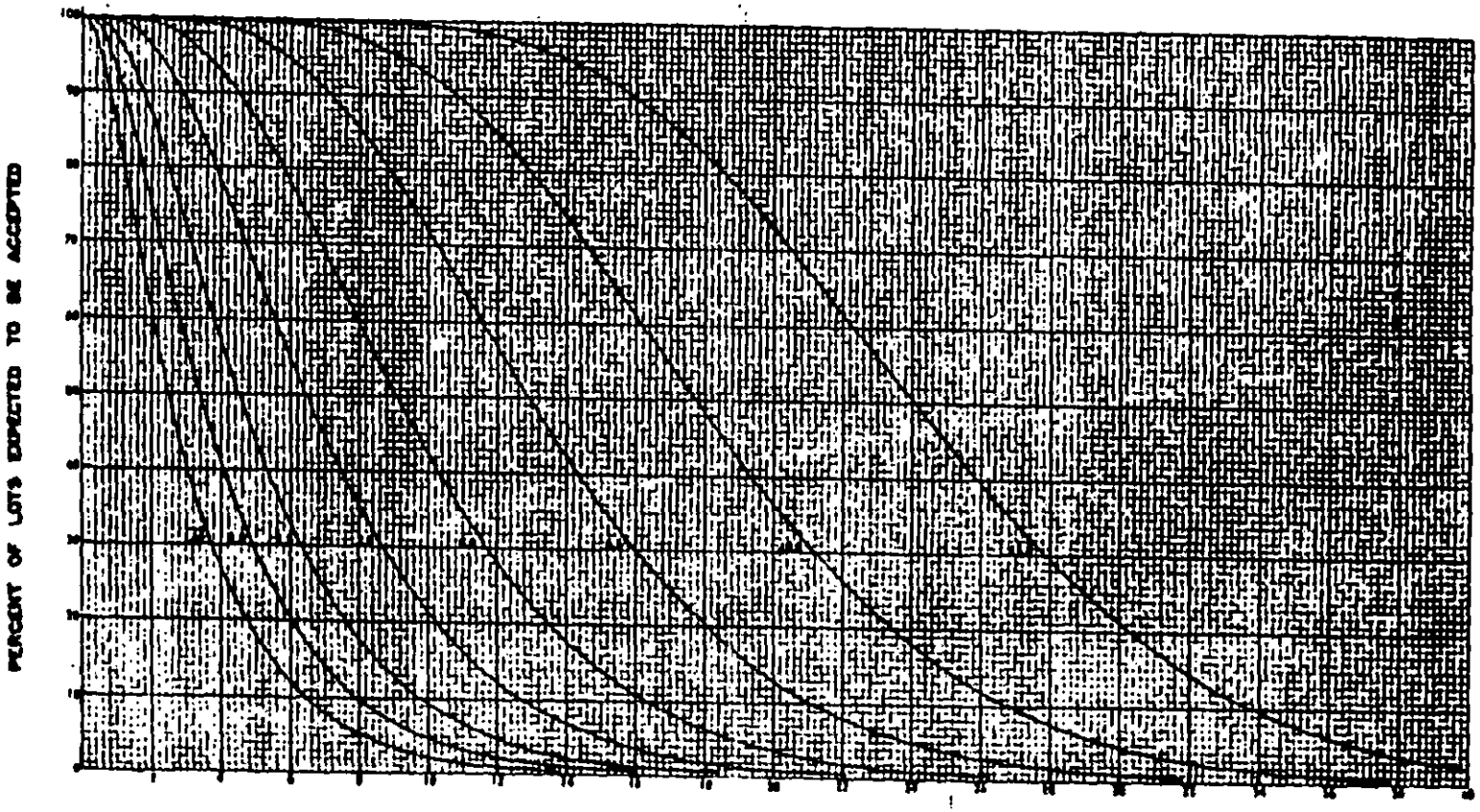


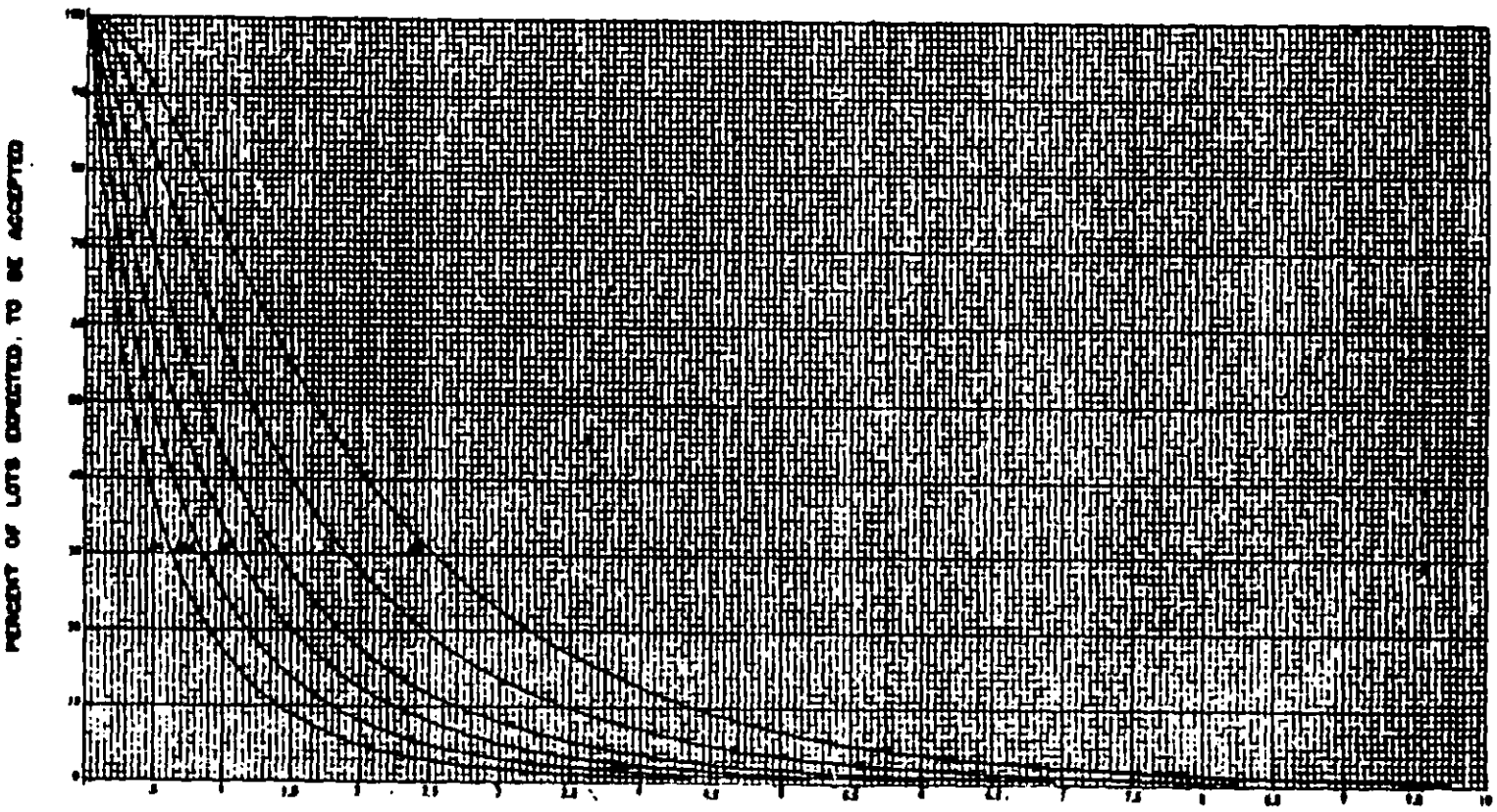
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

J

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

QUALITY OF SUBMITTED LOTS (in percent defective)

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

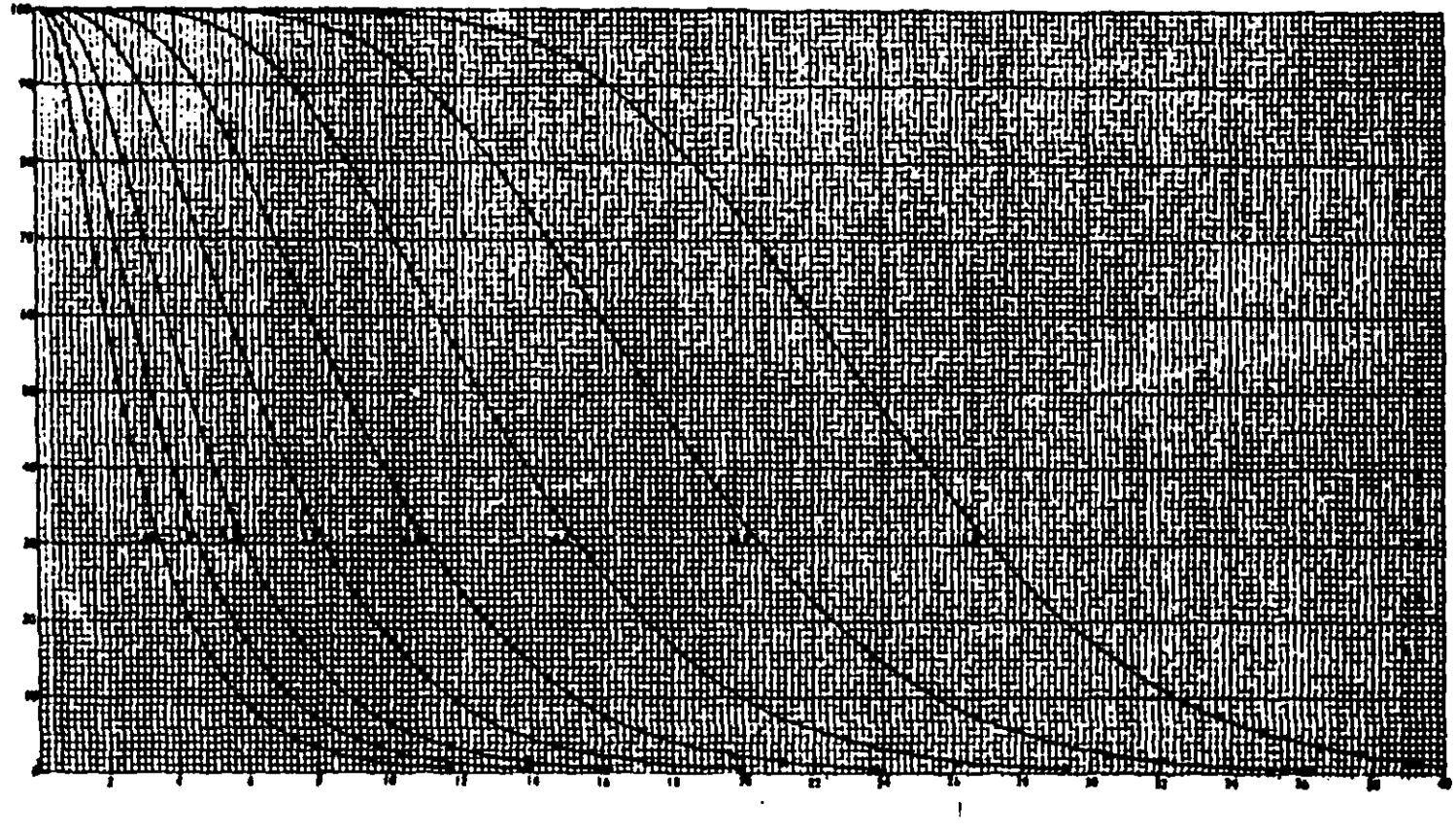
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

J (Continued)

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

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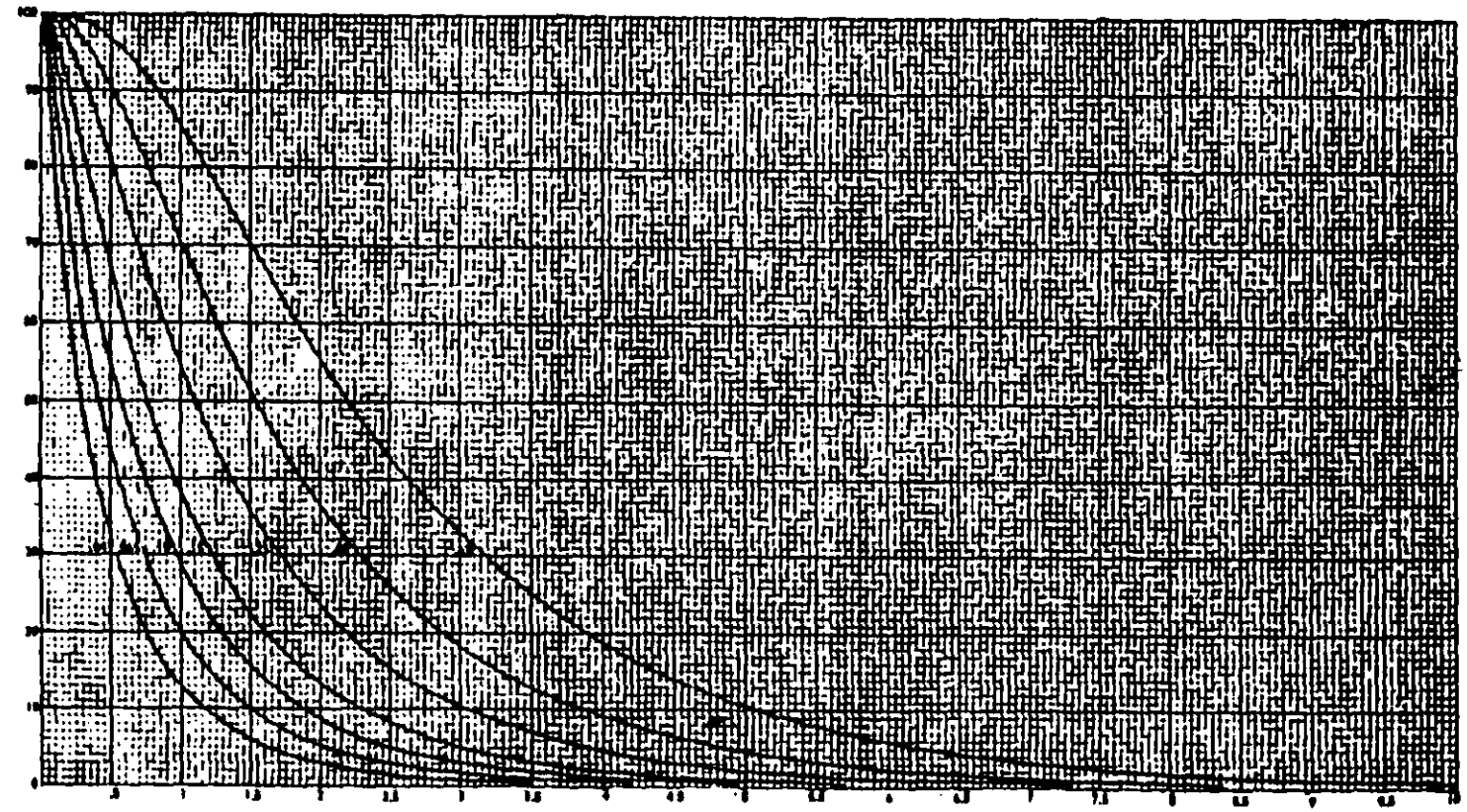
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

K

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

QUALITY OF SUBMITTED LOTS (In percent defective)

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

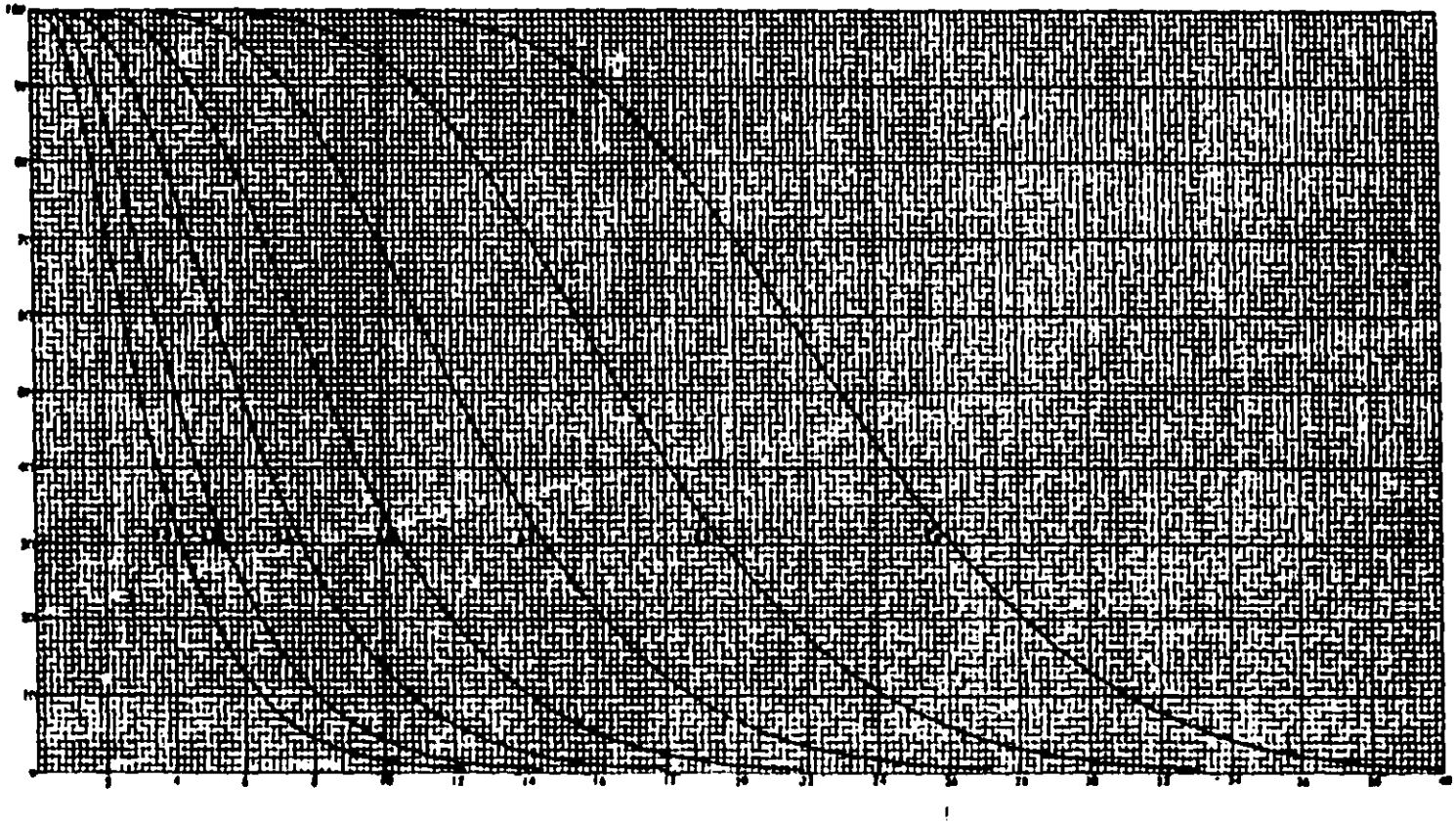
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

K (Continued)

(Curves for sampling plans based on ranges method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

QUALITY OF SUBMITTED LOTS (In percent defective)

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

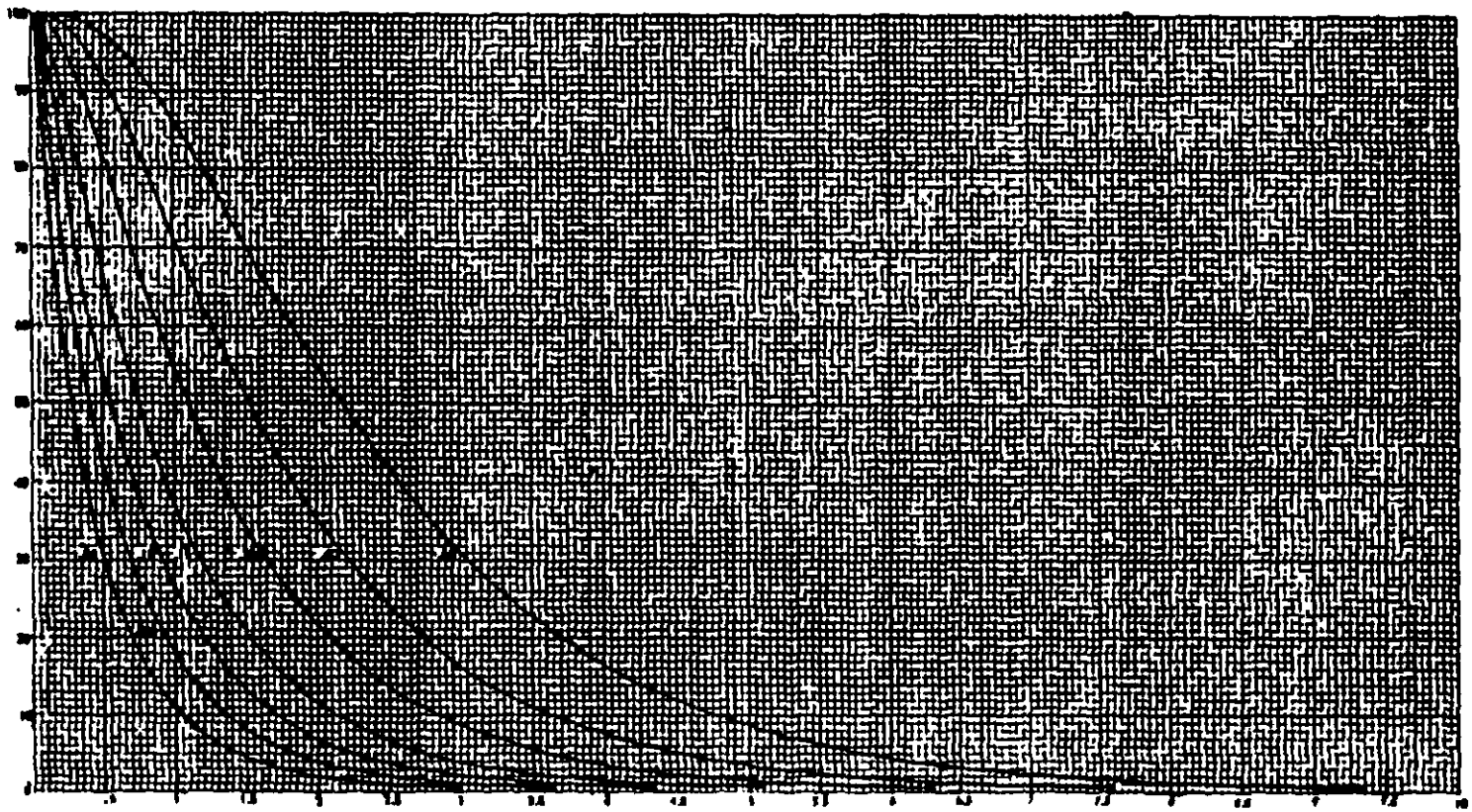
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

L

(Curves for sampling plans based on range method and known variability are essentially equivalent)



PERCENT OF LOTS EXPECTED TO BE ACCEPTED

The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

QUALITY OF SUBMITTED LOTS (In percent defective)

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

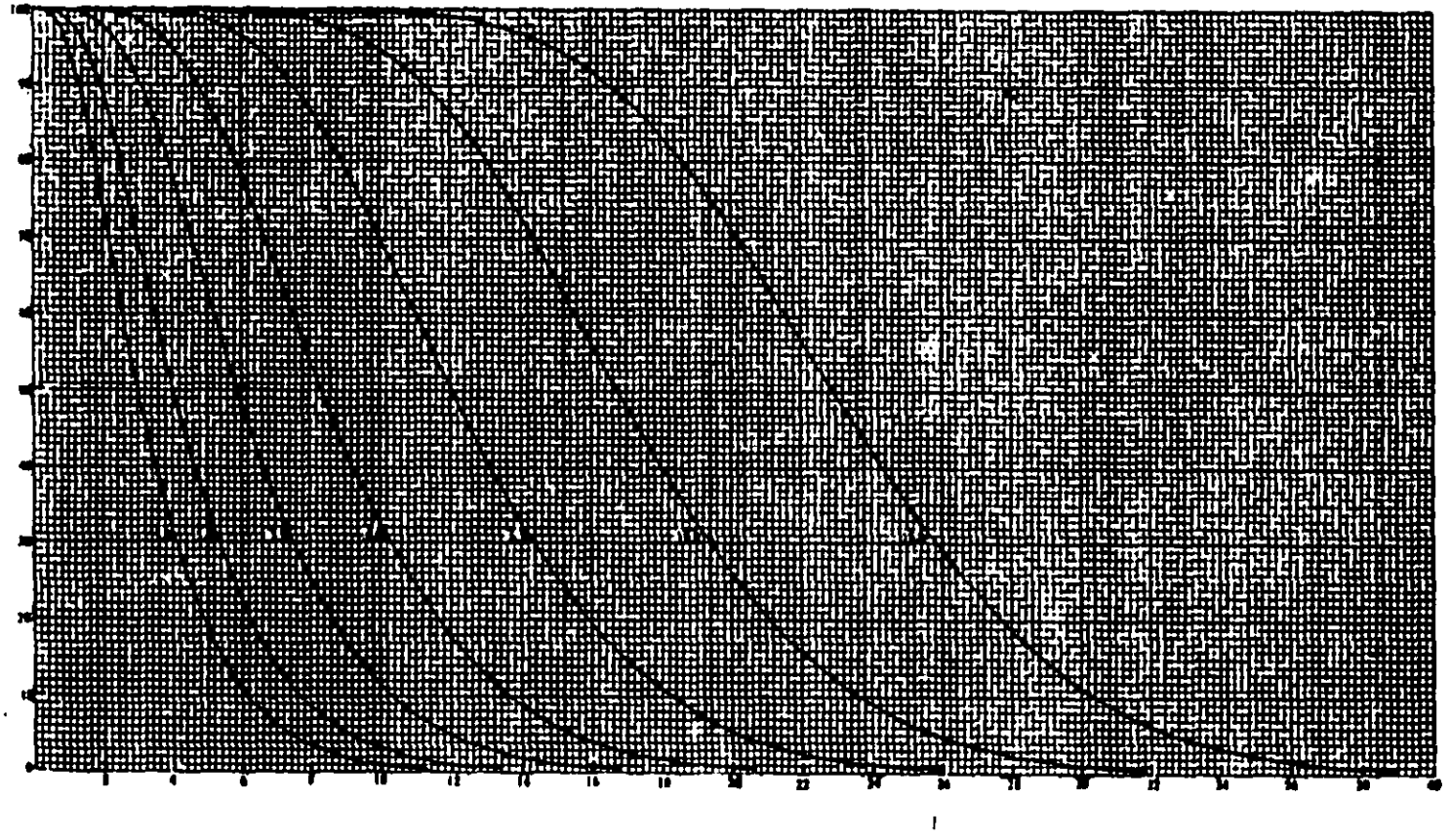
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

L (Continued)

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

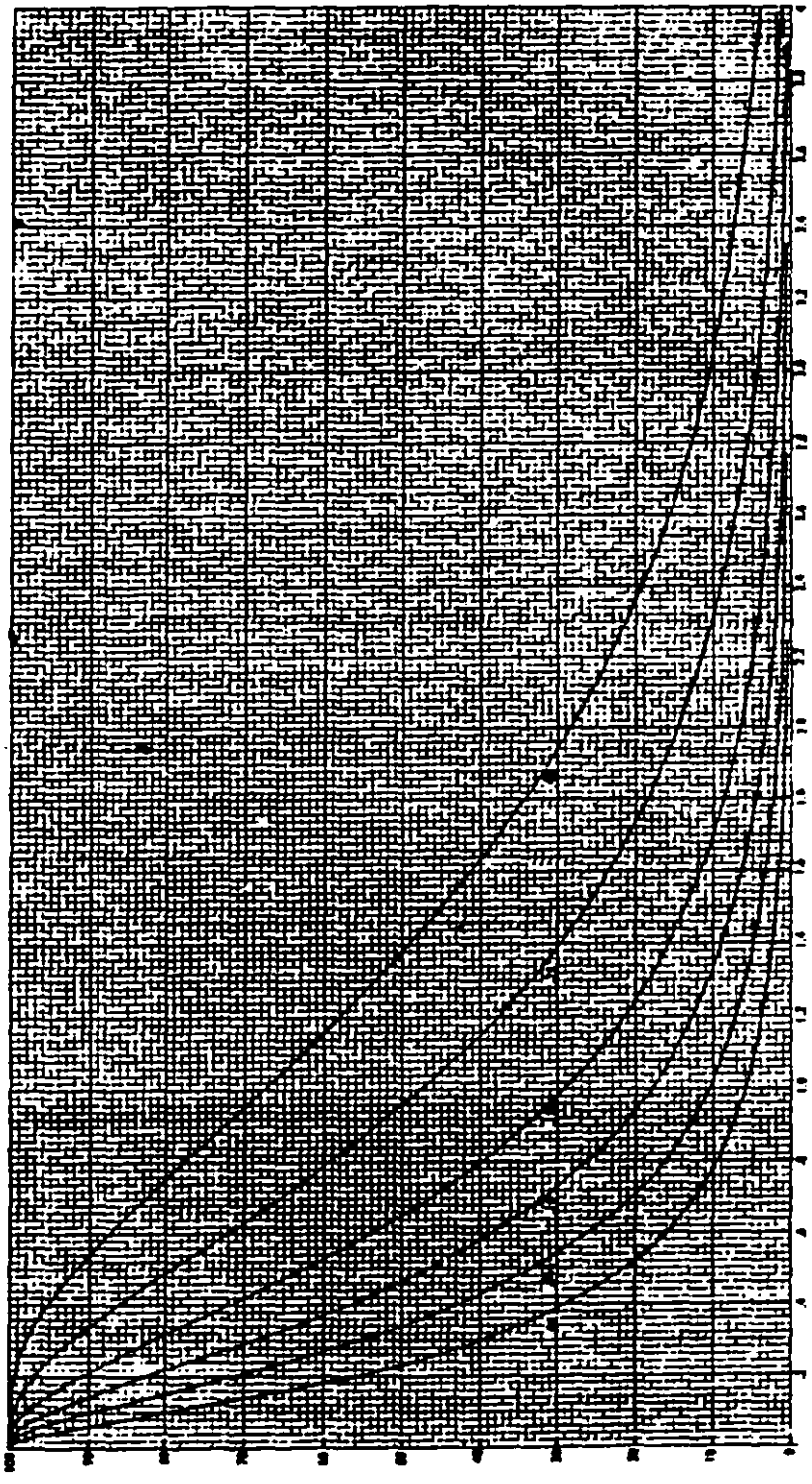
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

M

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

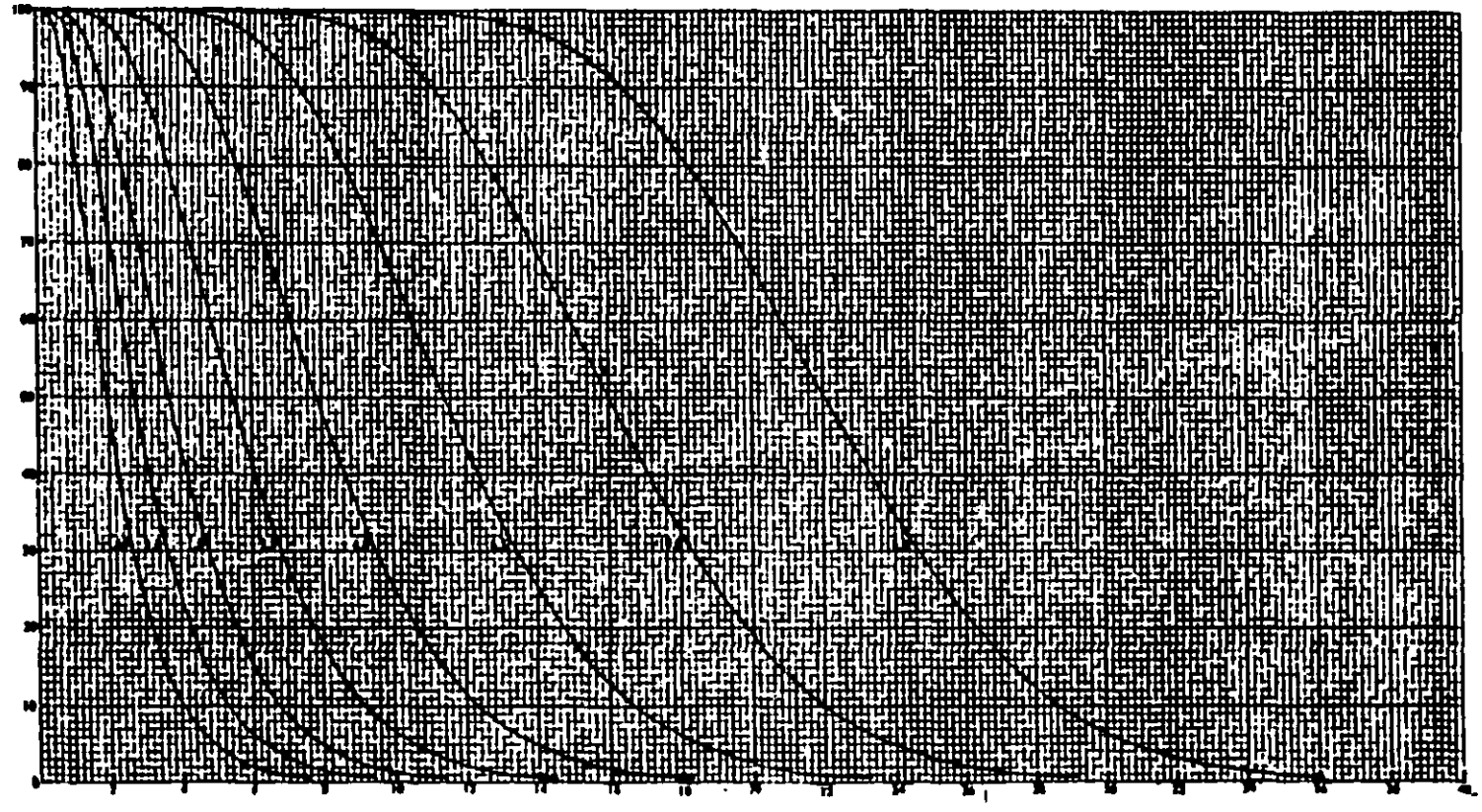
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

M (Continued)

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

QUALITY OF SUBMITTED LOTS (In percent defective)

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

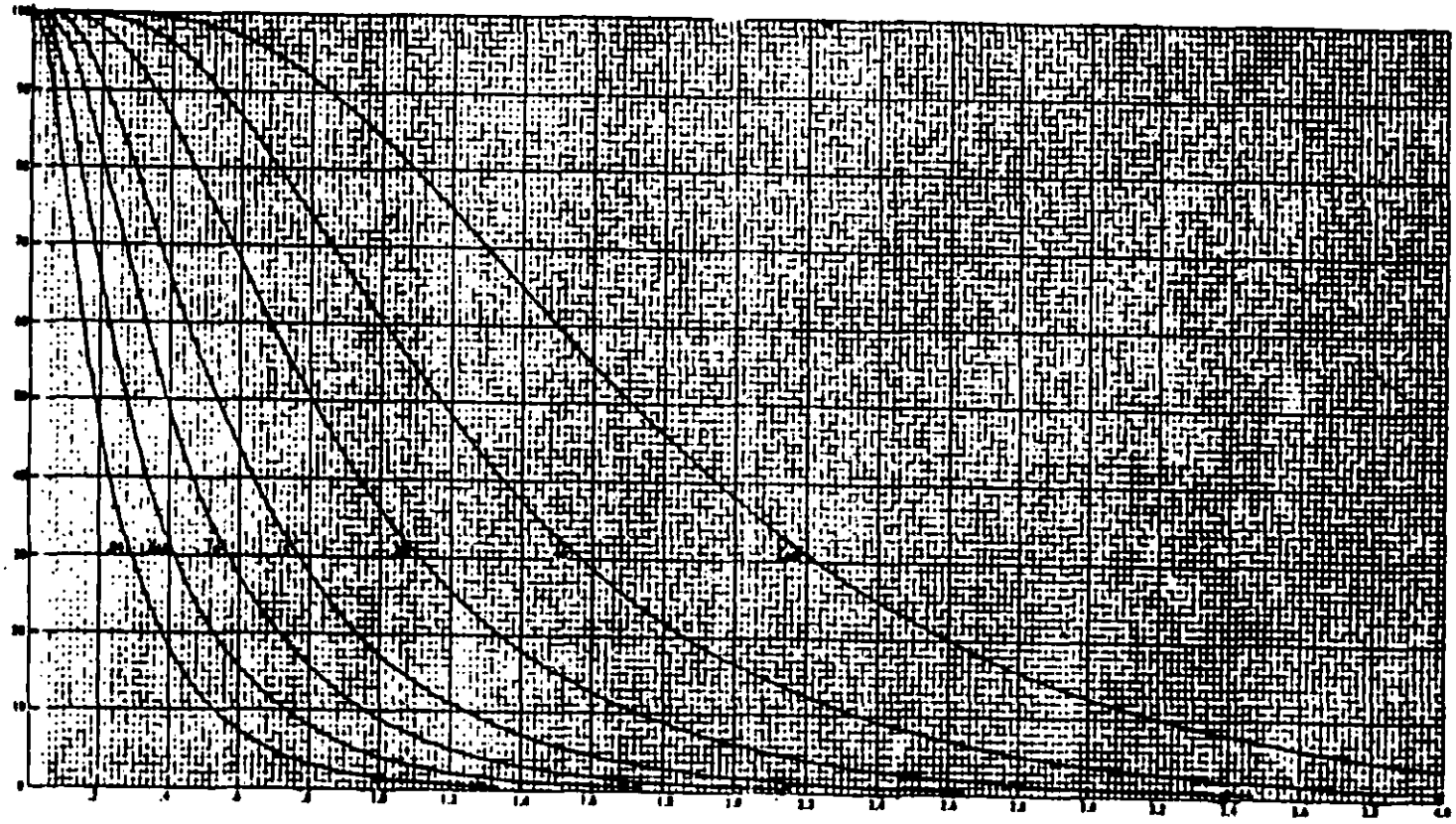
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

N

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

QUALITY OF SUBMITTED LOTS (In percent defective)

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

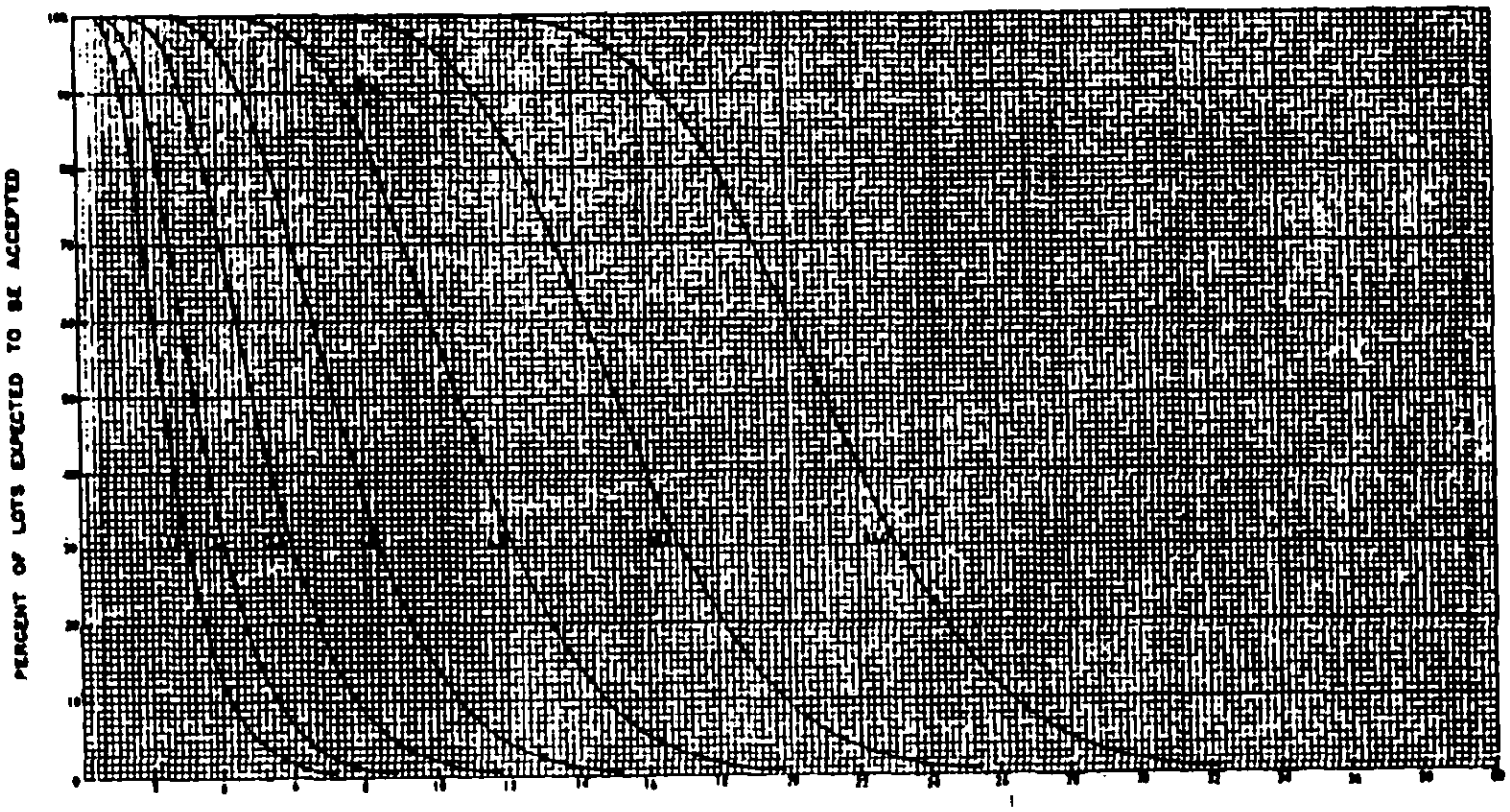
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

N (Continued)

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

QUALITY OF SUBMITTED LOTS (In percent defective)

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

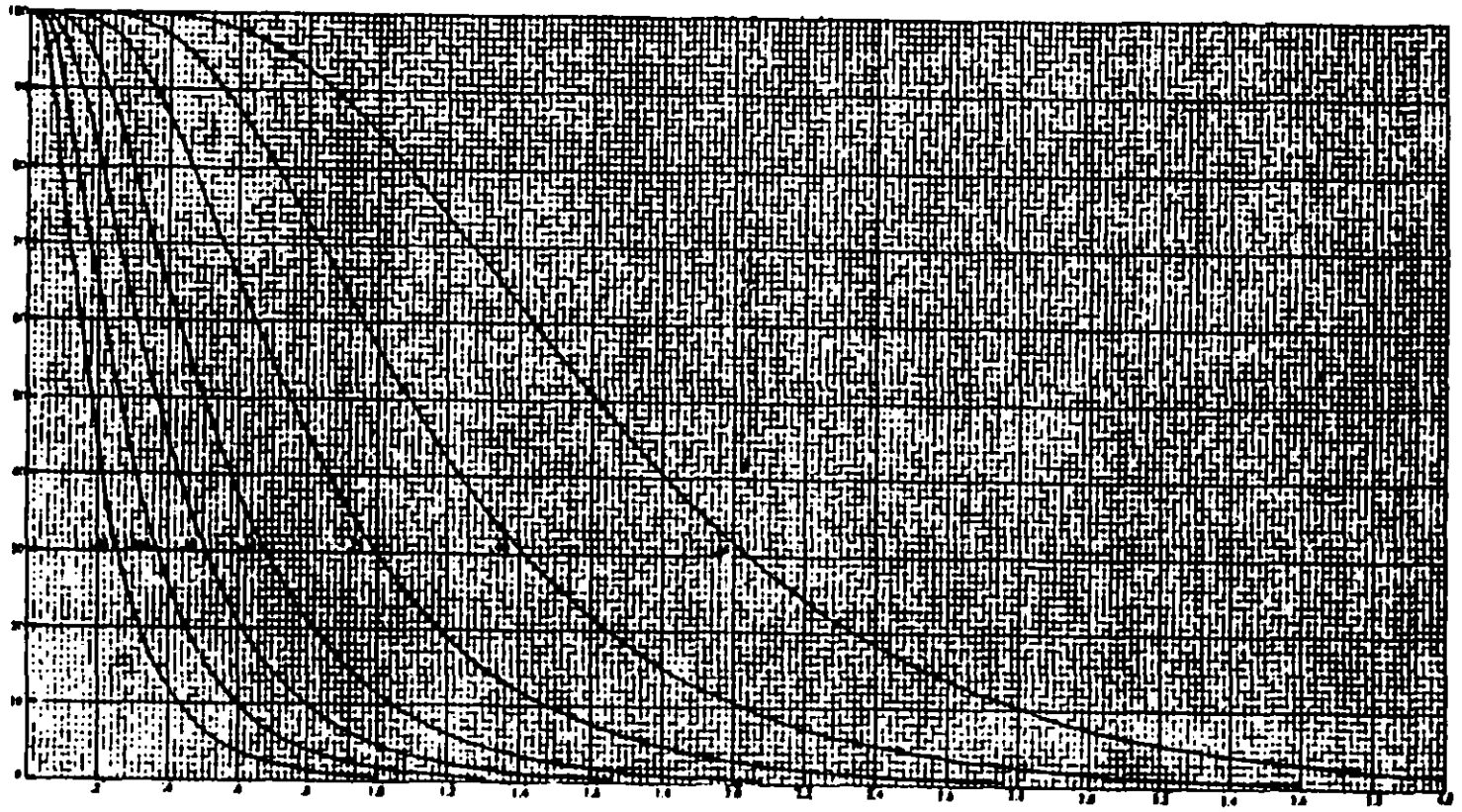
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

O

(Curves for sampling plans based on range method and known variability are essentially equivalent)



PERCENT OF LOTS EXPECTED TO BE ACCEPTED

The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

QUALITY OF SUBMITTED LOTS (in percent defective)

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

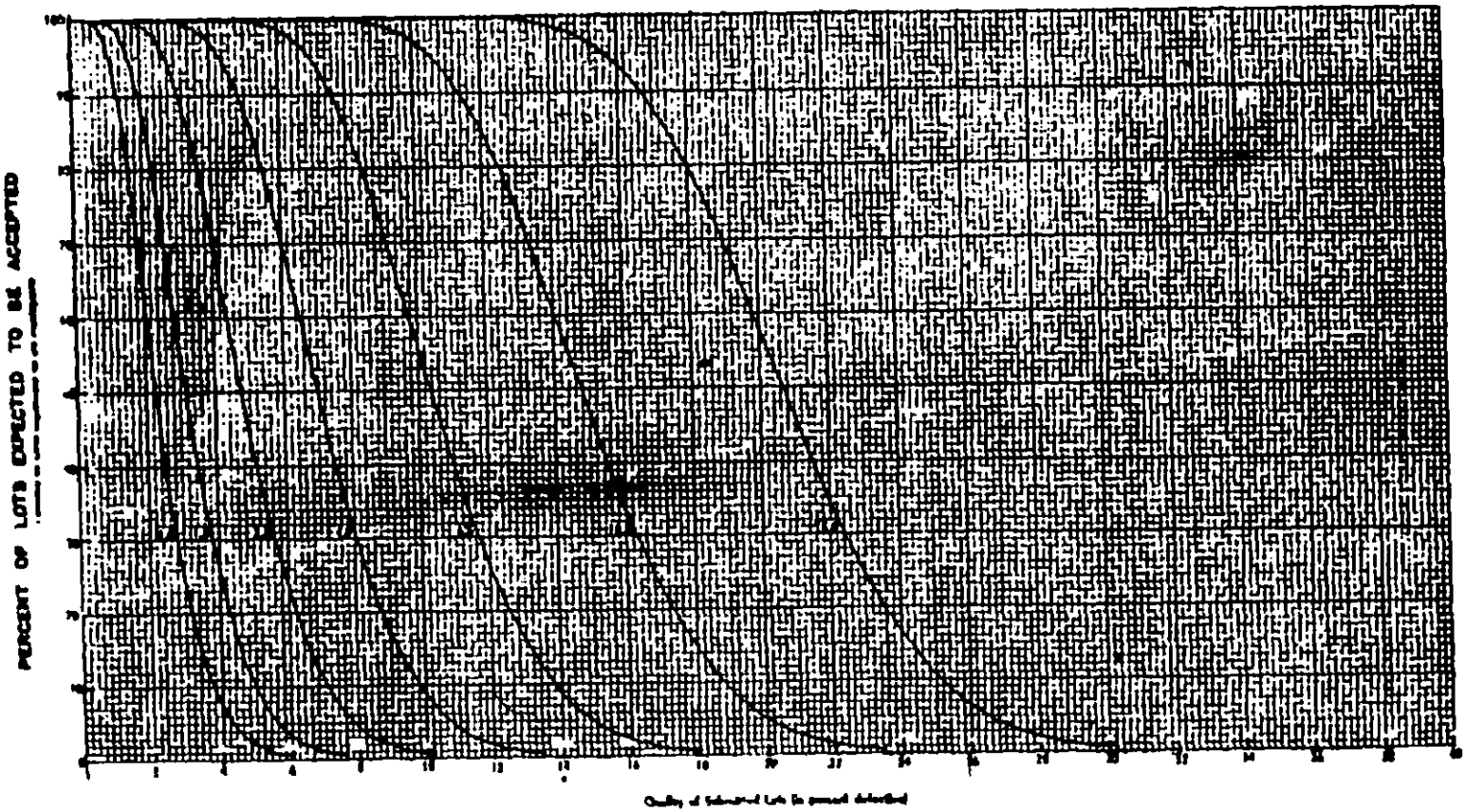
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

O (Continued)

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

QUALITY OF SUBMITTED LOTS (In percent defective)

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

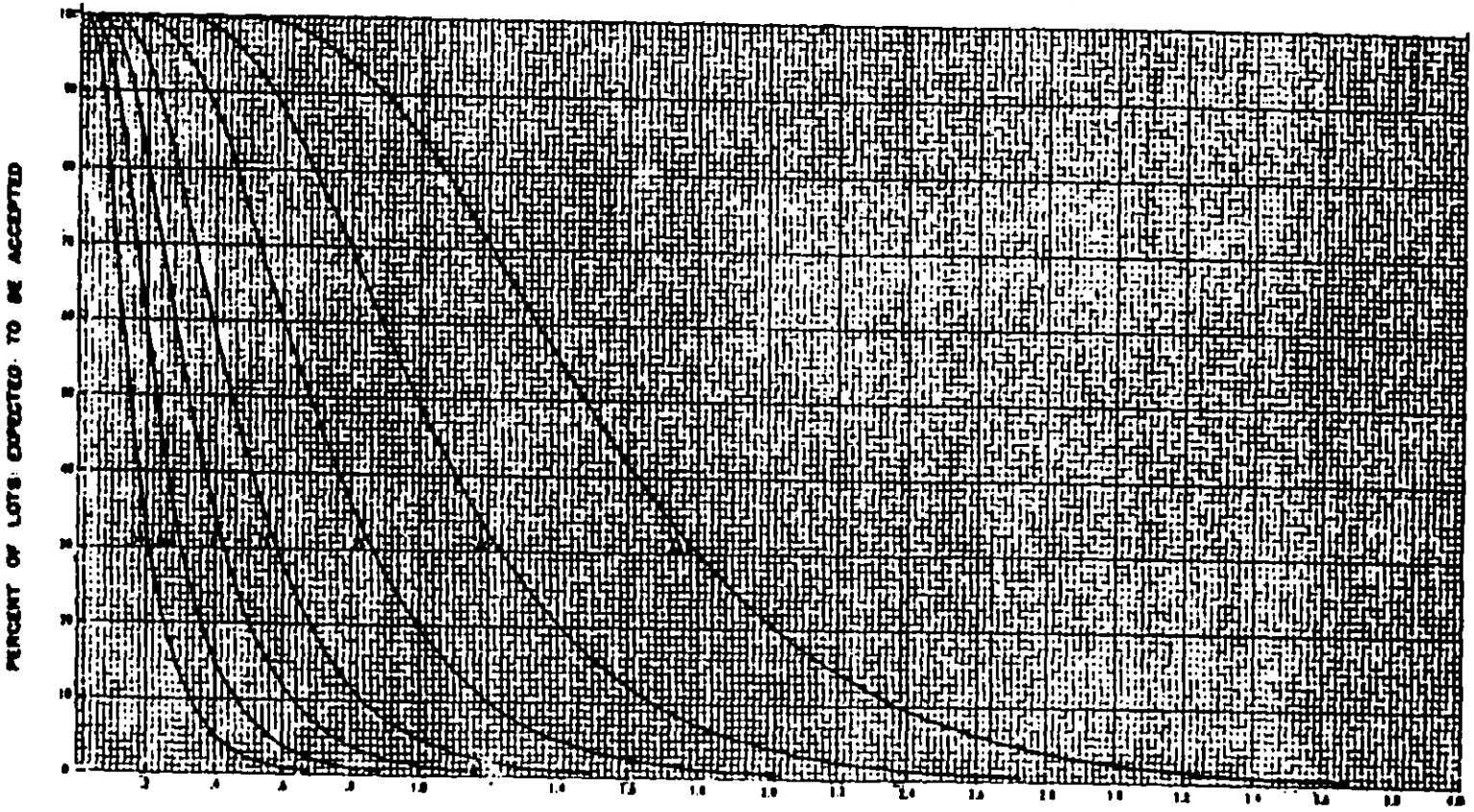
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

P

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

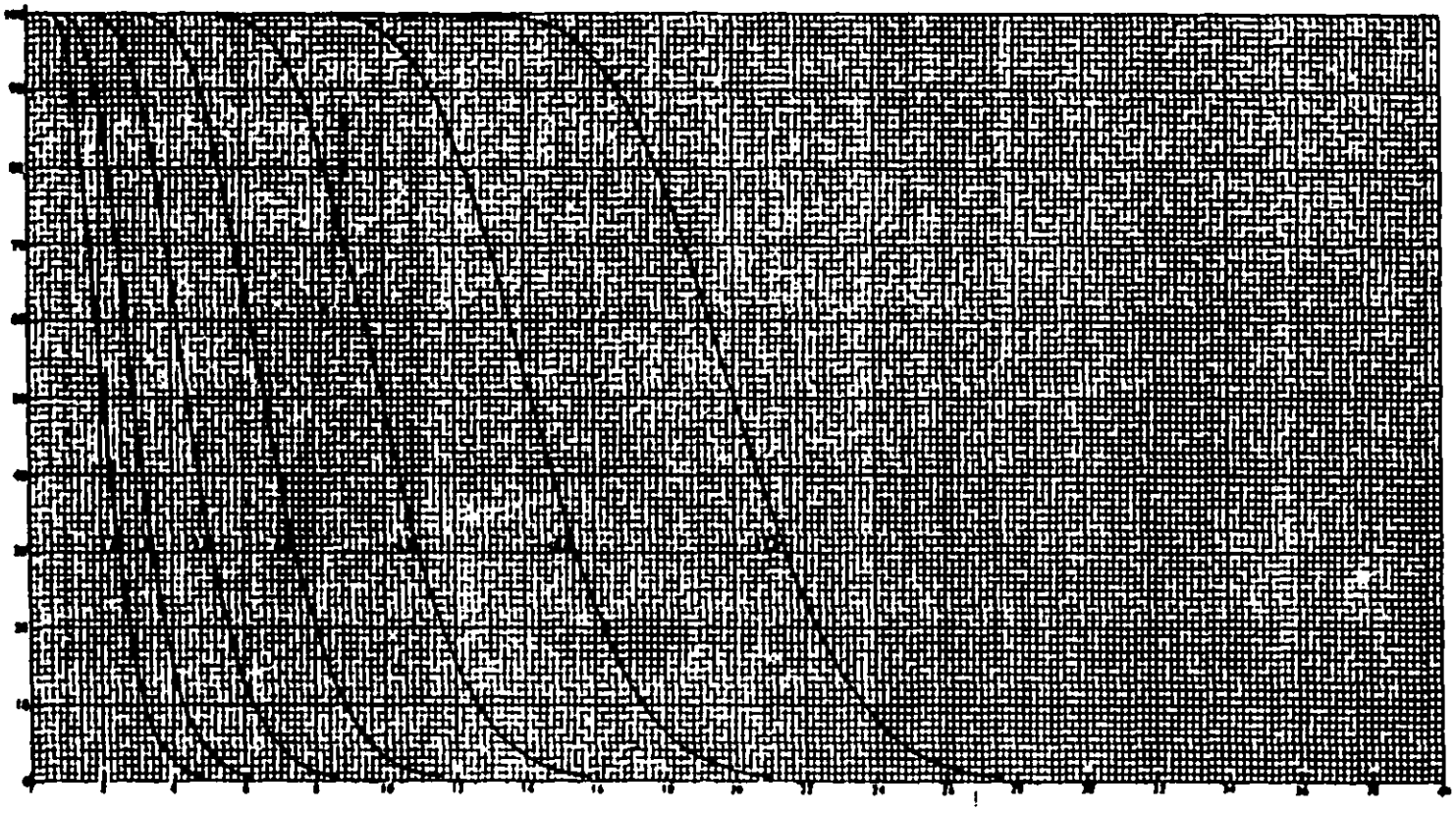
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

P (Continued)

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

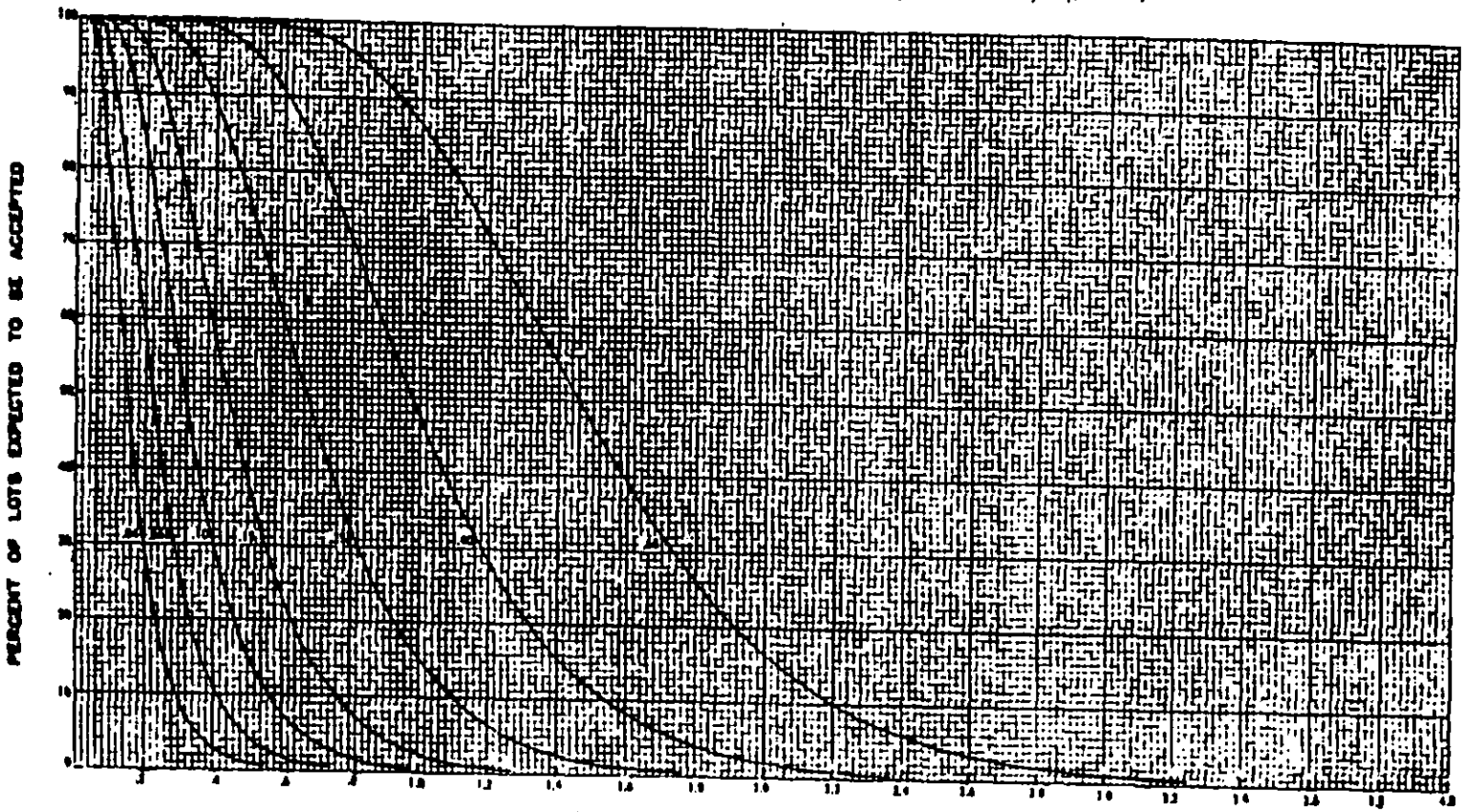
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

Q

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are obtained at random from a normal distribution.

QUALITY OF SUBMITTED LOTS (In percent defective)

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

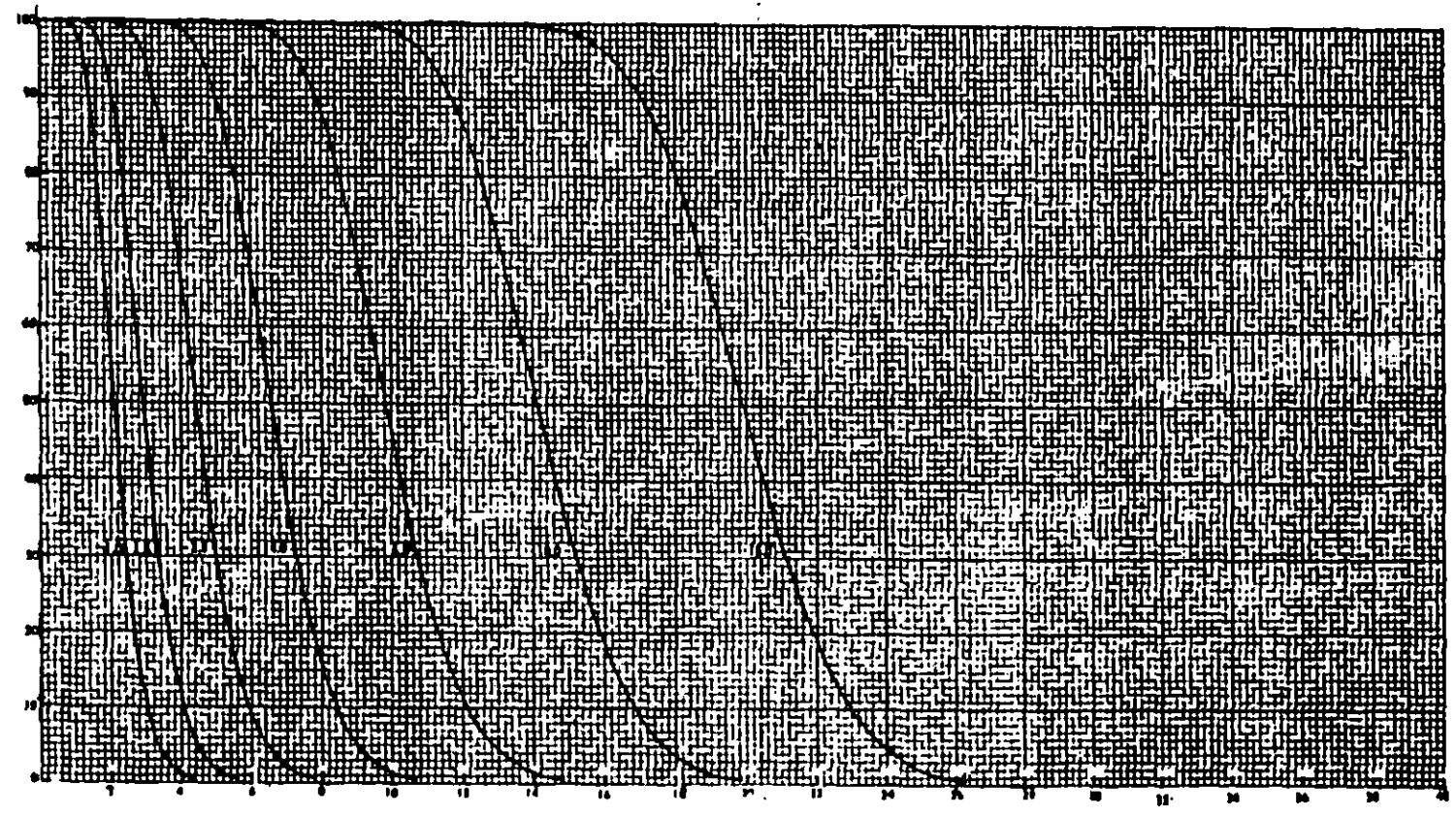
TABLE A-3

OPERATING CHARACTERISTIC CURVES FOR SAMPLING PLANS BASED ON STANDARD DEVIATION METHOD

SAMPLE SIZE CODE LETTER

Q (Continued)

(Curves for sampling plans based on range method and known variability are essentially equivalent)



The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

Note: Figures on curves are Acceptable Quality Levels for normal inspection.

SECTION B

VARIABILITY UNKNOWN—STANDARD DEVIATION METHOD

Part I

SINGLE SPECIFICATION LIMIT

B1. SAMPLING PLAN FOR SINGLE SPECIFICATION LIMIT

This part of the Standard describes the procedures for use with plans for a single specification limit when variability of the lot with respect to the quality characteristic is unknown and the standard deviation method is used. The acceptability criterion is given in two equivalent forms. These are identified as Form 1 and Form 2.

B1.1 Use of Sampling Plans. To determine whether the lot meets the acceptability criterion with respect to a particular quality characteristic and AQL value, the applicable sampling plan shall be used in accordance with the provisions of Section A, General Description of Sampling Plans, and those in this part of the Standard.

B1.2 Drawing of Samples. All samples shall be drawn in accordance with paragraph A7.2.

B1.3 Determination of Sample Size Code Letter. The sample size code letter shall be selected from Table A-2 in accordance with paragraph A7.1.

B2. SELECTING THE SAMPLING PLAN WHEN FORM 1 IS USED

B2.1 Master Sampling Tables. The master sampling tables for plans based on variability unknown for a single specification limit when using the standard deviation method are Tables B-1 and B-2. Table B-1 is used for normal and tightened inspection and Table B-2 for reduced inspection.

B2.2 Obtaining the Sampling Plan. The sampling plan consists of a sample size and an associated acceptability constant.[1] The sampling plan is obtained from Master Table B-1 or B-2.

B2.2.1 Sample Size. The sample size n is shown in the master table corresponding to each sample size code letter.

B2.2.2 Acceptability Constant. The acceptability constant k, corresponding to the sample size mentioned in paragraph B2.2.1, is indicated in the column of the master table corresponding to the applicable AQL value. Table B-1 is entered from the top for normal inspection and from the bottom for tightened inspection. Sampling plans for reduced inspection are provided in Table B-2.

B3. LOT-BY-LOT ACCEPTABILITY PROCEDURES WHEN FORM 1 IS USED[2]

B3.1 Acceptability Criterion. The degree of conformance of a quality characteristic with respect to a single specification limit shall be judged by the quantity $(U-\bar{X})/s$ or $(\bar{X}-L)/s$.

B3.2 Computation. The following quantity shall be computed: $(U-\bar{X})/s$ or $(\bar{X}-L)/s$, depending on whether the specification limit is an upper or lower limit, where

U is the upper specification limit,
L is the lower specification limit,
$\bar{X}$ is the sample mean, and
s is the estimate of lot standard deviation.

B3.3 Acceptability Criterion. Compare the quantity $(U-\bar{X})/s$ or $(\bar{X}-L)/s$ with the acceptability constant k. If $(U-\bar{X})/s$ or $(\bar{X}-L)/s$ is equal to or greater than k, the lot meets the acceptability criterion; if $(U-\bar{X})/s$ or $(\bar{X}-L)/s$ is less than k or negative, then the lot does not meet the acceptability criterion.

B4. SUMMARY FOR OPERATION OF SAMPLING PLAN WHEN FORM 1 IS USED

The following steps summarize the procedures to be followed:

(1) Determine the sample size code letter from Table A-2 by using the lot size and inspection level.

[1] See Appendix B for definitions of all symbols used in the sampling plans based on variability unknown-standard deviation method.
[2] See Example B-1 for a complete example of this procedure.

(2) Obtain plan from Master Table B-1 or B-2 by selecting the sample size n and the acceptability constant k.

(3) Select at random the sample of n units from the lot; inspect and record the measurement of the quality characteristic for each unit of the sample.

(4) Compute the sample mean $\bar{X}$ and estimate of lot standard deviation s, and also compute the quantity $(U-\bar{X})/s$ for an upper specification limit U or the quantity $(\bar{X}-L)/s$ for a lower specification limit L.

(5) If the quantity $(U-\bar{X})/s$ or $(\bar{X}-L)/s$ is equal to or greater than k, the lot meets the acceptability criterion; if $(U-\bar{X})/s$ or $(\bar{X}-L)/s$ is less than k or negative, then the lot does not meet the acceptability criterion.

B5. SELECTING THE SAMPLING PLAN WHEN FORM 2 IS USED

B5.1 Master Sampling Tables. The master sampling tables for plans based on variability unknown for a single specification limit when using the standard deviation method are Tables B-3 and B-4 of Part II. Table B-3 is used for normal and tightened inspection and Table B-4 for reduced inspection.

B5.2 Obtaining the Sampling Plan. The sampling plan consists of a sample size and an associated maximum allowable percent defective. The sampling plan is obtained from Master Table B-3 or B-4.

B5.2.1 Sample Size. The sample size n is shown in the master table corresponding to each sample size code letter.

B5.2.2 Maximum Allowable Percent Defective. The maximum allowable percent defective M for sample estimates corresponding to the sample size mentioned in paragraph B5.2.1 is indicated in the column of the master table corresponding to the applicable AQL value. Table B-3 is entered from the top for normal inspection and from the bottom for tightened inspection. Sampling plans for reduced inspection are provided in Table B-4.

B6. LOT-BY-LOT ACCEPTABILITY PROCEDURES WHEN FORM 2 IS USED[3]

B6.1 Acceptability Criterion. The degree of conformance of a quality characteristic with respect to a single specification limit shall be judged by the percent of nonconforming product outside the upper or lower specification limit. The percentage of nonconforming product is estimated by entering Table B-5 with the quality index and the sample size.

B6.2 Computation of Quality Index. The quality index $Q_U = (U-\bar{X})/s$ shall be computed if the specification limit is an upper limit U, or $Q_L = (\bar{X}-L)/s$ if it is a lower limit L. The quantities, $\bar{X}$ and s, are the sample mean and estimate of lot standard deviation, respectively.

B6.3 Estimate of Percent Defective in Lot. The quality of a lot shall be expressed by p_U, the estimated percent defective in the lot above the upper specification limit, or by p_L, the estimated percent defective below the lower specification limit. The estimated percent defective p_U or p_L is obtained by entering Table B-5 with Q_U or Q_L and the appropriate sample size.

B6.4 Acceptability Criterion. Compare the estimated lot percent defective p_U or p_L with the maximum allowable percent defective M. If p_U or p_L is equal to or less than M, the lot meets the acceptability criterion; if p_U or p_L is greater than M or if Q_U or Q_L is negative, then the lot does not meet the acceptability criterion.

B7. SUMMARY FOR OPERATION OF SAMPLING PLAN WHEN FORM 2 IS USED

The following steps summarize the procedures to be followed:

(1) Determine the sample size code letter from Table A-2 by using the lot size and the inspection level.

(2) Obtain plan from Master Table B-3 or B-4 by selecting the sample size n and the maximum allowable percent defective M.

(3) Select at random the sample of n units from the lot; inspect and record the measurement of the quality characteristic on each unit of the sample.

(4) Compute the sample mean $\bar{X}$ and the estimate of lot standard deviation s.

(5) Compute the quality index $Q_U = (U-\bar{X})/s$ if an upper specification limit U is specified, or $Q_L = (\bar{X}-L)/s$ if a lower specification limit L is specified.

(6) Determine the estimated lot percent defective p_U or p_L from Table B-5.

[3] See Example B-2 for a complete example of this procedure.

(7) If the estimated lot percent defective p_U or p_L is equal to or less than the maximum allowable percent defective M, the lot meets the acceptability criterion; if p_U or p_L is greater than M or if Q_U or Q_L is negative, then the lot does not meet the acceptability criterion.

EXAMPLE B-1

Example of Calculations

Single Specification Limit—Form 1

Variability Unknown - Standard Deviation Method

Example The maximum temperature of operation for a certain device is specified as 209° F. A lot of 40 items is submitted for inspection. Inspection Level IV, normal inspection, with AQL = 1% is to be used. From Tables A-2 and B-1 it is seen that a sample of size 5 is required. Suppose the measurements obtained are as follows: 197°, 188°, 184°, 205°, and 201°; and compliance with the acceptability criterion is to be determined.

Line	Information Needed	Value Obtained	Explanation
1	Sample Size: n	5	
2	Sum of Measurements: ΣX	975	
3	Sum of Squared Measurements: ΣX^2	190,435	
4	Correction Factor (CF): $(\Sigma X)^2/n$	190,125	$(975)^2/5$
5	Corrected Sum of Squares (SS): $\Sigma X^2 - CF$	310	190,435 - 190,125
6	Variance (V): $SS/(n-1)$	77.5	310/4
7	Estimate of Lot Standard Deviation s: $\sqrt{V}$	8.81	$\sqrt{77.5}$
8	Sample Mean $\bar{X}$: $\Sigma X/n$	195	975/5
9	Specification Limit (Upper): U	209	
10	The quantity: $(U-\bar{X})/s$	1.59	(209 - 195)/8.81
11	Acceptability Constant: k	1.53	See Table B-1
12	Acceptability Criterion: Compare $(U-\bar{X})/s$ with k	1.59 > 1.53	See Para. B3.3

The lot meets the acceptability criterion, since $(U-\bar{X})/s$ is greater than k.

NOTE: If a single lower specification limit L is given, then compute the quantity $(\bar{X}-L)/s$ in line 10 and compare it with k; the lot meets the acceptability criterion, if $(\bar{X}-L)/s$ is equal to or greater than k.

EXAMPLE B-2

Example of Calculations

Single Specification Limit—Form 2

Variability Unknown - Standard Deviation Method

Example The maximum temperature of operation for a certain device is specified as 209° F. A lot of 40 items is submitted for inspection. Inspection Level IV, normal inspection, with AQL = 1% is to be used. From Tables A-2 and B-1 it is seen that a sample of size 5 is required. Suppose the measurements obtained are as follows: 197°, 188°, 184°, 205°, and 201°; and compliance with the acceptability criterion is to be determined.

Line	Information Needed	Value Obtained	Explanation
1	*Sample Size:* n	5	
2	Sum of Measurements: ΣX	975	
3	Sum of Squared Measurements: ΣX^2	190,435	
4	Correction Factor (CF): $(\Sigma X)^2/n$	190,125	$(975)^2/5$
5	Corrected Sum of Squares (SS): $\Sigma X^2 CF$	310	190,435 - 190,125
6	Variance (V): $SS/(n-1)$	77.5	310/4
7	Estimate of Lot Standard Deviation s: $\sqrt{V}$	8.81	$\sqrt{77.5}$
8	Sample Mean $\bar{X}$: $\Sigma X/n$	195	975/5
9	Specification Limit (Upper): U	209	
10	Quality Index: $Q_U = (U-\bar{X})/s$	1.59	(209-195)/8.81
11	Est. of Lot Percent Def.: p_U	2.19%	See Table B-5
12	Max. Allowable Percent Def.: M	3.32%	See Table B-3
13	Acceptability Criterion: Compare p_U with M	2.19% < 3.32%	See Para. B6.4

The lot meets the acceptability criterion, since p_U is less than M.

NOTE: If a single lower specification limit L is given, then compute the quality index $Q_L = (\bar{X}-L)/s$ in line 10 and obtain the estimate of lot percent defective p_L. Compare p_L with M; the lot meets the acceptability criterion, if p_L is equal to or less than M.

TABLE B-1

Standard Deviation Method

Master Table For Normal and Tightened Inspection for Plans Based on Variability Unknown
(Single Specification Limit—Form 1)

Sample size code letter	Sample size	Acceptable Quality Levels (normal inspection)													
		.04	.065	.10	.15	.25	.40	.65	1.00	1.50	2.50	4.00	6.50	10.00	15.00
		k	k	k	k	k	k	k	k	k	k	k	k	k	k
B	3	↓	↓	↓	↓	↓	↓	↓	▼	▼	1.12	.958	.765	.566	.341
C	4								1.45	1.34	1.17	1.01	.814	.617	.393
D	5					↓	↓	1.65	1.53	1.40	1.24	1.07	.874	.675	.455
E	7				↓	2.00	1.88	1.75	1.62	1.50	1.33	1.15	.955	.755	.536
F	10	↓	↓	↓	2.24	2.11	1.98	1.84	1.72	1.58	1.41	1.23	1.03	.828	.611
G	15	2.64	2.53	2.42	2.32	2.20	2.06	1.91	1.79	1.65	1.47	1.30	1.09	.886	.664
H	20	2.69	2.58	2.47	2.36	2.24	2.11	1.96	1.82	1.69	1.51	1.33	1.12	.917	.695
I	25	2.72	2.61	2.50	2.40	2.26	2.14	1.98	1.85	1.72	1.53	1.35	1.14	.936	.712
J	30	2.73	2.61	2.51	2.41	2.28	2.15	2.00	1.86	1.73	1.55	1.36	1.15	.946	.723
K	35	2.77	2.65	2.54	2.45	2.31	2.18	2.03	1.89	1.76	1.57	1.39	1.18	.969	.745
L	40	2.77	2.66	2.55	2.44	2.31	2.18	2.03	1.89	1.76	1.58	1.39	1.18	.971	.746
M	50	2.83	2.71	2.60	2.50	2.35	2.22	2.08	1.93	1.80	1.61	1.42	1.21	1.00	.774
N	75	2.90	2.77	2.66	2.55	2.41	2.27	2.12	1.98	1.84	1.65	1.46	1.24	1.03	.804
O	100	2.92	2.80	2.69	2.58	2.43	2.29	2.14	2.00	1.86	1.67	1.48	1.26	1.05	.819
P	150	2.96	2.84	2.73	2.61	2.47	2.33	2.18	2.03	1.89	1.70	1.51	1.29	1.07	.841
Q	200	2.97	2.85	2.73	2.62	2.47	2.33	2.18	2.04	1.89	1.70	1.51	1.29	1.07	.845
		.065	.10	.15	.25	.40	.65	1.00	1.50	2.50	4.00	6.50	10.00	15.00	
		Acceptable Quality Levels (tightened inspection)													

All AQL values are in percent defective.

↓ Use first sampling plan below arrow, that is, both sample size as well as k value. When sample size equals or exceeds lot size, every item in the lot must be inspected.

TABLE B-2

Standard Deviation Method

Master Table for Reduced Inspection for Plans Based on Variability Unknown
(Single Specification Limit—Form 1)

Sample size code letter	Sample size	Acceptable Quality Levels											
		.04	.065	.10	.15	.25	.40	.65	1.00	1.50	2.50	4.00	6.50	10.00
		k	k	k	k	k	k	k	k	k	k	k	k	k
B	3	↓	↓	↓	↓	↓	↓	↓	↓	1.12	.958	.765	.566	.341
C	3									1.12	.958	.765	.566	.341
D	3									1.12	.958	.765	.566	.341
E	3							↓	↓	1.12	.958	.765	.566	.341
F	4						↓	1.45	1.34	1.17	1.01	.814	.617	.393
G	5				↓	↓	1.65	1.53	1.40	1.24	1.07	.874	.675	.455
H	7			↓	2.00	1.88	1.75	1.62	1.50	1.33	1.15	.955	.755	.536
I	10			2.24	2.11	1.98	1.84	1.72	1.58	1.41	1.23	1.03	.828	.611
J	10	↓	↓	2.24	2.11	1.98	1.84	1.72	1.58	1.41	1.23	1.03	.828	.611
K	15	2.53	2.42	2.32	2.20	2.06	1.91	1.79	1.65	1.47	1.30	1.09	.886	.664
L	20	2.58	2.47	2.36	2.24	2.11	1.96	1.82	1.69	1.51	1.33	1.12	.917	.695
M	20	2.58	2.47	2.36	2.24	2.11	1.96	1.82	1.69	1.51	1.33	1.12	.917	.695
N	25	2.61	2.50	2.40	2.26	2.14	1.98	1.85	1.72	1.53	1.35	1.14	.936	.712
O	30	2.61	2.51	2.41	2.28	2.15	2.00	1.86	1.73	1.55	1.36	1.15	.946	.723
P	50	2.71	2.60	2.50	2.35	2.22	2.08	1.93	1.80	1.61	1.42	1.21	1.00	.774
Q	75	2.77	2.66	2.55	2.41	2.27	2.12	1.98	1.84	1.65	1.46	1.24	1.03	.804

All AQL values are in percent defective.

↓ Use first sampling plan below arrow, that is, both sample size as well as k value. When sample size equals or exceeds lot size, every item in the lot must be inspected.

Part II

DOUBLE SPECIFICATION LIMIT

B8. SAMPLING PLAN FOR DOUBLE SPECIFICATION LIMIT

This part of the Standard describes the procedures for use with plans for a double specification limit when variability of the lot with respect to the quality characteristic is unknown and the standard deviation method is used.

B8.1 Use of Sampling Plans. To determine whether the lot meets the acceptability criterion with respect to a particular quality characteristic and AQL value(s) the applicable sampling plan shall be used in accordance with the provisions of Section A, General Description of Sampling Plans, and those in this part of the Standard.

B9. SELECTING THE SAMPLING PLAN

A sampling plan for each AQL value shall be selected from Table B-3 or B-4 as follows:

B9.1 Determination of Sample Size Code Letter. The sample size code letter shall be selected from Table A-2 in accordance with paragraph A7.1.

B9.2 Master Sampling Tables. The master sampling tables for plans based on variability unknown for a double specification limit when using the standard deviation method are Tables B-3 and B-4. Table B-3 is used for normal and tightened inspection and Table B-4 for reduced inspection.

B9.3 Obtaining Sampling Plan. A sampling plan consists of a sample size and the associated maximum allowable percent defective(s). The sampling plan to be applied in inspection shall be obtained from Master Table B-3 or B-4.

B9.3.1 Sample Size. The sample size n is shown in the master tables corresponding to each sample size code letter.

B9.3.2 Maximum Allowable Percent Defective. The maximum allowable percent defective for sample estimates of percent defective for the lower, upper, or both specification limits combined, corresponding to the sample size mentioned in paragraph B9.3.1, is shown in the column of the master table corresponding to the applicable AQL value(s). If different AQL's are assigned to each specification limit, designate the maximum allowable percent defective by M_L for the lower limit, and by M_U for the upper limit. If one AQL is assigned to both limits combined, designate the maximum allowable percent defective by M. Table B-3 is entered from the top for normal inspection and from the bottom for tightened inspection. Sampling plans for reduced inspection are provided in Table B-4.

B10. DRAWING OF SAMPLES

Samples shall be selected in accordance with paragraph A7.2.

B11. LOT-BY-LOT ACCEPTABILITY PROCEDURES

B11.1 Acceptability Criterion. The degree of conformance of a quality characteristic with respect to a double specification limit shall be judged by the percent of nonconforming product. The percentage of nonconforming product is estimated by entering Table B-5 with the quality index and the sample size.

B11.2 Computation of Quality Indices. The quality indices $Q_U = (U-\bar{X})/s$ and $Q_L = (\bar{X}-L)/s$ shall be computed, where

U is the upper specification limit,
L is the lower specification limit,
$\bar{X}$ is the sample mean, and
s is the estimate of lot standard deviation.

B11.3 Percent Defective in the Lot. The quality of a lot shall be expressed in terms of the lot percent defective. Its estimate will be designated by p_L, p_U, or p. The estimate p_U indicates conformance with respect to the upper specification limit, p_L with respect to the lower specification limit, and p for both specification limits combined. The estimates p_L and p_U shall be determined by entering Table B-5, respectively with Q_L and Q_U and the sample size. The estimate p shall be determined by adding the corresponding estimated percent defectives p_L and p_U found in the table.

B12. ACCEPTABILITY CRITERION AND SUMMARY FOR OPERATION OF SAMPLING PLANS

B12.1 One AQL value for both Upper and Lower Specification Limit Combined.

B12.1.1 Acceptability Criterion.[4] Compare the estimated lot percent defective $p = p_U + p_L$ with the maximum allowable percent defective M. If p is equal to or less than M, the lot meets the acceptability criterion; if p is greater than M or if either Q_U or Q_L or both are negative, then the lot does not meet the acceptability criterion.

B12.1.2 Summary for Operation of Sampling Plan. In cases where a single AQL value is established for the upper and lower specification limit combined for a single quality characteristic, the following steps summarize the procedures to be used:

(1) Determine the sample size code letter from Table A-2 by using the lot size and the inspection level.

(2) Select plan from Master Table B-3 or B-4. Obtain the sample size n and the maximum allowable percent defective M.

(3) Select at random the sample of n units from the lot; inspect and record the measurement of the quality characteristic on each unit of the sample.

(4) Compute the sample mean $\bar{X}$ and estimate of lot standard deviation s.

(5) Compute the quality indices $Q_U = (U-\bar{X})/s$ and $Q_L = (\bar{X}-L)/s$.

(6) Determine the estimated lot percent defective $p = p_U + p_L$ from Table B-5.

(7) If the estimated lot percent defective p is equal to or less than the maximum allowable percent defective M, the lot meets the acceptability criterion; if p is greater than M or if either Q_U or Q_L or both are negative, then the lot does not meet the acceptability criterion.

B12.2 Different AQL Values for Upper and Lower Specification Limit.

B12.2.1 Acceptability Criteria.[5] Compare the estimated lot percent defectives p_L and p_U with the corresponding maximum allowable percent defectives M_L and M_U; also compare $p = p_L + p_U$ with the larger of M_L and M_U. If p_L is equal to or less than M_L, p_U is equal to or less than M_U, and p is equal to or less than the larger of M_L and M_U, the lot meets the acceptability criteria; otherwise, the lot does not meet the acceptability criteria. If either Q_L or Q_U or both are negative, then the lot does not meet the acceptability criteria.

B12.2.2 Summary for Operation of Sampling Plan. In cases where a different AQL value is established for the upper and lower specification limit for a single quality characteristic, the following steps summarize the procedures to be used:

(1) Determine the sample size code letter from Table A-2 by using the lot size and inspection level.

(2) Select the sampling plan from Master Table B-3 or B-4. Obtain the sample size n and the maximum allowable percent defectives M_U and M_L, corresponding to the AQL values for the upper and lower specification limits, respectively.

(3) Select at random the sample of n units from the lot; inspect and record the measurement of the quality characteristic on each unit in the sample.

(4) Compute the sample mean $\bar{X}$ and estimate a lot standard deviation s.

(5) Compute the quality indices $Q_U = (U-\bar{X})/s$ and $Q_L = (\bar{X}-L)/s$.

(6) Determine the estimated lot percent defectives p_U and p_L, corresponding to the percent defectives above the upper and below the lower specification limits. Also determine the combined percent defective $p = pU + p_L$.

(7) If all three of the following conditions:

(a) p_U is equal to or less than M_U,

(b) p_L is equal to or less than M_L,

(c) p is equal to or less than the larger of M_L and M_U,

are satisfied, the lot meets the acceptability criteria; otherwise the lot does not meet the acceptability criteria. If either Q_L or Q_U or both are negative, then the lot does not meet the acceptability criteria.

[4] See Example B-3 for a complete example of this procedure.
[5] See Example B-4 for a complete example of this procedure.

EXAMPLE B-3

Example of Calculations

Double Specification Limit

Variability Unknown - Standard Deviation Method

One AQL Value for both Upper and Lower Specification Limit Combined

Example The minimum temperature of operation for a certain device is specified as 180° F. The maximum temperature is 209° F. A lot of 40 items is submitted for inspection. Inspection Level IV, normal inspection, with AQL = 1% is to be used. From Tables A-2 and B-3 it is seen that a sample of size 5 is required. Suppose the measurements obtained are as follows: 197°, 188°, 184°, 205°, and 201°; and compliance with the acceptability criterion is to be determined.

Line	Information Needed	Value Obtained	Explanation
1	Sample Size: n	5	
2	Sum of Measurements: ΣX	975	
3	Sum of Squared Measurements: ΣX^2	190,435	
4	Correction Factor (CF): $(\Sigma X)^2/n$	190,125	$(975)^2/5$
5	Corrected Sum of Squares (SS): $\Sigma X^2 - CF$	310	190,435-190,125
6	Variance (V): $SS/(n-1)$	77.5	310/4
7	*Estimate of Lot Standard Deviation* s: $\sqrt{V}$	8.81	$\sqrt{77.5}$
8	Sample Mean $\bar{X}$: $\Sigma X/n$	195	975/5
9	Upper Specification Limit: U	209	
10	Lower Specification Limit: L	180	
11	Quality Index: $Q_U = (U-\bar{X})/s$	1.59	(209-195)/8.81
12	Quality Index: $Q_L = (\bar{X}-L)/s$	1.70	(195-180)/8.81
13	Est. of Lot Percent Def. above U: p_U	2.19%	See Table B-5
14	Est. of Lot Percent Def. below L: p_L	.66%	See Table B-5
15	Total Est. Percent Def. in Lot: $p = p_U + p_L$	2.85%	2.19% + .66%
16	Max. Allowable Percent Def.: M	3.32%	See Table B-3
17	Acceptability Criterion: Compare $p = p_U + p_L$ with M	2.85% < 3.32%	See Para. B12.1.2 (7)

The lot meets the acceptability criterion, since $p = p_U + p_L$ is less than M.

EXAMPLE B-4

Example of Calculations

Double Specification Limit

Variability Unknown - Standard Deviation Method

Different AQL Values for Upper and Lower Specification Limits

Example The minimum temperature of operation for a certain device is specified as 180° F. The maximum temperature is 209° F. A lot of 40 items is submitted for inspection. Inspection Level IV, normal inspection, with AQL = 1% for the upper and AQL = 2.5% for the lower specification limit is to be used. From Tables A-2 and B-3 it is seen that a sample of size 5 is required. Suppose the measurements obtained are as follows: 197°, 188°, 184°, 205°, and 201°; and compliance with the acceptability criteria is to be determined.

Line	Information Needed	Value Obtained	Explanation
1	Sample Size: n	5	
2	Sum of Measurements: ΣX	975	
3	Sum of Squared Measurements: ΣX^2	190,435	
4	Correction Factor (CF): $(\Sigma X)^2/n$	190,125	$(975)^2/5$
5	Corrected Sum of Squares (SS): $\Sigma X^2 - CF$	310	190,435-190,125
6	Variance (V): $SS/(n-1)$	77.5	310/4
7	Estimate of Lot Standard Deviation s: $\sqrt{V}$	8.81	$\sqrt{77.5}$
8	Sample Mean $\bar{X}$: $\Sigma X/n$	195	975/5
9	Upper Specification Limit: U	209	
10	Lower Specification Limit: L	180	
11	Quality Index: $Q_U = (U-\bar{X})/s$	1.59	(209-195)/8.81
12	Quality Index: $Q_L = (\bar{X}-L)/s$	1.70	(195-180)/8.81
13	Est. of Lot Percent Def. above U: p_U	2.19%	See Table B-5
14	Est. of Lot Percent Def. below L: p_L	.66%	See Table B-5
15	Total Est. Percent Def. in Lot: $p = p_U + p_L$	2.85%	2.19% + .66%
16	Max. Allowable Percent Def. above U: M_U	3.32%	See Table B-3
17	Max. Allowable Percent Def. below L: M_L	9.80%	See Table B-3
18	Acceptability Criteria: (a) Compare p_U with M_U	2.19% < 3.32%	See Para. B12.2.2(7)(a)
	(b) Compare p_L with M_L	.66% < 9.80%	See Para. B12.2.2(7)(b)
	(c) Compare p with M_L	2.85% < 9.80%	See Para. B12.2.2(7)(c)

The lot meets the acceptability criteria, since 18(a), (b), and (c) are satisfied; i.e., $p_U < M_U$, $p_L < M_L$ and $p < M_L$.

TABLE B-3

Master Table for Normal and Tightened Inspection for Plans Based on Variability Unknown
(Double Specification Limit and Form 2—Single Specification Limit)

Sample size code letter	Sample size	Acceptable Quality Levels (normal inspection)													
		.04	.065	.10	.15	.25	.40	.65	1.00	1.50	2.50	4.00	6.50	10.00	15.00
		M	M	M	M	M	M	M	M	M	M	M	M	M	M
B	3	↓	↓	↓	↓	↓	↓	↓	▼	▼	7.59	18.86	26.94	33.69	40.47
C	4	↓	↓	↓	↓	↓	↓	↓	1.53	5.50	10.92	16.45	22.86	29.45	36.90
D	5	↓	↓	↓	↓	↓	↓	1.33	3.32	5.83	9.80	14.39	20.19	26.56	33.99
E	7	↓	↓	↓	↓	0.422	1.06	2.14	3.55	5.35	8.40	12.20	17.35	23.29	30.50
F	10	↓	↓	↓	0.349	0.716	1.30	2.17	3.26	4.77	7.29	10.54	15.17	20.74	27.57
G	15	0.099	0.186	0.312	0.503	0.818	1.31	2.11	3.05	4.31	6.56	9.46	13.71	18.94	25.61
H	20	0.135	0.228	0.365	0.544	0.846	1.29	2.05	2.95	4.09	6.17	8.92	12.99	18.03	24.53
I	25	0.155	0.250	0.380	0.551	0.877	1.29	2.00	2.86	3.97	5.97	8.63	12.57	17.51	23.97
J	30	0.179	0.280	0.413	0.581	0.879	1.29	1.98	2.83	3.91	5.86	8.47	12.36	17.24	23.58
K	35	0.170	0.264	0.388	0.535	0.847	1.23	1.87	2.68	3.70	5.57	8.10	11.87	16.65	22.91
L	40	0.179	0.275	0.401	0.566	0.873	1.26	1.88	2.71	3.72	5.58	8.09	11.85	16.61	22.86
M	50	0.163	0.250	0.363	0.503	0.789	1.17	1.71	2.49	3.45	5.20	7.61	11.23	15.87	22.00
N	75	0.147	0.228	0.330	0.467	0.720	1.07	1.60	2.29	3.20	4.87	7.15	10.63	15.13	21.11
O	100	0.145	0.220	0.317	0.447	0.689	1.02	1.53	2.20	3.07	4.69	6.91	10.32	14.75	20.66
P	150	0.134	0.203	0.293	0.413	0.638	0.949	1.43	2.05	2.89	4.43	6.57	9.88	14.20	20.02
Q	200	0.135	0.204	0.294	0.414	0.637	0.945	1.42	2.04	2.87	4.40	6.53	9.81	14.12	19.92
		.065	.10	.15	.25	.40	.65	1.00	1.50	2.50	4.00	6.50	10.00	15.00	
		Acceptability Quality Levels (tightened inspection)													

All AQL and table values are in percent defective.

↓ Use first sampling plan below arrow, that is, both sample size as well as M value. When sample size equals or exceeds lot size, every item in the lot must be inspected.

TABLE B-4

Standard Deviation Method

Master Table for Reduced Inspection for Plans Based on Variability Unknown
(Double Specification Limit and Form 2—Single Specification Limit)

Sample size code letter	Sample size	Acceptable Quality Levels												
		.04	.065	.10	.15	.25	.40	.65	1.00	1.50	2.50	4.00	6.50	10.00
		M	M	M	M	M	M	M	M	M	M	M	M	M
B	3	↓	↓	↓	↓	↓	↓	↓	↓	7.59	18.86	26.94	33.69	40.47
C	3	↓	↓	↓	↓	↓	↓	↓	↓	7.59	18.86	26.94	33.69	40.47
D	3	↓	↓	↓	↓	↓	↓	↓	↓	7.59	18.86	26.94	33.69	40.47
E	3	↓	↓	↓	↓	↓	↓	↓	↓	7.59	18.86	26.94	33.69	40.47
F	4	↓	↓	↓	↓	↓	↓	1.53	5.50	10.92	16.45	22.86	29.45	36.90
G	5	↓	↓	↓	↓	↓	1.33	3.32	5.83	9.80	14.39	20.19	26.56	33.99
H	7	↓	↓	↓	0.422	1.06	2.14	3.55	5.35	8.40	12.20	17.35	23.29	30.50
I	10	↓	↓	0.349	0.716	1.30	2.17	3.26	4.77	7.29	10.54	15.17	20.74	27.57
J	10	↓	↓	0.349	0.716	1.30	2.17	3.26	4.77	7.29	10.54	15.17	20.74	27.57
K	15	0.186	0.312	0.503	0.818	1.31	2.11	3.05	4.31	6.56	9.46	13.71	18.94	25.61
L	20	0.228	0.365	0.544	0.846	1.29	2.05	2.95	4.09	6.17	8.92	12.99	18.03	24.53
M	20	0.228	0.365	0.544	0.846	1.29	2.05	2.95	4.09	6.17	8.92	12.99	18.03	24.53
N	25	0.250	0.380	0.551	0.877	1.29	2.00	2.86	3.97	5.97	8.63	12.57	17.51	23.97
O	30	0.280	0.413	0.581	0.879	1.29	1.98	2.83	3.91	5.86	8.47	12.36	17.24	23.58
P	50	0.250	0.363	0.503	0.789	1.17	1.71	2.49	3.45	5.20	7.61	11.23	15.87	22.00
Q	75	0.228	0.330	0.467	0.720	1.07	1.60	2.29	3.20	4.87	7.15	10.63	15.13	21.11

All AQL and table values are in percent defective.

↓ Use first sampling plan below arrow, that is, both sample size as well as M value. When sample size equals or exceeds lot size, every item in the lot must be inspected.

TABLE B-5

Table for Estimating the Lot Percent Defective Using Standard Deviation Method[1]

TABLE B-5—Continued

Table for Estimating the Lot Percent Defective Using Standard Deviation Method

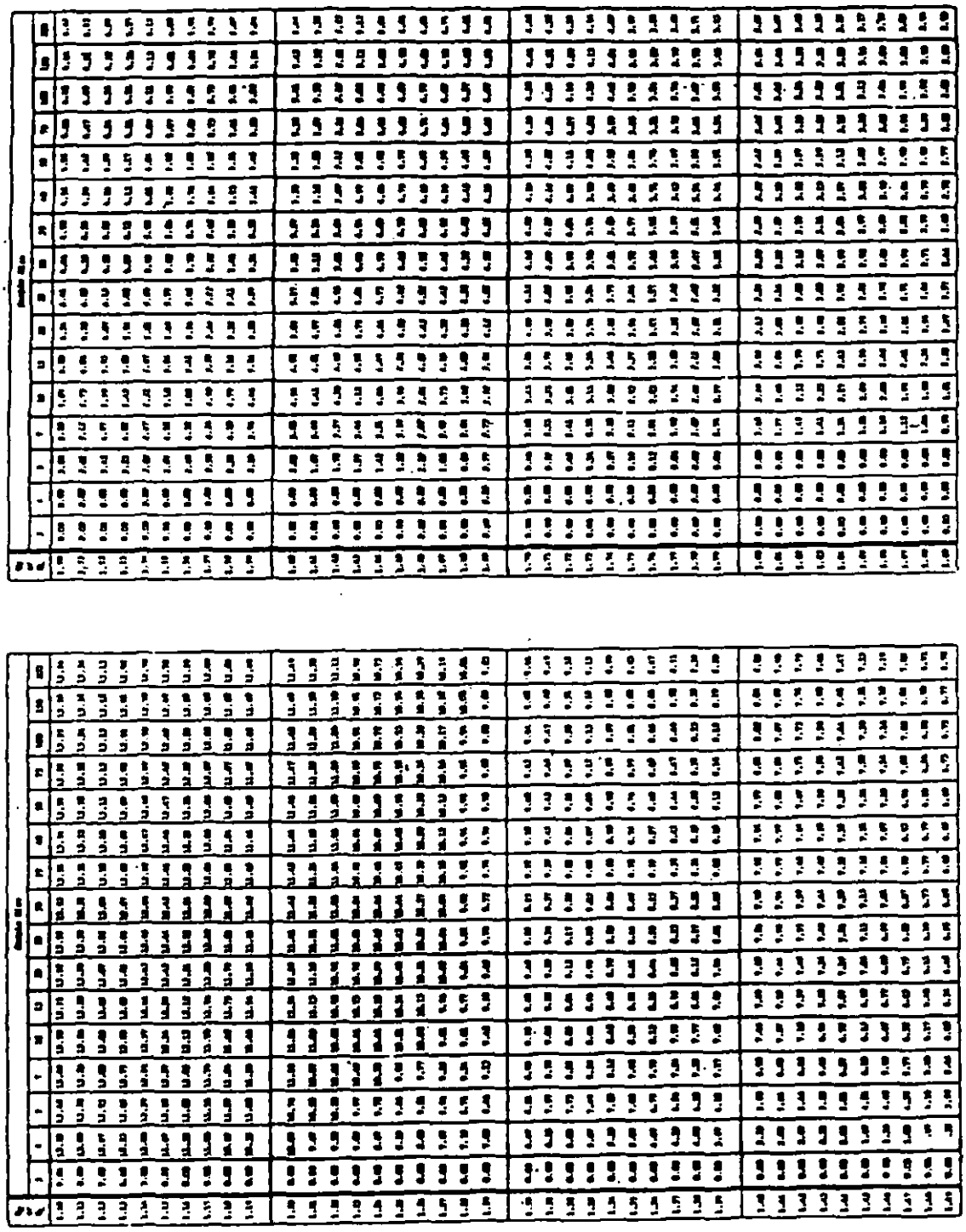


TABLE B-5—Continued

Table for Estimating the Lot Percent Defective Using Standard Deviation Method

TABLE B-5—Continued

Table for Estimating the Lot Percent Defective Using Standard Deviation Method

TABLE B-5—Continued

Table for Estimating the Lot Percent Defective Using Standard Deviation Method

Part III

ESTIMATION OF PROCESS AVERAGE AND CRITERIA FOR REDUCED AND TIGHTENED INSPECTION

B13. ESTIMATION OF PROCESS AVERAGE

The average percent defective, based upon a group of lots submitted for original inspection, is called the process average. Original inspection is the first inspection of a particular quantity of product submitted for acceptability as distinguished from the inspection of product which has been resubmitted after prior rejection. The process average shall be estimated from the results of inspection of samples drawn from a specified number of preceding lots for the purpose of determining severity of inspection during the course of a contract in accordance with paragraph B14.3. Any lot shall be included only once in estimating the process average. The estimate of the process average is designated by $\bar{p}_U$ when computed with respect to an upper specification limit, by $\bar{p}_L$ when computed with respect to a lower specification limit, and by $\bar{p}$ when computed with respect to a double specification limit.

B13.1 Abnormal Results. The results of inspection of product manufactured under conditions not typical of usual production shall be excluded from the estimated process average.

B13.2 Computation of the Estimated Process Average. The estimated process average is the arithmetic mean of the estimated lot percent defectives computed from the sampling inspection results of the preceding ten (10) lots or as may be otherwise designated. In order to estimate the lot percent defective, the quality indices Q_U and/or Q_L shall be computed for each lot. These are: $Q_U = (U-\bar{X})/s$ and $Q_L = (\bar{X}-L)/s$. (See paragraph B11.2.)

B13.2.1 Single Specification Limit.[6] The estimated lot percent defective shall be determined from Table B-5 for the plans based on the standard deviation method. The quality index Q_U shall be used for the case of an upper specification limit or Q_L for the case of a lower specification limit. Table B-5 is entered with Q_U or Q_L and the sample size, and the corresponding estimated lot percent defective p_U or p_L, respectively, is read from the table. The estimated process average $\bar{p}_U$ is the arithmetic mean of the individual estimated lot percent defectives p_U's. Similarly, the estimated process average $\bar{p}_L$ is the arithmetic mean of the individual estimated lot percent defectives p_L's.

B13.2.2 Double Specification Limit. The estimated lot percent defective shall be determined from Table B-5 for the plans based on the standard deviation method. The quality indices Q_U and Q_L shall be computed. Table B-5 is entered separately with Q_U and Q_L and the sample size, and the corresponding p_U and p_L are read from the table. The estimated lot percent defective is $p = p_U + p_L$. The estimated process average $\bar{p}$ is the arithmetic mean of the individual estimated lot percent defectives p's.

B13.2.3 Special Case. If the quality index Q_U or Q_L is a negative number, then Table B-5 is entered by disregarding the negative sign. However, in this case the estimated lot percent defective above the upper limit or below the lower limit is obtained by subtracting the percentage found in the table from 100%.[7]

B14. NORMAL, TIGHTENED, AND REDUCED INSPECTION

This Standard established sampling plans for normal, tightened, and reduced inspection.

B14.1 At Start of Inspection. Normal inspection shall be used at the start of inspection unless otherwise designated.

B14.2 During Inspection. During the course of inspection, normal inspection shall be used when inspection conditions are such that tightened or reduced inspection is not required in accordance with paragraphs B14.3 and B14.4.

B14.3 Tightened Inspection. Tightened inspection shall be instituted when the estimated process average computed from the

[6] When Form 1—Single Specification Limit is used for the acceptability criterion, the estimate of lot percent defective p_U or p_L is not obtained; in order to estimate the process average, it is necessary to complete paragraphs B6.2 and B6.3 of Form 2.

[7] For example, if $Q_U = -.50$ and $Q_L = 1.60$, using sample size 50, $p_U = 100\% - 30.93\% = 69.07\%$, $p_L = 5.33\%$ and $p = 69.07\% + 5.33\% = 74.40\%$.

preceding ten (10) lots (or such other number of lots designated) in accordance with paragraph B13.2 is greater than the AQL, and when more than a certain number T of these lots have estimates of the percent defective exceeding the AQL. The T values are given in Table B-6 for the process average computed from 5, 10, or 15 lots.[8] Normal inspection shall be reinstated if the estimated process average of lots under tightened inspection is equal to or less than the AQL.

B14.4 Reduced Inspection. Reduced inspection may be instituted provided that all of the following conditions are satisfied:

Condition A. The preceding ten (10) lots (or such other number of lots designated) have been under normal inspection and none has been rejected.

Condition B. The estimated percent defective for each of these preceding lots is less than the applicable lower limit shown in Table B-7; or for certain sampling plans, the estimated lot percent defective is equal to zero for a specified number of consecutive lots (see Table B-7).

Condition C. Production is at a steady rate.

Normal inspection shall be reinstated if any one of the following conditions occurs under reduced inspection.

Condition D. A lot is rejected.

Condition E. The estimated process average is greater than the AQL.

Condition F. Production becomes irregular or delayed.

Condition G. Other conditions as may warrant that normal inspection should be reinstated.

B14.5 Sampling Plans for Tightened or Reduced Inspection. Sampling plans for tightened and reduced inspection are provided in Section B, Parts I and II.

[8] If the sample size code letter is not the same for all samples used, the entry in Table B-6 is determined by the sample size code letter corresponding to the smallest sample size used in any of the lots included in the estimation of the process average.

TABLE B-5 Standard Deviation Method

Values of T for Tightened Inspection

Sample size code letter	Acceptable Quality Levels (in percent defective)														Number of Lots
	.04	.065	.10	.15	.25	.40	.65	1.0	1.5	2.5	4.0	6.5	10.0	15.0	
B	*	*	*	*	*	*	*	*	*	2 4 5	3 5 6	4 6 8	4 7 9	4 8 11	5 10 15
C	*	*	*	*	*	*	*	2 3 5	2 4 6	3 5 7	3 6 8	4 7 9	4 7 10	4 8 11	5 10 15
D	*	*	*	*	*	*	2 4 5	3 4 6	3 5 7	3 6 8	4 6 9	4 7 10	4 7 10	4 8 11	5 10 15
E	*	*	*	*	2 4 5	3 4 6	3 5 6	3 5 7	4 6 8	4 6 9	4 7 9	4 7 10	4 8 11	4 8 11	5 10 15
F	*	*	*	3 4 6	3 5 6	3 5 7	3 6 8	4 6 8	4 6 9	4 7 9	4 7 10	4 8 11	4 8 11	4 8 11	5 10 15
G	3 4 6	3 5 6	3 5 6	3 5 7	3 6 7	4 6 8	4 6 9	4 7 9	4 7 9	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	5 10 15
H	3 5 6	3 5 7	3 5 7	3 6 8	4 6 8	4 6 9	4 7 9	4 7 9	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
I	3 5 7	3 6 7	4 6 8	4 6 8	4 6 9	4 7 9	4 7 9	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
J	3 6 8	4 6 8	4 6 8	4 6 9	4 7 9	4 7 9	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
K	4 6 8	4 6 8	4 6 9	4 6 9	4 7 9	4 7 9	4 7 10	4 7 10	4 8 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
L	4 6 8	4 6 9	4 6 9	4 7 9	4 7 9	4 7 10	4 7 10	4 7 10	4 8 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
M	4 6 9	4 7 9	4 7 9	4 7 9	4 7 10	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
N	4 7 9	4 7 9	4 7 10	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
O	4 7 10	4 7 10	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15

*There are no sampling plans provided in this Standard for these code letters and AQL values.

TABLE B-6—Continued **Standard Deviation Method**

Values of T for Tightened Inspection

Sample size code letter	Acceptable Quality Levels (in percent defective)														Number of Lots
	.04	.065	.10	.15	.25	.40	.65	1.0	1.5	2.5	4.0	6.5	10.0	15.0	
P	4 7 10	4 7 10	4 7 10	4 8 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 12	5 10 15
Q	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 12	5 10 15

The top figure in each block refers to the preceding 5 lots, the middle figure to the preceding 10 lots and the bottom figure to the preceding 15 lots.

Tightened inspection is required when the number of lots with estimates of percent defective above the AQL from the preceding 5, 10, or 15 lots is greater than the given value of T in the table, and the process average from these lots exceeds the AQL.

All estimates of the lot percent defective are obtained from Table B-5.

TABLE B-7

Standard Deviation Method

Limits of Estimated Lot Percent Defective for Reduced Inspection

Sample size code letter	Acceptable Quality Levels														Number of Lots
	.04	.065	.10	.15	.25	.40	.65	1.0	1.5	2.5	4.0	6.5	10.0	15.0	
B	*	*	*	*	*	*	*	*	*	[42]**	[28]**	[18]**	[12]**	[9]**	
C	*	*	*	*	*	*	*	[45]**	[31]**	[22]**	[15]**	[10]**	[7]**	.77 15.00 ▲	5 10 15
D	*	*	*	*	*	*	[33]**	[25]**	[18]**	[13]**	[9]**	0.00 4.40 6.50	.74 9.96 10.00	6.06 15.00 ▲	5 10 15
E	*	*	*	*	[25]**	[18]**	[14]**	[11]**	.00 .10 .88	.00 .88 2.49	.13 2.65 4.00	1.38 5.96 6.50	4.24 10.00 ▲	9.09 15.00 ▲	5 10 15
F	*	*	*	▼ .000 .002	.000 .001 .029	.000 .016 .123	.000 .101 .369	.003 .317 .81	.044 .74 1.50	.306 1.80 2.50	1.05 3.56 4.00	2.81 6.50 ▲	5.79 10.00 ▲	10.47 15.00 ▲	5 10 15
G	▼ .000 .003	.000 .002 .010	.000 .006 .028	.000 .018 .062	.002 .057 .151	.011 .143 .315	.047 .330 .626	.136 .643 1.00	.323 1.14 1.50	.84 2.23 2.50	1.84 3.94 4.00	3.80 6.50 ▲	6.86 10.00 ▲	11.52 15.00 ▲	5 10 15
H	.000 .004 .013	.000 .010 .029	.002 .023 .058	.005 .048 .105	.017 .111 .215	.048 .225 .396	.123 .445 .65	.266 .785 1.00	.521 1.31 1.50	1.14 2.40 2.50	2.24 4.00 ▲	4.29 6.50 ▲	7.40 10.00 ▲	12.07 15.00 ▲	5 10 15
I	.001 .009 .021	.002 .020 .043	.006 .039 .077	.014 .071 .133	.037 .146 .248	.083 .274 .40	.185 .509 .65	.360 .863 1.00	.653 1.39 1.50	1.33 2.48 2.50	2.49 4.00 ▲	4.59 6.50 ▲	7.74 10.00 ▲	12.43 15.00 ▲	5 10 15
J	.002 .013 .027	.005 .027 .052	.012 .050 .089	.023 .087 .146	.054 .169 .25	.113 .306 .40	.233 .550 .65	.431 .909 1.00	.750 1.44 1.50	1.47 2.50 ▲	2.66 4.00 ▲	4.81 6.50 ▲	7.98 10.00 ▲	12.69 15.00 ▲	5 10 15

*There are no sampling plans provided in this Standard for these code letters and AQL values.

TABLE B-7—Continued

Standard Deviation Method

Limits of Estimated Lot Percent Defective for Reduced Inspection

Sample size code letter	Acceptable Quality Levels														Number of Lots
	.04	.065	.10	.15	.25	.40	.65	1.0	1.5	2.5	4.0	6.5	10.0	15.0	
K	.004	.008	.017	.032	.069	.137	.270	.483	.821	1.57	2.79	4.96	8.15	12.88	5
	.017	.033	.059	.099	.186	.328	.577	.940	1.47	2.50	4.00	6.50	10.00	15.00	10
	.032	.058	.097	.15	.25	.40	.65	1.00	1.50	▲	▲	▲	▲	▲	15
L	.005	.011	.022	.040	.082	.157	.300	.525	.876	1.64	2.88	5.08	8.29	13.03	5
	.020	.038	.065	.108	.199	.343	.596	.961	1.49	2.50	4.00	6.50	10.00	15.00	10
	.035	.063	.10	.15	.25	.40	.65	1.00	1.50	▲	▲	▲	▲	▲	15
M	.008	.016	.030	.052	.102	.187	.345	.587	.959	1.76	3.03	5.27	8.50	13.25	5
	.025	.045	.075	.120	.215	.364	.621	.989	1.50	2.50	4.00	6.50	10.00	15.00	10
	.04	.065	.10	.15	.25	.40	.65	1.00	▲	▲	▲	▲	▲	▲	15
N	.014	.026	.044	.072	.134	.235	.414	.681	1.082	1.92	3.24	5.52	8.81	13.60	5
	.031	.054	.087	.136	.236	.389	.65	1.00	1.50	2.50	4.00	6.50	10.00	15.00	10
	.04	.065	.10	.15	.25	.40	▲	▲	▲	▲	▲	▲	▲	▲	15
O	.018	.032	.053	.085	.153	.261	.453	.733	1.149	2.01	3.36	5.67	8.98	13.80	5
	.034	.058	.093	.143	.245	.40	.65	1.00	1.50	2.50	4.00	6.50	10.00	15.00	10
	.04	.065	.10	.15	.25	▲	▲	▲	▲	▲	▲	▲	▲	▲	15
P	.023	.039	.064	.101	.177	.296	.501	.799	1.237	2.13	3.52	5.87	9.22	14.07	5
	.038	.064	.10	.15	.25	.40	.65	1.00	1.50	2.50	4.00	6.50	10.00	15.00	10
	.04	.065	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	15
Q	.025	.044	.069	.108	.188	.312	.525	.830	1.276	2.19	3.59	5.96	9.32	14.19	5
	.04	.065	.10	.15	.25	.40	.65	1.00	1.50	2.50	4.00	6.50	10.00	15.00	10
	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	15

All AQL and table values, except those in the brackets, are in percent defective.

▼▲Use the first figure in direction of arrow and corresponding number of lots. In each block the top figure refers to the preceding 5 lots, the middle figure to the preceding 10 lots, and the bottom figure to the preceding 15 lots.

Reduced inspection may be instituted when every estimated lot percent defective from the preceding 5, 10, or 15 lots is below the figure given in the table; reduced inspection for sampling plans marked (**) in the table requires that the estimated lot percent defective is equal to zero for the number of consecutive lots indicated in brackets. In addition, all other conditions for reduced inspection, in Part III of Section B, must be satisfied.

All estimates of the lot percent defective are obtained from Table B-5.

TABLE B-8

Values of F for Maximum Standard Deviation (MSD)

Sample size code letter	Sample size	Acceptable Quality Levels (in percent defective)													
		.04	.065	.10	.15	.25	.40	.65	1.00	1.50	2.50	4.00	6.50	10.00	15.00
B	3										.436	.453	.475	.502	.538
C	4								.339	.353	.374	.399	.432	.472	.528
D	5							.294	.308	.323	.346	.372	.408	.452	.511
E	7					.242	.253	.266	.280	.295	.318	.345	.381	.425	.485
F	10				.214	.224	.235	.248	.261	.276	.298	.324	.359	.403	.460
G	15	.182	.188	.195	.202	.211	.222	.235	.248	.262	.284	.309	.344	.386	.442
H	20	.177	.183	.190	.197	.206	.216	.229	.242	.255	.277	.302	.336	.377	.432
I	25	.174	.180	.187	.193	.203	.212	.225	.238	.251	.273	.297	.331	.372	.426
J	30	.173	.179	.185	.192	.201	.210	.223	.236	.249	.270	.295	.328	.369	.423
K	35	.170	.176	.183	.189	.198	.208	.220	.232	.245	.266	.291	.323	.364	.416
L	40	.169	.176	.182	.188	.198	.207	.219	.232	.245	.266	.290	.323	.363	.416
M	50	.166	.172	.178	.184	.194	.203	.214	.227	.241	.261	.284	.317	.356	.408
N	75	.162	.168	.174	.181	.189	.199	.211	.223	.235	.255	.279	.310	.348	.399
O	100	.160	.166	.172	.179	.187	.197	.208	.220	.233	.253	.276	.307	.345	.395
P	150	.158	.163	.170	.175	.185	.193	.206	.216	.230	.249	.271	.302	.341	.388
Q	200	.157	.163	.168	.175	.183	.193	.203	.215	.228	.248	.269	.302	.338	.386

The MSD may be obtained by multiplying the factor F by the difference between the upper specification limit U and lower specification limit L. The formula is MSD = F(U-L). The MSD serves as a guide for the magnitude of the estimate of lot standard deviation when using plans for the double specification limit case, based on the estimate of lot standard deviation of unknown variability. The estimate of lot standard deviation, if it is less than the MSD, helps to insure, but does not guarantee, lot acceptability.

NOTE: There is a corresponding acceptability constant in Table B-1 for each value of F. For reduced inspection, find the acceptability constant of Table B-2 in Table B-1 and use the corresponding value of F.

APPENDIX B

Definitions

Symbol	Read	Definition
n		Sample size for a single lot.
$\bar{X}$	X bar	Sample mean. Arithmetic mean of sample measurements from a single lot.
s		Estimate of lot standard deviation. Standard deviation of sample measurements from a single lot. (See Examples in Section B.)
U		Upper specification limit.
L		Lower specification limit.
k		The acceptability constant given in Tables B-1 and B-2.
Q_U	Q sub U	Quality index for use with Table B-5.
Q_L	Q sub L	Quality index for use with Table B-5.
p_U	p sub U	Sample estimate of the lot percent defective above U from Table B-5.
p_L	p sub L	Sample estimate of the lot percent defective below L from Table B-5.
p		Total sample estimate of the lot percent defective $p = p_U + p_L$.
M		Maximum allowable percent defective for sample estimates given in Tables B-3 and B-4.
M_U	M sub U	Maximum allowable percent defective above U given in Tables B-3 and B-4. (For use when different AQL values for U and L are specified.)
M_L	M sub L	Maximum allowable percent defective below L given in Tables B-3 and B-4. (For use when different AQL values for U and L are specified.)
$\bar{p}$	p bar	Sample estimate of the process percent defective, i.e., the estimated process average.
$\bar{p}_U$	p bar sub U	The estimated process average for an upper specification limit.
$\bar{p}_L$	p bar sub L	The estimated process average for a lower specification limit.
T		The maximum number of estimated process averages which may exceed the AQL given in Table B-6. (For use in determining application of tightened inspection.)
F		A factor used in determining the Maximum Standard Deviation (MSD). The F values are given in Table B-8.
>	Greater than	Greater than
<	Less than	Less than
Σ	Sum of	Sum of

SECTION C

VARIABILITY UNKNOWN—RANGE METHOD

Part I

SINGLE SPECIFICATION LIMIT

C1. SAMPLING PLAN FOR SINGLE SPECIFICATION LIMIT

This part of the Standard describes the procedures for use with plans for a single specification limit when variability of the lot with respect to the quality characteristic is unknown and the range method is used. The acceptability criterion is given in two equivalent forms. These are identified as Form 1 and Form 2.

C1.1 Use of Sampling Plans. To determine whether the lot meets the acceptability criterion with respect to a particular quality characteristic and AQL value, the applicable sampling plan shall be used in accordance with the provisions of Section A, General Description of Sampling Plans, and those in this part of the Standard.

C1.2 Drawing of Samples. All samples shall be drawn in accordance with paragraph A7.2.

C1.3 Determination of Sample Size Code Letter. The sample size code letter shall be selected from Table A-2 in accordance with paragraph A7.1.

C2. SELECTING THE SAMPLING PLAN WHEN FORM 1 IS USED

C2.1 Master Sampling Tables. The master sampling tables for plans based on variability unknown for a single specification limit when using the range method are Tables C-1 and C-2. Table C-1 is used for normal and tightened inspection and Table C-2 for reduced inspection.

C2.2 Obtaining the Sampling Plan. The sampling plan consists of a sample size and an associated acceptability constant.[1] The sampling plan is obtained from Master Table C-1 or C-2.

C2.2.1 Sample Size. The sample size n is shown in the master table corresponding to each sample size code letter.

C2.2.2 Acceptability Constant. The acceptability constant k, corresponding to the sample size mentioned in paragraph C2.2.1, is indicated in the column of the master table corresponding to the applicable AQL value. Table C-1 is entered from the top for normal inspection and from the bottom for tightened inspection. Sampling plans for reduced inspection are provided in Table C-2.

C3. LOT-BY-LOT ACCEPTABILITY PROCEDURES WHEN FORM 1 IS USED[2]

C3.1 Acceptability Criterion. The degree of conformance of a quality characteristic with respect to a single specification limit shall be judged by the quantity $(U-\bar{X})/\bar{R}$ or $(\bar{X}-L)/\bar{R}$.

C3.2 Computation. The following quantity shall be computed: $(U-\bar{X})/\bar{R}$ or $(\bar{X}-L)/\bar{R}$, depending on whether the specification limit is an upper or a lower limit, where

U is the upper specification limit,
L is the lower specification limit,
$\bar{X}$ is the sample mean, and
$\bar{R}$ is the average range of the sample.

In this Standard, $\bar{R}$ is the average range of subgroup ranges. Each of the subgroups consists of 5 measurements, except for those plans with sample size 3, 4, or 7 in which case the subgroup size is the same as the sample size. In computing $\bar{R}$, the order of the sample measurements as made must be retained. Subgroups of consecutive measurements must be formed and the range of each subgroup obtained. $\bar{R}$ is the average of the individual subgroup ranges.

C3.3 Acceptability Criterion. Compare the quantity $(U-\bar{X})/\bar{R}$ or $(\bar{X}-L)/\bar{R}$ with the acceptability constant k. If $(U-\bar{X})/\bar{R}$ or $(\bar{X}-L)/\bar{R}$ is equal to or greater than k, the lot meets the acceptability criterion; if $(U-\bar{X})/\bar{R}$ or $(\bar{X}-L)/\bar{R}$ is less than k or negative, then the lot does not meet the acceptability criterion.

[1] See Appendix C for definitions of all symbols used in the sampling plans based on variability unknown-range method.
[2] See Example C-1 for a complete example of this procedure.

C4. SUMMARY FOR OPERATION OF SAMPLING PLAN WHEN FORM 1 IS USED

The following steps summarize the procedures to be followed:

(1) Determine the sample size code letter from Table A-2 by using the lot size and the inspection level.

(2) Obtain plan from Master Table C-1 or C-2 by selecting the sample size n and the acceptability constant k.

(3) Select at random the sample of n units from the lot; inspect and record the measurement of the quality characteristic for each unit of the sample.

(4) Compute the sample mean $\bar{X}$ and the average range of the sample $\bar{R}$, and also compute the quantity $(U-\bar{X})/\bar{R}$ for an upper specification limit U or the quantity $(\bar{X}-L)/\bar{R}$ for a lower specification limit L.

(5) If the quantity $(U-\bar{X})/\bar{R}$ or $(\bar{X}-L)/\bar{R}$ is equal to or greater than k, the lot meets the acceptability criterion; if $(U-\bar{X})/\bar{R}$ or $(\bar{X}-L)/\bar{R}$ is less than k or negative, then the lot does not meet the acceptability criterion.

C5. SELECTING THE SAMPLING PLAN WHEN FORM 2 IS USED

C5.1 Master Sampling Tables. The master sampling tables for plans based on variability unknown for a single specification limit when using the range method are Tables C-3 and C-4 of Part II. Table C-3 is used for normal and tightened inspection and Table C-4 for reduced inspection.

C5.2 Obtaining the Sampling Plan. The sampling plan consists of a sample size and an associated maximum allowable percent defective. The sampling plan is obtained from Master Table C-3 or C-4.

C5.2.1 Sample Size. The sample size n is shown in the master table corresponding to each sample size code letter.

C5.2.2 Maximum Allowable Percent Defective. The maximum allowable percent defective M for sample estimates corresponding to the sample size mentioned in paragraph C5.2.1 is indicated in the column of the master table corresponding to the applicable AQL value. Table C-3 is entered from the top for normal inspection and from the bottom for tightened inspection. Sampling plans for reduced inspection are provided in Table C-4.

C6. LOT-BY-LOT ACCEPTABILITY PROCEDURES WHEN FORM 2 IS USED[3]

C6.1 Acceptability Criterion. The degree of conformance of a quality characteristic with respect to a single specification limit shall be judged by the percent of nonconforming product outside the upper or lower specification limit. The percentage of nonconforming product is estimated by entering Table C-5 with the quality index and the sample size.

C6.2 Computation of Quality Index. The quality index $Q_U = (U-\bar{X})c/\bar{R}$ shall be computed if the specification limit is an upper limit U, or $Q_L = (\bar{X}-L)c/\bar{R}$ if it is a lower limit L. The quantities, $\bar{X}$ and $\bar{R}$, are the sample mean and average range of the sample, respectively. The computation of $\bar{R}$ is explained in paragraph C3.2. The factor c is provided in Master Tables C-3 and C-4 corresponding to the sample size code letter.

C6.3 Estimate of Percent Defective in Lot. The quality of a lot shall be expressed by p_U, the estimated percent defective in the lot above the upper specification limit, or by p_L, the estimated percent defective below the lower specification limit. The estimated percent defective p_U or p_L is obtained by entering Table C-5 with Q_U or Q_L and the appropriate sample size.

C6.4 Acceptability Criterion. Compare the estimated lot percent defective p_U or p_L with the maximum allowable percent defective M. If p_U or p_L is equal to or less than M, the lot meets the acceptability criterion; if p_U or p_L is greater than M or if Q_U or Q_L is negative, then the lot does not meet the acceptability criterion.

C7. SUMMARY OF OPERATION OF SAMPLING PLAN WHEN FORM 2 IS USED

The following steps summarize the procedures to be followed:

(1) Determine the sample size code letter from Table A-2 by using the lot size and the inspection level.

(2) Obtain plan from Master Table C-3 or C-4 by selecting the sample size n, the factor c, and the maximum allowable percent defective M.

(3) Select at random the sample of n units from the lot; inspect and record the measurement of the quality characteristic on each unit of the sample.

[3] See Example C-2 for a complete example of this procedure.

(4) Compute the sample mean $\bar{X}$ and the average range of the sample $\bar{R}$.

(5) Compute the quality index $Q_U = (U-\bar{X})c/\bar{R}$ if the upper specification limit U is specified, or $Q_L = (\bar{X}-L)c/\bar{R}$ if the lower specification limit L is specified.

(6) Determine the estimated lot percent defective p_U or p_L from Table C-5.

(7) If the estimated lot percent defective p_U or p_L is equal to or less than the maximum allowable percent defective M, the lot meets the acceptability criterion; if p_U or p_L is greater than M or if Q_U or Q_L is negative, then the lot does not meet the acceptability criterion.

EXAMPLE C-1

Example of Calculations

Single Specification Limit—Form 1

Variability Unknown - Range Method

Example The lower specification limit for electrical resistance of a certain electrical component is 620 ohms. A lot of 100 items is submitted for inspection. Inspection Level IV, normal inspection, with AQL = .4% is to be used. From Tables A-2 and C-1 it is seen that a sample of size 10 is required. Suppose that values of the sample resistances in the order reading from left to right are as follows:

643, 651, 619, 627, 658, (R_1 = 658 - 619 = 39)
670, 673, 641, 638, 650, (R_2 = 673 - 638 = 35)

and compliance with the acceptability criterion is to be determined.

Line	Information Needed	Value Obtained	Explanation
1	Sample Size: n	10	
2	Sum of Measurements: ΣX	6470	
3	Sample Mean $\bar{X}$: $\Sigma X/n$	647	6470/10
4	Average Range $\bar{R}$: ΣR/no. of subgroups	37	(39+35)/2
5	Specification Limit (Lower): L	620	
6	The quantity: $(\bar{X}-L)/\bar{R}$	.730	(647-620)/37
7	Acceptability Constant: k	.811	See Table C-1
8	Acceptability Criterion: Compare $(\bar{X}-L)/\bar{R}$ with k	.730 < .811	See Para. C3.3

The lot does not meet the acceptability criterion, since $(\bar{X}-L)/\bar{R}$ is less than k.

NOTE: If a single upper specification limit U is given, then compute the quantity $(U-\bar{X})/\bar{R}$ in line 6 and compare it with k; the lot meets the acceptability criterion, if $(U-\bar{X})/\bar{R}$ is equal to or greater than k.

EXAMPLE C-2

Example of Calculations

Single Specification Limit—Form 2

Variability Unknown - Range Method

Example A lower specification limit for electrical resistance of a certain electrical component is 620 ohms. A lot of 100 items is submitted for inspection. Inspection Level IV, normal inspection, with AQL = .4% is to be used. From Tables A-2 and C-1 it is seen that a sample of size 10 is required. Suppose the values of the sample resistances in the order reading from left to right are as follows:

643, 651, 619, 627, 658, (R_1 = 658 - 619 = 39)
670, 673, 641, 638, 650, (R_2 = 673 - 638 = 35)

and compliance with the acceptability criterion is to be determined.

Line	Information Needed	Value Obtained	Explanation
1	Sample Size: n	10	
2	Sum of Measurements: ΣX	6470	
3	Sample Mean $\bar{X}$: $\Sigma X/n$	647	6470/10
4	Average Range $\bar{R}$: ΣR/no. of subgroups	37	(39+35)/2
5	Factor c	2.405	See Table C-3
6	Specification Limit (Lower): L	620	
7	Quality Index: $Q_L = (\bar{X}-L)c/\bar{R}$	1.76	(647-620)2.405/37
8	Est. of Lot Percent Def.: p_L	2.54%	See Table C-5
9	Max. Allowable Percent Def.: M	1.14%	See Table C-3
10	Acceptability Criterion: Compare p_L with M	2.54% > 1.14%	See Para. C6.4

The lot does not meet the acceptability criterion, since p_L is greater than M.

NOTE: If a single upper specification limit U is given, then compute the quality index $Q_U = (U-\bar{X})c/\bar{R}$ in line 7 and obtain the estimate of lot percent defective p_U. Compare p_U with M; the lot meets the acceptability criterion, if p_U is equal to or less than M.

TABLE C-1

Range Method

Master Table for Normal and Tightened Inspection for Plans Based on Variability Unknown
(Single Specification Limit—Form 1)

Sample size code letter	Sample size	Acceptable Quality Levels (normal inspection)													
		.04	.065	.10	.15	.25	.40	.65	1.00	1.50	2.50	4.00	6.50	10.00	15.00
		k	k	k	k	k	k	k	k	k	k	k	k	k	k
B	3	▼	▼	▼	▼	▼	▼	▼	▼	▼	.587	.502	.401	.296	.178
C	4	▼	▼	▼	▼	▼	▼	▼	.651	.598	.525	.450	.364	.276	.176
D	5	▼	▼	▼	▼	▼	▼	.663	.614	.565	.498	.431	.352	.272	.184
E	7	▼	▼	▼	▼	.702	.659	.613	.569	.525	.465	.405	.336	.266	.189
F	10	▼	▼	▼	.916	.863	.811	.755	.703	.650	.579	.507	.424	.341	.252
G	15	1.09	1.04	.999	.958	.903	.850	.792	.738	.684	.610	.536	.452	.368	.276
H	25	1.14	1.10	1.05	1.01	.951	.896	.835	.779	.723	.647	.571	.484	.398	.305
I	30	1.15	1.10	1.06	1.02	.959	.904	.843	.787	.730	.654	.577	.490	.403	.310
J	35	1.16	1.11	1.07	1.02	.964	.908	.848	.791	.734	.658	.581	.494	.406	.313
K	40	1.18	1.13	1.08	1.04	.978	.921	.860	.803	.746	.668	.591	.503	.415	.321
L	50	1.19	1.14	1.09	1.05	.988	.931	.893	.812	.754	.676	.598	.510	.421	.327
M	60	1.21	1.16	1.11	1.06	1.00	.948	.885	.826	.768	.689	.610	.521	.432	.336
N	85	1.23	1.17	1.13	1.08	1.02	.962	.899	.839	.780	.701	.621	.530	.441	.345
O	115	1.24	1.19	1.14	1.09	1.03	.975	.911	.851	.791	.711	.631	.539	.449	.353
P	175	1.26	1.21	1.16	1.11	1.05	.994	.929	.868	.807	.726	.644	.552	.460	.363
Q	230	1.27	1.21	1.16	1.12	1.06	.996	.931	.870	.809	.728	.645	.553	.462	.364
		.065	.10	.15	.25	.40	.65	1.00	1.50	2.50	4.00	6.50	10.00	15.00	
		Acceptable Quality Levels (tightened inspection)													

All AQL values are in percent defective.

▼ Use first sampling plan below arrow, that is, both sample size as well as k value. When sample size equals or exceeds lot size, every item in the lot must be inspected.

TABLE C-2

Range Method

Master Table for Reduced Inspection for Plans Based on Variability Unknown
(Single Specification Limit—Form 1)

Sample size code letter	Sample size	Acceptable Quality Levels												
		.04	.065	.10	.15	.25	.40	.65	1.00	1.50	2.50	4.00	6.50	10.00
		k	k	k	k	k	k	k	k	k	k	k	k	k
B	3	↓	↓	↓	↓	↓	↓	↓	↓	.587	.502	.401	.296	.178
C	3									.587	.502	.401	.296	.178
D	3									.587	.502	.401	.296	.178
E	3									.587	.502	.401	.296	.178
F	4						↓	.651	.598	.525	.450	.364	.276	.176
G	5						.663	.614	.565	.498	.431	.352	.272	.184
H	7				.702	.659	.613	.569	.525	.465	.405	.336	.266	.189
I	10			.916	.863	.811	.755	.703	.650	.579	.507	.424	.341	.252
J	10			.916	.863	.811	.755	.703	.650	.579	.507	.424	.341	.252
K	15	1.04	.999	.958	.903	.850	.792	.738	.684	.610	.536	.452	.368	.276
L	25	1.10	1.05	1.01	.951	.896	.835	.779	.723	.647	.571	.484	.398	.305
M	25	1.10	1.05	1.01	.951	.896	.835	.779	.723	.647	.571	.484	.398	.305
N	30	1.10	1.06	1.02	.959	.904	.843	.787	.730	.654	.577	.490	.403	.310
O	35	1.11	1.07	1.02	.964	.908	.848	.791	.734	.658	.581	.494	.406	.313
P	60	1.16	1.11	1.06	1.00	.948	.885	.826	.768	.689	.610	.521	.432	.336
Q	85	1.17	1.13	1.08	1.02	.962	.899	.839	.780	.701	.621	.530	.441	.345

All AQL values are in percent defective.

↓ Use first sampling plan below arrow, that is, both sample size as well as k value. When sample size equals or exceeds lot size, every item in the lot must be inspected.

Part II

DOUBLE SPECIFICATION LIMIT

C8. SAMPLING PLAN FOR DOUBLE SPECIFICATION LIMIT

This part of the Standard describes the procedures for use with plans for a double specification limit when variability of the lot with respect to the quality characteristic is unknown and the range method is used.

C8.1 Use of Sampling Plans. To determine whether the lot meets the acceptability criterion with respect to a particular quality characteristic and AQL value(s), the applicable sampling plan shall be used in accordance with the provisions of Section A, General Description of Sampling Plans, and those in this part of the Standard.

C9. SELECTING THE SAMPLING PLAN

A sampling plan for each AQL value shall be selected from Table C-3 or C-4 as follows:

C9.1 Determination of Sample Size Code Letter. The sample size code letter shall be selected from Table A-2 in accordance with paragraph A7.1.

C9.2 Master Sampling Tables. The master sampling tables for plans based on variability unknown for a double specification limit when using the range method are Tables C-3 and C-4. Table C-3 is used for normal and tightened inspection and Table C-4 for reduced inspection.

C9.3 Obtaining Sampling Plan. A sampling plan consists of a sample size and the associated maximum allowable percent defective(s). The sampling plan to be applied in inspection shall be obtained from Master Table C-3 or C-4.

C9.3.1 Sample Size. The sample size n is shown in the master tables corresponding to each sample size code letter.

C9.3.2 Maximum Allowable Percent Defective. The maximum allowable percent defective for sample estimates of percent defective for the lower, upper, or both specification limits combined, corresponding to the sample size mentioned in paragraph C9.3.1, is shown in the column of the master table corresponding to the applicable AQL value(s). If different AQL's are assigned to each specification limit, designate the maximum allowable percent defective by M_L for the lower limit, and by M_U for the upper limit. If one AQL is assigned to both limits combined, designate the maximum allowable percent defective by M. Table C-3 is entered from the top for normal inspection and from the bottom for tightened inspection. Sampling plans for reduced inspection are provided in Table C-4.

C10. DRAWING OF SAMPLES

Samples shall be selected in accordance with paragraph A7.2.

C11. LOT-BY-LOT ACCEPTABILITY PROCEDURES

C11.1 Acceptability Criterion. The degree of conformance of a quality characteristic with respect to a double specification limit shall be judged by the percent of nonconforming product. The percentage of nonconforming product is estimated by entering Table C-5 with the quality index and the sample size.

C11.2 Computation of Quality Indices. The quality indices $Q_U = (U-\bar{X})c/R$ and $Q_L = (\bar{X}-L)c/R$ shall be computed, where

U is the upper specification limit,
L is the lower specification limit,
c is a factor provided in Tables C-3 and C-4,
$\bar{X}$ is the sample mean, and
R is the average range of the sample.

In this Standard, R is the average range of the subgroup ranges. Each of the subgroups consists of 5 measurements, except for those plans with sample size 3, 4, or 7 in which case the subgroup size is the same as the sample size. In computing R, the order of the sample measurements as made must be retained. Subgroups of consecutive measurements must be formed and the range of each subgroup obtained. $\bar{R}$ is the average of the individual subgroup ranges.

C11.3 Percent Defective in the Lot. The quality of a lot shall be expressed in terms of the lot percent defective. Its estimate will be designated by p_L, p_U, or p. The estimate p_U indicates conformance with respect to the upper specification limit, p_L with respect to the lower specification limit, and p for both specification limits combined. The

estimates p_L and p_U shall be determined by entering Table C-5, respectively with Q_L and Q_U and the sample size. The estimate p shall be determined by adding the corresponding estimated percent defectives p_L and p_U found in the table.

C12. ACCEPTABILITY CRITERION AND SUMMARY FOR OPERATION OF SAMPLING PLANS

C12.1 One AQL value for both Upper and Lower Specification Limit Combined.

C12.1.1 Acceptability Criterion.[4] Compare the estimated lot percent defective $p = p_U + p_L$ with the maximum allowable percent defective M. If p is equal to or less than M, the lot meets the acceptability criterion; if p is greater than M or if either Q_U or Q_L or both are negative, then the lot does not meet the acceptability criterion.

C12.1.2 Summary for Operation of Sampling Plan. In cases where a single AQL value is established for the upper and lower specification limit combined for a single quality characteristic, the following steps summarize the procedures to be used:

(1) Determine the sample size code letter from Table A-2 by using the lot size and the inspection level.

(2) Select plan from Master Table C-3 or C-4. Obtain the sample size n, the factor c, and the maximum allowable percent defective M.

(3) Select at random the sample of n units from the lot; inspect and record the measurement of the quality characteristic on each unit of the sample.

(4) Compute the sample mean $\bar{X}$ and average range of the sample R.

(5) Compute the quality indices $Q_U = (U-\bar{X})c/R$ and $Q_L = (\bar{X}-L)c/R$.

(6) Determine the estimated lot percent defective $p = p_U + p_L$ from Table C-5.

(7) If the estimated lot percent defective p is equal to or less than the maximum allowable percent defective M, the lot meets the acceptability criterion; if p is greater than M or if either Q_U or Q_L or both are negative, then the lot does not meet the acceptability criterion.

C12.2 Different AQL values for Upper and Lower Specification Limit.

C12.2.1 Acceptability Criteria.[5] Compare the estimated lot percent defectives p_L and p_U with the corresponding maximum allowable percent defectives M_L and M_U; also compare $p = p_L + p_U$ with the larger of M_L and M_U. If p_L is equal to or less than M_L, p_U is equal to or less than M_U, and p is equal to or less than the larger of M_L and M_U, the lot meets the acceptability criteria; otherwise, the lot does not meet the acceptability criteria. If either Q_L or Q_U or both are negative, then the lot does not meet the acceptability criteria.

C12.2.2 Summary for Operation of Sampling Plan. In cases where a different AQL value is established for the upper and lower specification limit for a single quality characteristic, the following steps summarize the procedures to be used:

(1) Determine the sample size code letter from Table A-2 by using the lot size and inspection level.

(2) Select the sampling plan from Master Table C-3 or C-4. Obtain the sample size n, the factor c, and the maximum allowable percent defectives M_U and M_L, corresponding to AQL values for the upper and lower specification limits, respectively.

(3) Select at random the sample of n units from the lot; inspect and record the measurement of the quality characteristic on each unit in the sample.

(4) Compute the sample mean $\bar{X}$ and average range of the sample R.

(5) Compute the quality indices $Q_U = (U-\bar{X})c/R$ and $Q_L = (\bar{X}-L)c/R$.

(6) Determine the estimated lot percent defectives p_U and p_L, corresponding to the percent defectives above the upper and below the lower specification limits. Also determine the combined percent defective $p = p_U + p_L$.

(7) If all three of the following conditions:

(a) p_U is equal to or less than M_U.

(b) p_L is equal to or less than M_L.

(c) p is equal to or less than the larger of M_L and M_U.

are satisfied, the lot meets the acceptability criteria; otherwise, the lot does not meet the acceptability criteria. If either Q_L or Q_U or both are negative, then the lot does not meet the acceptability criteria.

[4] See Example C-3 for a complete example of this procedure.
[5] See Example C-4 for a complete example of this procedure.

EXAMPLE C-3

Example of Calculations

Double Specification Limit

Variability Unknown - Average Range Method

One AQL Value for Both Upper and Lower Specification Limit Combined

Example The specifications for electrical resistance of a certain electrical component is 650.0 ± 30 ohms. A lot of 100 items is submitted for inspection. Inspection Level IV, normal inspection, with AQL = .4% is to be used. From Tables A-2 and C-3 it is seen that a sample of size 10 is required. Suppose the values of the sample resistance in the order reading from left to right are as follows:

643, 651, 619, 627, 658, (R_1 = 658 - 619 = 39)
670, 673, 641, 638, 650, (R_2 = 673 - 638 = 35)

and compliance with the acceptability criterion is to be determined.

Line	Information Needed	Value Obtained	Explanation
1	Sample Size: n	10	
2	Sum of Measurements: ΣX	6470	
3	Sample Mean $\bar{X}$: $\Sigma X/n$	647	6470/10
4	Average Range $\bar{R}$: ΣR/no. of subgroups	37	(39 + 35)/2
5	Factor c	2.405	See Table C-3
6	Upper Specification Limit: U	680	
7	Lower Specification Limit: L	620	
8	Quality Index: $Q_U = (U-\bar{X})c/R$	2.15	(680-647)2.405/37
9	Quality Index: $Q_L = (\bar{X}-L)c/R$	1.76	(647-620)2.405/37
10	Est. of Lot Percent Def. above U: p_U	.35%	See Table C-5
11	Est. of Lot Percent Def. below L: p_L	2.54%	See Table C-5
12	Total Est. Percent Def. in Lot: $p = p_U + p_L$	2.89%	.35% + 2.54%
13	Max. Allowable Percent Def.: M	1.14%	See Table C-3
14	Acceptability Criterion: Compare $p = p_U + p_L$ with M	2.89% > 1.14%	See Para. C12.1.2(7)

The lot does not meet the acceptability criterion, since $p = p_U + p_L$ is greater than M.

EXAMPLE C-4

Example of Calculations

Double Specification Limit

Variability Unknown - Average Range Method

Different AQL Values for Upper and Lower Specification Limits

Example The specifications for electrical resistance of a certain electrical component is 650.0 ± 30 ohms. A lot of 100 items is submitted for inspection. Inspection Level IV, normal inspection, with AQL = 2.5% for the upper and AQL = 1% for the lower specification limit is to be used. From Tables A-2 and C-3 it is seen that a sample of size 10 is required. Suppose the values of the sample resistances in the order reading from left to right are as follows:

643, 651, 619, 627, 658, (R_1 = 658 - 619 = 39)
670, 673, 641, 638, 650, (R_2 = 673 - 638 = 35)

and compliance with the acceptability criteria is to be determined.

Line	Information Needed	Value Obtained	Explanation
1	Sample Size: n	10	
2	Sum of Measurements: ΣX	6470	
3	Sample Mean $\bar{X}$: $\Sigma X/n$	647	6470/10
4	Average Range $\bar{R}$: ΣR/no. of subgroups	37	(39 + 35)/2
5	Factor c	2.405	See Table C-3
6	Upper Specification Limit: U	680	
7	Lower Specification Limit: L	620	
8	Quality Index: $Q_U = (U-\bar{X})c/\bar{R}$	2.15	(680-647)2.405/37
9	Quality Index: $Q_L = (\bar{X}-L)c/\bar{R}$	1.76	(647-620)2.405/37
10	Est. of Lot Percent Def. above U: p_U	.35%	See Table C-5
11	Est. of Lot Percent Def. below L: p_L	2.54%	See Table C-5
12	Total Est. Percent Def. in Lot: $p = p_U + p_L$	2.89%	.35% + 2.54%
13	Max. Allowable Percent Def. above U: M_U	7.42%	See Table C-3
14	Max. Allowable Percent Def. below L: M_L	3.23%	See Table C-3
15	Acceptability Criteria: (a) Compare p_U with M_U	.35% < 7.42%	See Para. C12.2.2(7)(a)
	(b) Compare p_L with M_L	2.54% < 3.23%	See Para. C12.2.2(7)(b)
	(c) Compare p with M_U	2.89% < 7.42%	See Para. C12.2.2(7)(c)

The lot meets the acceptability criteria, since 15(a), (b) and (c) are satisfied; i.e., $p_U < M_U$, $p_L < M_L$ and $p < M_U$.

TABLE C-3

Master Table for Normal and Tightened Inspection for Plans Based on Variability Unknown
(Double Specification Limit and for Form 2—Single Specification Limit)

Sample size code letter	Sample size	c factor	Acceptable Quality Levels (normal inspection)													
			.04	.065	.10	.15	.25	.40	.65	1.00	1.50	2.50	4.00	6.50	10.00	15.00
			M	M	M	M	M	M	M	M	M	M	M	M	M	M
B	3	1.910	↓	↓	↓	↓	↓	↓	↓	▼	▼	7.59	18.86	26.94	33.69	40.47
C	4	2.234								1.53	5.50	10.92	16.45	22.86	29.45	36.90
D	5	2.474	↓	↓	↓	↓	↓	↓	1.42	3.44	5.93	9.90	14.47	20.27	26.59	33.95
E	7	2.830					.28	.89	1.99	3.46	5.32	8.47	12.35	17.54	23.50	30.66
F	10	2.405	↓	↓	↓	.23	.58	1.14	2.05	3.23	4.77	7.42	10.79	15.49	21.06	27.90
G	15	2.379	.061	.136	.253	.430	.786	1.30	2.10	3.11	4.44	6.76	9.76	14.09	19.30	25.92
H	25	2.358	.125	.214	.336	.506	.827	1.27	1.95	2.82	3.96	5.98	8.65	12.59	17.48	23.79
I	30	2.353	.147	.240	.366	.537	.856	1.29	1.96	2.81	3.92	5.88	8.50	12.36	17.19	23.42
J	35	2.349	.165	.261	.391	.564	.883	1.33	1.98	2.82	3.90	5.85	8.42	12.24	17.03	23.21
K	40	2.346	.160	.252	.375	.539	.842	1.25	1.88	2.69	3.73	5.61	8.11	11.84	16.55	22.38
L	50	2.342	.169	.261	.381	.542	.838	1.25	1.60	2.63	3.64	5.47	7.91	11.57	16.20	22.26
M	60	2.339	.158	.244	.356	.504	.781	1.16	1.74	2.47	3.44	5.17	7.54	11.10	15.64	21.63
N	85	2.335	.156	.242	.350	.493	.755	1.12	1.67	2.37	3.30	4.97	7.27	10.73	15.17	21.05
O	115	2.333	.153	.230	.333	.468	.718	1.06	1.58	2.25	3.14	4.76	6.99	10.37	14.74	20.57
P	175	2.331	.139	.210	.303	.427	.655	.972	1.46	2.08	2.93	4.47	6.60	9.89	14.15	19.88
Q	230	2.330	.142	.215	.308	.432	.661	.976	1.47	2.08	2.92	4.46	6.57	9.84	14.10	19.82
			.065	.10	.15	.25	.40	.65	1.00	1.50	2.50	4.00	6.50	10.00	15.00	
			Acceptable Quality Levels (tightened inspection)													

All AQL and table values are in percent defective.

↓ Use first sampling plan below arrow, that is, both sample size as well as M value. When sample size equals or exceeds lot size, every item in the lot must be inspected.

Range Method

TABLE C-4

Master Table for Reduced Inspection for Plans Based on Variability Unknown
(Double Specification Limit and Form 2—Single Specification Limit)

Sample size code letter	Sample size	c factor	Acceptable Quality Levels												
			.04	.065	.10	.15	.25	.40	.65	1.00	1.50	2.50	4.00	6.50	10.00
			M	M	M	M	M	M	M	M	M	M	M	M	M
B	3	1.910	↓	↓	↓	↓	↓	↓	↓	↓	7.59	18.86	26.94	33.69	40.47
C	3	1.910									7.59	18.86	26.94	33.69	40.47
D	3	1.910									7.59	18.86	26.94	33.69	40.47
E	3	1.910									7.59	18.86	26.94	33.69	40.47
F	4	2.234							1.53	5.50	10.92	16.45	22.86	29.45	36.90
G	5	2.474						1.42	3.44	5.93	9.90	14.47	20.27	26.59	33.95
H	7	2.830				.28	.89	1.99	3.46	5.32	8.47	12.35	17.54	23.50	30.66
I	10	2.405			.23	.58	1.14	2.05	3.23	4.77	7.42	10.79	15.49	21.06	27.90
J	10	2.405			.23	.58	1.14	2.05	3.23	4.77	7.42	10.79	15.49	21.06	27.90
K	15	2.379	.136	.253	.430	.786	1.30	2.10	3.11	4.44	6.76	9.76	14.09	19.30	25.92
L	25	2.358	.214	.336	.506	.827	1.27	1.95	2.82	3.96	5.98	8.65	12.59	17.48	23.79
M	25	2.358	.214	.336	.506	.827	1.27	1.95	2.82	3.96	5.98	8.65	12.59	17.48	23.79
N	30	2.353	.240	.366	.537	.856	1.29	1.96	2.81	3.92	5.88	8.50	12.36	17.19	23.42
O	35	2.349	.261	.391	.564	.883	1.33	1.98	2.82	3.90	5.85	8.42	12.24	17.03	23.21
P	60	2.339	.244	.356	.504	.781	1.16	1.74	2.47	3.44	5.17	7.54	11.10	15.64	21.63
Q	85	2.335	.242	.350	.493	.755	1.12	1.67	2.37	3.30	4.97	7.27	10.73	15.17	21.05

All AQL and table values are in percent defective.

Use first sampling plan below arrow, that is, both sample size as well as M value. When sample size equals or exceeds lot size, every item in the lot must be inspected.

TABLE C-5

Table for Estimating the Lot Percent Defective Using Range Method[1]

TABLE C-5--Continued

Table for Estimating the Lot Percent Defective Using Range Method

TABLE C-5—Continued

Table for Estimating the Lot Percent Defective Using Range Method

TABLE C-5—Continued

Table for Estimating the Lot Percent Defective Using Range Method

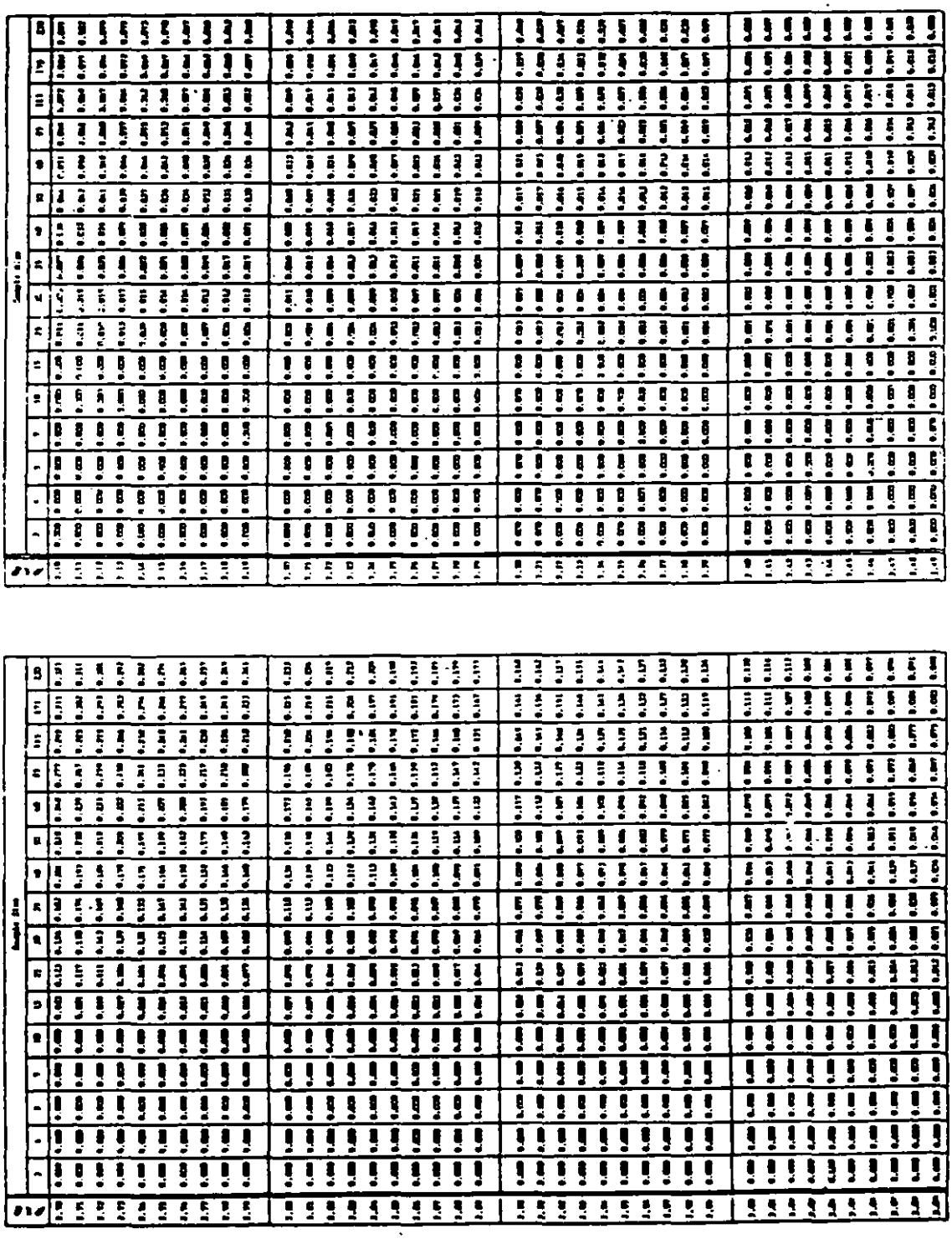


TABLE C-5—Continued

Table for Estimating the Lot Percent Defective Using Range Method

Part III

ESTIMATION OF PROCESS AVERAGE AND CRITERIA FOR REDUCED AND TIGHTENED INSPECTION

C13. ESTIMATION OF PROCESS AVERAGE

The average percent defective, based upon a group of lots submitted for original inspection, is called the process average. Original inspection is the first inspection of a particular quantity of product submitted for acceptability as distinguished from the inspection of product which has been resubmitted after prior rejection. The process average shall be estimated from the results of inspection of samples drawn from a specified number of preceding lots for the purpose of determining severity of inspection during the course of a contract in accordance with paragraph C14.3. Any lot shall be included only once in estimating the process average. The estimate of the process average is designated by $\bar{p}_U$ when computed with respect to an upper specification limit, by $\bar{p}_L$ when computed with respect to a lower specification limit, and by $\bar{p}$ when computed with respect to a double specification limit.

C13.1 Abnormal Results. The results of inspection of product manufactured under conditions not typical of usual production shall be excluded from the estimated process average.

C13.2 Computation of the Estimated Process Average. The estimated process average is the arithmetic mean of the estimated lot percent defectives computed from the sampling inspection results of the preceding ten (10) lots or as may be otherwise designated. In order to estimate the lot percent defective, the quality indices Q_U and/or Q_L shall be computed for each lot. These are: $Q_U = (U-\bar{X})c/R$ and $Q_L = (\bar{X}-L)c/R$. (See paragraph C11.2.)

C13.2.1 Single Specification Limit.[6] The estimated lot percent defective shall be determined from Table C-5 for the plans based on the range method. The quality index Q_U shall be used for the case of an upper specification limit or Q_L for the case of a lower specification limit. Table C-5 is entered with Q_U or Q_L and the sample size, and the corresponding estimated lot percent defective p_U or p_L, respectively, is read from the table. The estimated process average $\bar{p}_U$ is the arithmetic mean of the individual estimated lot percent defectives p_U's. Similarly, the estimated process average $\bar{p}_L$ is the arithmetic mean of the individual estimated lot percent defectives p_L's.

C13.2.2 Double Specification Limit. The estimated lot percent defective shall be determined from Table C-5 for the plans based on the range method. The quality indices Q_U and Q_L shall be computed. Table C-5 is entered separately with Q_U and Q_L and the sample size, and the corresponding p_U and p_L are read from the table. The estimated lot percent defective is $p = p_U + p_L$. The estimated process average $\bar{p}$ is the arithmetic mean of the individual estimated lot percent defectives p's.

C13.2.3 Special Case. If the quality index Q_U or Q_L is a negative number, then Table C-5 is entered by disregarding the negative sign. However, in this case the estimated lot percent defective above the upper limit or below the lower limit is obtained by subtracting the percentage found in the table from 100%.[7]

C14. NORMAL, TIGHTENED, AND REDUCED INSPECTION

This Standard established sampling plans for normal, tightened, and reduced inspection.

C14.1 At Start of Inspection. Normal inspection shall be used at the start of inspection unless otherwise designated.

C14.2 During Inspection. During the course of inspection, normal inspection shall be used when inspection conditions are such that tightened or reduced inspection is not required in accordance with paragraphs C14.3 and C14.4.

C14.3 Tightened Inspection. Tightened inspection shall be instituted when the estimated process average computed from the

[6] When Form 1—Single Specification Limit is used for the acceptability criterion, the estimate of lot percent defective p_U or p_L is not obtained; in order to estimate the process average, it is necessary to complete paragraphs C6.2 and C6.3 of Form 2.

[7] For example, if $Q_U = -.50$ and $Q_L = 1.60$, using sample size 60, $p_U = 100\% - 30.94\% = 69.06\%$, $p_L = 5.32\%$ and $p = 69.06\% + 5.32\% = 74.38\%$.

preceding ten (10) lots (or such other number of lots designated) in accordance with paragraph C13.2 is greater than the AQL, and when more than a certain number T of these lots have estimates of the percent defective exceeding the AQL. The T-values are given in Table C-6 for the process average computed from 5, 10 or 15 lots.[6] Normal inspection shall be reinstated if the estimated process average of lots under tightened inspection is equal to or less than the AQL.

C14.4 Reduced Inspection. Reduced inspection may be instituted provided that all of the following conditions are satisfied:

Condition A. The preceding ten (10) lots (or such other number of lots designated) have been under normal inspection and none has been rejected.

Condition B. The estimated percent defective for each of these preceding lots is less than the applicable lower limit shown in Table C-7; or for certain sampling plans, the estimated lot percent defective is equal to zero for a specified number of consecutive lots (see Table C-7).

Condition C. Production is at a steady rate.

Normal inspection shall be reinstated if any one of the following conditions occurs under reduced inspection.

Condition D. A lot is rejected.

Condition E. The estimated process average is greater than the AQL.

Condition F. Production becomes irregular or delayed.

Condition G. Other conditions as may warrant that normal inspection should be reinstated.

C14.5 Sampling Plans for Tightened or Reduced Inspection. Sampling plans for tightened and reduced inspection are provided in Section C, Parts I and II.

[6] If the sample size code letter is not the same for all samples used, the entry in Table C-6 is determined by the sample size code letter corresponding to the smallest sample size used in any of the lots included in the estimation of the process average.

TABLE C-6 Range Method

Values of T for Tightened Inspection

Sample size code letter	Acceptable Quality Levels (in percent defective)														Number of Lots
	.04	.065	.10	.15	.25	.40	.65	1.0	1.5	2.5	4.0	6.5	10.0	15.0	
B	*	*	*	*	*	*	*	*	*	2 4 5	3 5 6	4 6 8	4 7 9	4 8 11	5 10 15
C	*	*	*	*	*	*	*	2 3 5	2 4 6	3 5 7	3 6 8	4 7 9	4 7 10	4 8 11	5 10 15
D	*	*	*	*	*	*	2 4 5	3 4 6	3 5 7	3 6 8	4 6 9	4 7 10	4 7 10	4 8 11	5 10 15
E	*	*	*	*	2 3 4	2 4 5	3 4 6	3 5 6	3 5 7	4 6 8	4 7 9	4 7 10	4 7 10	4 8 11	5 10 15
F	*	*	*	2 4 5	3 4 5	3 5 6	3 5 7	3 5 7	4 6 8	4 6 9	4 7 9	4 7 10	4 8 11	4 8 11	5 10 15
G	2 4 5	2 4 5	3 4 6	3 5 6	3 5 7	3 5 7	4 6 8	4 6 8	4 6 9	4 7 9	4 7 10	4 8 11	4 8 11	4 8 11	5 10 15
H	3 5 6	3 5 7	3 5 7	3 6 7	4 6 8	4 6 8	4 7 9	4 7 9	4 7 10	4 7 10	4 7 11	4 8 11	4 8 11	4 8 11	5 10 15
I	3 5 7	3 5 7	3 6 7	4 6 8	4 6 8	4 6 9	4 7 9	4 7 9	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
J	3 5 7	3 6 7	4 6 8	4 6 8	4 6 9	4 7 9	4 7 9	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
K	3 6 7	4 6 8	4 6 8	4 6 8	4 7 9	4 7 9	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
L	4 6 8	4 6 8	4 6 9	4 6 9	4 7 9	4 7 9	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
M	4 6 8	4 6 9	4 7 9	4 7 9	4 7 9	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
N	4 7 9	4 7 9	4 7 9	4 7 10	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
O	4 7 9	4 7 10	4 7 10	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15

*There are no sampling plans provided in this Standard for these code letters and AQL values.

TABLE C-6—Continued **Range Method**

Values of T for Tightened Inspection

Sample size code letter	Acceptable Quality Levels (in percent defective)														Number of Lots
	.04	.065	.10	.15	.25	.40	.65	1.0	1.5	2.5	4.0	6.5	10.0	15.0	
P	4 7 10	4 7 10	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 12	5 10 15
Q	4 7 10	4 7 10	4 7 10	4 8 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 12	5 10 15

The top figure in each block refers to the preceding 5 lots, the middle figure to the preceding 10 lots and the bottom figure to the preceding 15 lots.

Tightened inspection is required when the number of lots with estimates of percent defective above the AQL from the preceding 5, 10, or 15 lots is greater than the given value of T in the table, and the process average from these lots exceeds the AQL.

All estimates of the lot percent defective are obtained from Table C-5.

TABLE C-7

Range Method

Limits of Estimated Lot Percent Defective for Reduced Inspection

Sample size code letter	Acceptable Quality Levels														Number of Lots
	.04	.065	.10	.15	.25	.40	.65	1.0	1.5	2.5	4.0	6.5	10.0	15.0	
B	*	*	*	*	*	*	*	*	*	[42]**	[28]**	[18]**	[12]**	[9]**	
C	*	*	*	*	*	*	*	[45]**	[31]**	[22]**	[15]**	[10]**	[7]**	.77 15.00 ▲	5 10 15
D	*	*	*	*	*	*	[33]**	[25]**	[18]**	[13]**	[9]**	0.00 4.40 6.50	.74 9.96 10.00	6.06 15.00 ▲	5 10 15
E	*	*	*	*	[30]**	[23]**	[17]**	[13]**	[10]**	.00 .35 1.84	0.00 1.84 4.00	.79 5.74 6.50	3.52 10.00 ▲	8.45 15.00 ▲	5 10 15
F	*	*	*	[19]**	[14]**	[11]**	.000 .008 .158	.000 .104 .50	.00 .40 1.14	.061 1.32 2.50	.53 3.01 4.00	2.04 6.06 6.50	4.92 10.00 ▲	9.66 15.00 ▲	5 10 15
G	[12]**	[10]**	[8]**	.000 .002 .020	.000 .015 .074	.000 .060 .199	.006 .192 .466	.040 .449 .90	.148 .90 1.50	.536 1.94 2.50	1.41 3.63 4.00	3.27 6.50 ▲	6.30 10.00 ▲	11.01 15.00 ▲	5 10 15
H	.000 .003 .011	.000 .009 .025	.002 .020 .052	.004 .042 .096	.014 .101 .199	.042 .209 .374	.112 .422 .65	.248 .755 1.00	.498 1.26 1.50	1.12 2.34 2.50	2.20 4.00 ▲	4.27 ..50 ▲	7.40 10.00 ▲	12.13 15.00 ▲	5 10 15
I	.001 .006 .017	.002 .015 .037	.004 .032 .067	.010 .061 .118	.028 .130 .230	.069 .252 .40	.162 .478 .65	.326 .822 1.00	.608 1.34 1.50	1.27 2.42 2.50	2.42 4.00 ▲	4.52 6.50 ▲	7.68 10.00 ▲	12.43 15.00 ▲	5 10 15
J	.001 .010 .022	.004 .021 .044	.007 .042 .079	.017 .075 .133	.042 .151 .248	.094 .281 .40	.202 .516 .65	.386 .867 1.00	.691 1.39 1.50	1.39 2.47 2.50	2.57 4.00 ▲	4.71 6.50 ▲	7.91 10.00 ▲	12.65 15.00 ▲	5 10 15

*There are no sampling plans provided in this Standard for these code letters and AQL values.

TABLE C-7—Continued

Range Method

Limits of Estimated Lot Percent Defective for Reduced Inspection

Sample size code letter	Acceptable Quality Levels														Number of Lots
	.04	.065	.10	.15	.25	.40	.65	1.0	1.5	2.5	4.0	6.5	10.0	15.0	
K	.002 .013 .026	.005 .027 .050	.012 .049 .088	.024 .087 .144	.056 .167 .25	.114 .302 .40	.235 .544 .65	.435 .899 1.00	.758 1.43 1.50	1.48 2.50 ▲	2.69 4.00 ▲	4.86 6.50 ▲	8.06 10.00 ▲	12.82 15.00 ▲	5 10 15
L	.004 .018 .033	.010 .036 .059	.020 .062 .097	.036 .102 .15	.076 .190 .25	.148 .332 .40	.288 .581 .65	.509 .942 1.00	.857 1.47 1.50	1.62 2.50 ▲	2.86 4.00 ▲	5.07 6.50 ▲	8.31 10.00 ▲	13.09 15.00 ▲	5 10 15
M	.007 .025 .036	.014 .041 .064	.026 .069 .10	.046 .112 .15	.092 .206 .25	.174 .352 .40	.326 .604 .65	.562 .968 1.00	.927 1.50 ▲	1.72 2.50 ▲	2.99 4.00 ▲	5.22 6.50 ▲	8.48 10.00 ▲	13.27 15.00 ▲	5 10 15
N	.012 .028 .042	.022 .051 .065	.038 .082 .10	.064 .129 .15	.122 .226 .25	.216 .378 .40	.389 .636 .65	.648 1.00 ▲	1.041 1.50 ▲	1.87 2.50 ▲	3.19 4.00 ▲	5.46 6.50 ▲	8.76 10.00 ▲	13.57 15.00 ▲	5 10 15
O	.015 .033 .04	.029 .056 .065	.048 .089 .10	.078 .139 .15	.144 .238 .25	.246 .393 .40	.434 .65 ▲	.709 1.00 ▲	1.119 1.50 ▲	1.98 2.50 ▲	3.32 4.00 ▲	5.63 6.50 ▲	8.95 10.00 ▲	13.79 15.00 ▲	5 10 15
P	.021 .036 .04	.036 .061 .065	.059 .095 .10	.093 .146 .15	.166 .248 .25	.280 .40 ▲	.480 .65 ▲	.771 1.00 ▲	1.199 1.50 ▲	2.08 2.50 ▲	3.46 4.00 ▲	5.80 6.50 ▲	9.15 10.00 ▲	14.02 15.00 ▲	5 10 15
Q	.024 .038 .04	.040 .063 .065	.065 .099 .10	.103 .149 .15	.179 .25 ▲	.300 .40 ▲	.507 .65 ▲	.808 1.00 ▲	1.248 1.50 ▲	2.15 2.50 ▲	3.54 4.00 ▲	5.90 6.50 ▲	9.27 10.00 ▲	14.15 15.00 ▲	5 10 15

All AQL and table values, except those in the brackets, are in percent defective.

[A]Use the first figure in direction of arrow and corresponding number of lots. In each block the top figure refers to the preceding 5 lots, the middle figure to the preceding 10 lots, and the bottom figure to the preceding 15 lots.

Reduced inspection may be instituted when every estimated lot percent defective from the preceding 5, 10, or 15 lots is below the figure given in the table; reduced inspection for sampling plans marked (**) in the table requires that the estimated lot percent defective is equal to zero for the number of consecutive lots indicated in brackets. In addition, all other conditions for reduced inspection, in Part III of Section C, must be satisfied.

All estimates of the lot percent defective are obtained from Table C-5.

TABLE C-8

Values of f for Maximum Average Range (MAR)

Sample size code letter	Sample size	Acceptable Quality Levels (in percent defective)													
		.04	.065	.10	.15	.25	.40	.65	1.00	1.50	2.50	4.00	6.50	10.00	15.00
B	3										.833	.865	.907	.958	1.028
C	4								.756	.788	.836	.891	.965	1.056	1.180
D	5							.730	.764	.801	.857	.923	1.011	1.118	1.263
E	7					.695	.727	.765	.804	.846	.910	.985	1.086	1.209	1.374
F	10				.529	.553	.579	.610	.642	.677	.730	.793	.876	.977	1.112
G	15	.444	.460	.477	.493	.517	.542	.572	.602	.637	.688	.748	.830	.928	1.058
H	25	.416	.432	.447	.463	.486	.509	.537	.567	.600	.649	.707	.785	.879	1.004
I	30	.411	.426	.442	.457	.480	.503	.531	.560	.593	.642	.699	.776	.870	.993
J	35	.408	.423	.438	.454	.476	.499	.527	.556	.588	.637	.694	.771	.864	.987
K	40	.402	.417	.432	.447	.469	.492	.519	.548	.580	.628	.684	.761	.852	.968
L	50	.396	.411	.426	.441	.463	.486	.503	.542	.573	.621	.676	.752	.843	.963
M	60	.390	.405	.419	.434	.455	.478	.505	.533	.564	.608	.666	.740	.830	.949
N	85	.382	.398	.412	.427	.448	.470	.497	.525	.555	.602	.656	.729	.818	.934
O	115	.378	.392	.406	.421	.442	.464	.490	.517	.548	.594	.648	.720	.808	.923
P	175	.371	.384	.399	.413	.434	.455	.481	.508	.538	.584	.637	.708	.794	.908
Q	230	.369	.384	.397	.412	.432	.454	.480	.507	.536	.582	.633	.706	.792	.906

The MAR may be obtained by multiplying the factor f by the difference between the upper specification limit U and lower specification limit L. The formula is MAR = f(U-L). The MAR serves as a guide for the magnitude of the average range of the sample when using plans for the double specification limit case, based on the average range of the sample of unknown variability. The average range of the sample, if it is less than the MAR, helps to insure, but does not guarantee, lot acceptability.

NOTE: There is a corresponding acceptability constant in Table C-1 for each value of f. For reduced inspection, find the acceptability constant of Table C-2 in Table C-1 and use the corresponding value of f.

APPENDIX C

Definitions

Symbol	Read	Definitions
n		Sample size for a single lot.
$\bar{X}$	X bar	Sample mean. Arithmetic mean of sample measurements from a single lot.
R		Range. The difference between the largest and smallest measurements in a subgroup. In this Standard, the subgroup size is 5 except for those plans in which n = 3, 4, or 7, in which case the subgroup is the same as the sample size.
R_1		Range of the first subgroup.
R_2		Range of the second subgroup.
$\bar{R}$	R bar	Average range. The arithmetic mean of the range values of the subgroups of the sample measurements from a single lot.
U		Upper specification limit.
L		Lower specification limit.
k		The acceptability constant given in Tables C-1 and C-2.
c		A factor used in determining the quality index when using the range method. The c values are given in Tables C-3 and C-4.
Q_U	Q sub U	Quality index for use with Table C-5.
Q_L	Q sub L	Quality index for use with Table C-5.
p_U	p sub U	Sample estimate of the lot percent defective above U from Table C-5.
p_L	p sub L	Sample estimate of the lot percent defective below L from Table C-5.
p		Total sample estimate of the lot percent defective $p = p_U + p_L$.
M		Maximum allowable percent defective for sample estimates given in Tables C-3 and C-4.
M_U	M sub U	Maximum allowable percent defective above U given in Tables C-3 and C-4. (For use when different AQL values for U and L are specified.)
M_L	M sub L	Maximum allowable percent defective below L given in Tables C-3 and C-4. (For use when different AQL values for U and L are specified.)
$\bar{p}$	p bar	Sample estimate of the process percent defective, i.e., the estimated process average.
$\bar{p}_U$	p bar sub U	The estimated process average for an upper specification limit.
$\bar{p}_L$	p bar sub L	The estimated process average for a lower specification limit.
T		The maximum number of estimated process averages which may exceed the AQL given in Table C-6. (For use in determining application to tightened inspection.)

SECTION D

VARIABILITY KNOWN

Part I

SINGLE SPECIFICATION LIMIT

D1. SAMPLING PLAN FOR SINGLE SPECIFICATION LIMIT

This part of the Standard describes the procedures for use with plans for a single specification limit when variability of the lot with respect to the quality characteristic is known. The acceptability criterion is given in two equivalent forms. These are identified as Form 1 and Form 2.

D1.1 Use of Sampling Plans. To determine whether the lot meets the acceptability criterion with respect to a particular quality characteristic and AQL value, the applicable sampling plan shall be used in accordance with the provisions of Section A, General Description of Sampling Plans, and those in this part of the Standard.

D1.2 Drawing of Samples. All samples shall be drawn in accordance with paragraph A7.2.

D1.3 Determination of Sample Size Code Letter. The sample size code letter shall be selected from Table A-2 in accordance with paragraph A7.1.

D2. SELECTING THE SAMPLING PLAN WHEN FORM 1 IS USED

D2.1 Master Sampling Tables. The master sampling tables for plans based on variability known for a single specification limit are Tables D-1 and D-2. Table D-1 is used for normal and tightened inspection and Table D-2 for reduced inspection.

D2.2 Obtaining Sampling Plan. The sampling plan consists of a sample size and an associated acceptability constant.[1] The sampling plan is obtained from Master Table D-1 and D-2.

D2.2.1 Sample Size. The sample size n is shown in the master table corresponding to each sample size code letter and AQL.

D2.2.2 Acceptability Constant. The acceptability constant k, corresponding to the sample size mentioned in paragraph D2.2.1, is indicated in the column of the master table corresponding to the applicable AQL value. Table D-1 is entered from the top for normal inspection and from the bottom for tightened inspection. Sampling plans for reduced inspection are provided in Table D-2.

D3. LOT-BY-LOT ACCEPTABILITY PROCEDURES WHEN FORM 1 IS USED[2]

D3.1 Acceptability Criterion. The degree of conformance of a quality characteristic with respect to a single specification limit shall be judged by the quantity $(U-\bar{X})/\sigma$ or $(\bar{X}-L)/\sigma$.

D3.2 Computation. The following quantity shall be computed: $(U-\bar{X})/\sigma$ or $(\bar{X}-L)/\sigma$, depending on whether the specification limit is an upper or a lower limit, where

U is the upper specification limit,
L is the lower specification limit,
$\bar{X}$ is the sample mean, and
σ is the known variability.

D3.3 Acceptability Criterion. Compare the quantity $(U-\bar{X})/\sigma$ or $(\bar{X}-L)/\sigma$ with the acceptability constant k. If $(U-\bar{X})/\sigma$ or $(\bar{X}-L)/\sigma$ is equal to or greater than k, the lot meets the acceptability criterion; if $(U-\bar{X})/\sigma$ or $(\bar{X}-L)/\sigma$ is less than k or negative, then the lot does not meet the acceptability criterion.

D4. SUMMARY FOR OPERATION OF SAMPLING PLAN WHEN FORM 1 IS USED

The following steps summarize the procedures to be followed:

(1) Determine the sample size code letter from Table A-2 by using the lot size and the inspection level.

[1] See Appendix D for definitions of all symbols used in the sampling plans based on variability known.
[2] See Example D-1 for a complete example of this procedure.

(2) Obtain plan from Master Table D-1 or D-2 by selecting the sample size n and the acceptability constant k.

(3) Select at random the sample of n units from the lot; inspect and record the measurement of the quality characteristic for each unit of the sample.

(4) Compute the sample mean $\bar{X}$, and also compute the quantity $(U-\bar{X})/\sigma$ for an upper specification limit U or the quantity $(\bar{X}-L)/\sigma$ for a lower specification limit L.

(5) If the quantity $(U-\bar{X})/\sigma$ or $(\bar{X}-L)/\sigma$ is equal to or greater than k, the lot meets the acceptability criterion; if $(U-\bar{X})/\sigma$ or $(\bar{X}-L)/\sigma$ is less than k or negative, then the lot does not meet the acceptability criterion.

D5. SELECTING THE SAMPLING PLAN WHEN FORM 2 IS USED

D5.1 Master Sampling Tables. The master sampling tables for plans based on variability known for a single specification limit are Tables D-3 and D-4 of Part II. Table D-3 is used for normal and tightened inspection and Table D-4 for reduced inspection.

D5.2 Obtaining the Sampling Plan. The sampling plan consists of a sample size and an associated maximum allowable percent defective. The sampling plan is obtained from Master Table D-3 or D-4.

D5.2.1 Sample Size. The sample size n is shown in the master table corresponding to each sample size code letter.

D5.2.2 Maximum Allowable Percent Defective. The maximum allowable percent defective M for sample estimates corresponding to the sample size mentioned in paragraph D5.2.1 is indicated in the column of the master table corresponding to the applicable AQL value. Table D-3 is entered from the top for normal inspection and from the bottom for tightened inspection. Sampling plans for reduced inspection are provided in Table D-4.

D6. LOT-BY-LOT ACCEPTABILITY PROCEDURES WHEN FORM 2 IS USED[3]

D6.1 Acceptability Criterion. The degree of conformance of a quality characteristic with respect to a single specification limit shall be judged by the percent of nonconforming product outside the upper or lower specification limit. The percentage of nonconforming product is estimated by entering Table D-5 with the quality index.

D6.2 Computation of Quality Index. The quality index $Q_U = (U-\bar{X})v/\sigma$ shall be computed if the specification limit is an upper limit U, or $Q_L = (\bar{X}-L)v/\sigma$ if it is a lower limit L. The quantities, $\bar{X}$ and σ, are the sample mean and known variability, respectively. The factor v is provided in Tables D-3 and D-4 corresponding to the sample size.

D6.3 Estimate of Percent Defective in Lot. The quality of a lot shall be expressed by p_U, the estimated percent defective in the lot above the upper specification limit, or by p_L, the estimated percent defective below the lower specification limit. The estimated percent defective p_U or p_L is obtained by entering Table D-5 with Q_U or Q_L.

D6.4 Acceptability Criterion. Compare the estimated lot percent defective p_U or p_L with the maximum allowable percent defective M. If p_U or p_L is equal to or less than M, the lot meets the acceptability criterion; if p_U or p_L is greater than M or if Q_U or Q_L is negative, then the lot does not meet the acceptability criterion.

D7. SUMMARY FOR OPERATION OF SAMPLING PLAN WHEN FORM 2 IS USED

The following steps summarize the procedures to be followed:

(1) Determine the sample size code letter from Table A-2 by using the lot size and the inspection level.

(2) Obtain plan from Master Table D-3 or D-4 by selecting the sample size n, the factor v, and the maximum allowable percent defective M.

(3) Select at random the sample of n units from the lot; inspect and record the measurement of the quality characteristic on each unit of the sample.

(4) Compute the sample mean $\bar{X}$.

(5) Compute the quality index $Q_U = (U-\bar{X})v/\sigma$ if an upper specification limit U is specified, or $Q_L = (\bar{X}-L)v/\sigma$ if a lower specification limit L is specified.

(6) Determine the estimated lot percent defective p_U or p_L from Table D-5.

[3] See Example D-2 for a complete example of this procedure.

(7) If the estimated lot percent defective p_U or p_L is equal to or less than the maximum allowable percent defective M, the lot meets the acceptability criterion; if p_U or p_L is greater than M or if Q_U or Q_L is negative, then the lot does not meet the acceptability criterion.

EXAMPLE D-1

Example of Calculations

Single Specification Limit—Form 1

Variability Known

Example The specified minimum yield point for certain steel castings is 58,000 psi. A lot of 500 items is submitted for inspection. Inspection Level IV, normal inspection, with AQL = 1.5% is to be used. The variability σ is known to be 3000 psi. From Tables A-2 and D-1 it is seen that a sample of size 10 is required. Suppose the yield points of the sample specimens are:

62,500; 60,500; 68,000; 59,000; 65,500;
62,000; 61,000; 69,000; 58,000; 64,500;

and compliance with the acceptability criterion is to be determined.

Line	Information Needed	Value Obtained	Explanation
1	Sample Size: n	10	
2	Known Variability: σ	3,000	
3	Sum of Measurements: ΣX	630,000	
4	Sample Mean $\bar{X}$: $\Sigma X/n$	63,000	63,000/10
5	Specification Limit (Lower): L	58,000	
6	The Quantity: $(\bar{X}-L)/\sigma$	1.67	(63,000-58,000)/3000
7	Acceptability Constant: k	1.70	See Table D-1
8	Acceptability Criterion: Compare $(\bar{X}-L)/\sigma$ with k	1.67 < 1.70	See Para. D3.3

The lot does not meet the acceptability criterion, since $(\bar{X}-L)/\sigma$ is less than k.

NOTE: If a single upper specification limit U is given, then compute the quantity $(U-\bar{X})/\sigma$ in line 6 and compare it with k; the lot meets the acceptability criterion if $(U-\bar{X})/\sigma$ is equal to or greater than k.

EXAMPLE D-2

Example of Calculations

Single Specification Limit—Form 2

Variability Known

Example The specified minimum yield point for certain steel castings is 58,000 psi. A lot of 500 items is submitted for inspection. Inspection Level IV, normal inspection, with AQL = 1.5% is to be used. The variability σ is known to be 3000 psi. From Tables A-2 and D-1 it is seen that a sample of size 10 is required. Suppose the yield points of the sample specimens are:

62,500; 60,500; 68,000; 59,000; 65,500;
62,000; 61,000; 69,000; 58,000; 64,500;

and compliance with the acceptability criterion is to be determined.

Line	Information Needed	Value Obtained	Explanation
1	Sample Size: n	10	
2	Known Variability: σ	3,000	
3	Sum of Measurements: ΣX	630,000	
4	Sample Mean $\bar{X}$: $\Sigma X/n$	63,000	630,000/10
5	Factor: v	1.054	
6	Specification Limit (Lower): L	58,000	
7	Quality Index: $Q_L = (\bar{X}-L)v/\sigma$	1.76	$\frac{(63,000-58,000)1.054}{3,000}$
8	Est. of Lot Percent Def: p_L	3.92%	See Table D-5
9	Max. Allowable Percent Def.: M	3.63%	See Table D-3
10	Acceptability Criterion: Compare p_L with M	3.92% > 3.63%	See Para. D6.4

The lot does not meet the acceptability criterion, since p_L is greater than M.

NOTE: If a single upper specification limit U is given, then compute the quality index $Q_U = (U-\bar{X})v/\sigma$ in line 7 and obtain the estimate of the percent defective p_U. Compare p_U with M; the lot meets the acceptability criterion if p_U is equal to or less than M.

TABLE D-1

Master Table for Normal and Tightened Inspection for Plans Based on Variability Known
(Single Specification Limit—Form 1)

Sample size code letter	Acceptable Quality Levels (normal inspection)						
	.04	.065	.10	.15	.25	.40	.65
	n k	n k	n k	n k	n k	n k	n k
B	↓	↓	↓	↓	↓	↓	↓
C	↓	↓	↓	↓	↓	↓	↓
D	↓	↓	↓	↓	↓	↓	2 1.58
E	↓	↓	↓	↓	2 1.94	2 1.81	3 1.69
F	↓	↓	↓	3 2.19	3 2.07	3 1.91	4 1.80
G	3 2.58	3 2.49	4 2.39	4 2.30	4 2.14	5 2.05	5 1.88
H	4 2.63	4 2.55	5 2.46	5 2.34	6 2.23	6 2.08	7 1.95
I	5 2.69	6 2.59	6 2.49	6 2.37	7 2.25	8 2.13	8 1.96
J	6 2.72	6 2.58	7 2.50	7 2.38	8 2.26	9 2.13	10 1.99
K	7 2.77	7 2.63	8 2.54	9 2.45	9 2.29	10 2.16	11 2.01
L	8 2.77	8 2.64	9 2.54	10 2.45	11 2.31	12 2.18	13 2.03
M	10 2.83	11 2.72	11 2.59	12 2.49	13 2.35	14 2.21	16 2.07
N	14 2.88	15 2.77	16 2.65	17 2.54	19 2.41	21 2.27	23 2.12
O	19 2.92	20 2.80	22 2.69	23 2.57	25 2.43	27 2.29	30 2.14
P	27 2.96	30 2.84	31 2.72	34 2.62	37 2.47	40 2.33	44 2.17
Q	37 2.97	40 2.85	42 2.73	45 2.62	49 2.48	54 2.34	59 2.18
	.065	.10	.15	.25	.40	.65	1.00
	Acceptable Quality Levels (tightened inspection)						

All AQL values are in percent defective.

↓ Use first sampling plan below arrow, that is, both sample size as well as k value. When sample size equals or exceeds lot size, every item in the lot must be inspected.

TABLE D-1—Continued

Master Table for Normal and Tightened Inspection for Plans Based on Variability Known
(Single Specification Limit—Form 1)

Sample size code letter	Acceptable Quality Levels (normal inspection)													
	1.00		1.50		2.50		4.00		6.50		10.00		15.00	
	n	k	n	k	n	k	n	k	n	k	n	k	n	k
B	▼		▼		▼		▼		▼		▼		▼	
C	2	1.36	2	1.25	2	1.09	2	.936	3	.755	3	.573	4	.344
D	2	1.42	2	1.33	3	1.17	3	1.01	3	.825	4	.641	4	.429
E	3	1.56	3	1.44	4	1.28	4	1.11	5	.919	5	.728	6	.515
F	4	1.69	4	1.53	5	1.39	5	1.20	6	.991	7	.797	8	.584
G	6	1.78	6	1.62	7	1.45	8	1.28	9	1.07	11	.877	12	.649
H	7	1.80	8	1.68	9	1.49	10	1.31	12	1.11	14	.906	16	.685
I	9	1.83	10	1.70	11	1.51	13	1.34	15	1.13	17	.924	20	.706
J	11	1.86	12	1.72	13	1.53	15	1.35	18	1.15	21	.942	24	.719
K	12	1.88	14	1.75	15	1.56	18	1.38	20	1.17	24	.964	27	.737
L	14	1.89	15	1.75	18	1.57	20	1.38	23	1.17	27	.965	31	.741
M	17	1.93	19	1.79	22	1.61	25	1.42	29	1.21	33	.995	38	.770
N	25	1.97	28	1.84	32	1.65	36	1.46	42	1.24	49	1.03	56	.803
O	33	2.00	36	1.86	42	1.67	48	1.48	55	1.26	64	1.05	75	.819
P	49	2.03	54	1.89	61	1.69	70	1.51	82	1.29	95	1.07	111	.841
Q	65	2.04	71	1.89	81	1.70	93	1.51	109	1.29	127	1.07	147	.845
	1.50		2.50		4.00		6.50		10.00		15.00			
	Acceptable Quality Levels (tightened inspection)													

All AQL values are in percent defective.

▼ Use first sampling plan below arrow, that is, both sample size as well as k value. When sample size equals or exceeds lot size, every item in the lot must be inspected.

TABLE D-2

Master Table for Reduced Inspection for Plans Based on Variability Known
(Single Specification Limit—Form 1)

Sample size code letter	Acceptable Quality Levels						
	.04	.065	.10	.15	.25	.40	.65
	n k	n k	n k	n k	n k	n k	n k
B	↓	↓	↓	↓	↓	↓	↓
C	↓	↓	↓	↓	↓	↓	↓
D	↓	↓	↓	↓	↓	↓	↓
E	↓	↓	↓	↓	↓	↓	↓
F	↓	↓	↓	↓	↓	↓	2 1.36
G	↓	↓	↓	↓	↓	2 1.58	2 1.42
H	↓	↓	↓	2 1.94	2 1.81	3 1.69	3 1.56
I	↓	↓	3 2.19	3 2.07	3 1.91	4 1.80	4 1.69
J	↓	↓	3 2.19	3 2.07	3 1.91	4 1.80	4 1.69
K	3 2.49	4 2.39	4 2.30	4 2.14	5 2.05	5 1.88	6 1.78
L	4 2.55	5 2.46	5 2.34	6 2.23	6 2.08	7 1.95	7 1.80
M	4 2.55	5 2.46	5 2.34	6 2.23	6 2.08	7 1.95	7 1.80
N	6 2.59	6 2.49	6 2.37	7 2.25	8 2.13	8 1.96	9 1.83
O	6 2.58	7 2.50	7 2.38	8 2.26	9 2.13	10 1.99	11 1.86
P	11 2.72	11 2.59	12 2.49	13 2.35	14 2.21	16 2.07	17 1.93
Q	15 2.77	16 2.65	17 2.54	19 2.41	21 2.27	23 2.12	25 1.97

All AQL values are in percent defective.

Use first sampling plan below arrow, that is, both sample size as well as k value. When sample size equals or exceeds lot size, every item in the lot must be inspected.

TABLE D-2—Continued

Master Table for Reduced Inspection for Plans Based on Variability Known
(Single Specification Limit—Form 1)

Sample size code letter	Acceptable Quality Levels											
	1.00		1.50		2.50		4.0		6.5		10.00	
	n	k	n	k	n	k	n	k	n	k	n	k
B	↓		↓		↓		↓		↓		↓	
C												
D												
E												
F	2	1.25	2	1.09	2	.936	3	.755	3	.573	4	.344
G	2	1.33	3	1.17	3	1.01	3	.825	4	.641	4	.429
H	3	1.44	4	1.28	4	1.11	5	.919	5	.728	6	.515
I	4	1.53	5	1.39	5	1.20	6	.991	7	.797	8	.584
J	4	1.53	5	1.39	5	1.20	6	.991	7	.797	8	.584
K	6	1.62	7	1.45	8	1.28	9	1.07	11	.877	12	.649
L	8	1.68	9	1.49	10	1.31	12	1.11	14	.906	16	.685
M	8	1.68	9	1.49	10	1.31	12	1.11	14	.906	16	.685
N	10	1.70	11	1.51	13	1.34	15	1.13	17	.924	20	.706
O	12	1.72	13	1.53	15	1.35	18	1.15	21	.942	24	.719
P	19	1.79	22	1.61	25	1.42	29	1.21	33	.995	38	.770
Q	28	1.84	32	1.65	36	1.46	42	1.24	49	1.03	56	.803

All AQL values are in percent defective.

↓ Use first sampling plan below arrow, that is, both sample size as well as k value. When sample size equals or exceeds lot size, every item in the lot must be inspected.

Part II

DOUBLE SPECIFICATION LIMIT

D8. SAMPLING PLAN FOR DOUBLE SPECIFICATION LIMIT

This part of the Standard describes the procedures for use with plans for a double specification limit when variability of the lot with respect to the quality characteristic is known.

D8.1 Use of Sampling Plans. To determine whether the lot meets the acceptability criterion with respect to a particular quality characteristic and AQL value(s), the applicable sampling plan shall be used in accordance with the provisions of Section A, General Description of Sampling Plans, and those in this part of the Standard.

D9. SELECTING THE SAMPLING PLAN

A sampling plan for each AQL value shall be selected from Table D-3 or D-4 as follows:

D9.1 Determination of Sample Size Code Letter. The sample size code letter shall be selected from Table A-2 in accordance with paragraph A7.1.

D9.2 Master Sampling Tables. The master sampling tables for plans based on variability known for a double specification limit are Tables D-3 and D-4. Table D-3 is used for normal and tightened inspection and Table D-4 for reduced inspection.

D9.3 Obtaining Sampling Plan. A sampling plan consists of a sample size and an associated maximum allowable percent defective(s). The sampling plan to be applied in inspection shall be obtained from Master Table D-3 or D-4.

D9.3.1 Sample Size. The sample size n is shown in the master tables corresponding to each sample size code letter and AQL.

D9.3.2 Maximum Allowable Percent Defective. The maximum allowable percent defective for sample estimates of percent defective for the lower, upper, or both specification limits combined, corresponding to the sample size mentioned in paragraph D9.3.1, is shown in the column of the master table corresponding to the applicable AQL value(s). If different AQL's are assigned to each specification limit, designate the maximum allowable percent defective by M_L for the lower limit, and by M_U for the upper limit. If one AQL is assigned to both limits combined, designate the maximum allowable percent defective by M. Table D-3 is entered from the top for normal inspection and from the bottom for tightened inspection. Sampling plans for reduced inspection are provided in Table D-4.

D10. DRAWING OF SAMPLES

Samples shall be selected in accordance with paragraph A7.2.

D11. LOT-BY-LOT ACCEPTABILITY PROCEDURES

D11.1 Acceptability Criterion. The degree of conformance of a quality characteristic with respect to a double specification limit shall be judged by the percent of nonconforming product. The percentage of nonconforming product is estimated by entering Table D-5 with the quality index.

D11.2 Computation of Quality Indices. The quality indices $Q_U = (U-\bar{X})v/\sigma$ and $Q_L = (\bar{X}-L)v/\sigma$ shall be computed, where

U is the upper specification limit,
L is the lower specification limit,
v is a factor provided in Tables D-3 and D-4,
$\bar{X}$ is the sample mean, and
σ is the known variability.

D11.3 Percent Defective in the Lot. The quality of a lot shall be expressed in terms of the lot percent defective. Its estimate will be designated by p_L, p_U, or p. The estimate p_U indicates conformance with respect to the upper specification limit, p_L with respect to the lower specification limit, and p for both specification limits combined. The estimates p_L and p_U shall be determined by entering Table D-5, respectively with Q_L and Q_U. The estimate p shall be determined by adding the corresponding estimated percent defectives p_L and p_U found in the table.

D12. ACCEPTABILITY CRITERION AND SUMMARY FOR OPERATION OF SAMPLING PLANS

D12.1 One AQL value for both Upper and Lower Specification Limit Combined.

D12.1.1 Acceptability Criterion.[4] Compare the estimated lot percent defective $p = p_U + p_L$ with the maximum allowable percent defective M. If p is equal to or less than M, the lot meets the acceptability criterion; if p is greater than M or if Q_U or Q_L or both are negative, then the lot does not meet the acceptability criterion.

D12.1.2 Summary of Operation of Sampling Plan. In cases where a single AQL value is established for the upper and lower specification limit combined for a single quality characteristic, the following steps summarize the procedures to be used:

(1) Determine the sample size code letter from Table A-2 by using the lot size and the inspection level.

(2) Select plan from Master Table D-3 or D-4. Obtain the sample size n, the factor v, and the maximum allowable percent defective M.

(3) Select at random the sample of n units from the lot; inspect and record the measurement of the quality characteristic on each unit of the sample.

(4) Compute the sample mean $\bar{X}$.

(5) Compute the quality indices $Q_U = (U-\bar{X})v/\sigma$ and $Q_L = (\bar{X}-L)v/\sigma$.

(6) Determine the estimated lot percent defective $p = p_U + p_L$ from Table D-5.

(7) If the estimated lot percent defective p is equal to or less than the maximum allowable percent defective M, the lot meets the acceptability criterion; if p is greater than M or if Q_U or Q_L or both are negative, then the lot does not meet the acceptability criterion.

D12.2 Different AQL Values for Upper and Lower Specification Limit.

D12.2.1 Acceptability Criteria.[5] Compare the estimated lot percent defectives p_L and p_U with the corresponding maximum allowable percent defectives M_L and M_U; also compare $p = p_L + p_U$ with the larger of M_L and M_U. If p_L is equal to or less than M_L, p_U is equal to or less than M_U, and p is equal to or less than the larger of M_L and M_U, the lot meets the acceptability criteria; otherwise, the lot does not meet the acceptability criteria. If either Q_L or Q_U or both are negative, then the lot does not meet the acceptability criteria.

D12.2.2 Summary of Operation of Sampling Plan. In cases where a different AQL value is established for the upper and lower specification limit for a single quality characteristic, the following steps summarize the procedures to be used:

(1) Determine the sample size code letter from Table A-2 by using the lot size and inspection level.

(2) Select the sampling plan from Master Table D-3 or D-4. Obtain the sample size n and the factor v, corresponding to the larger of the two AQL values, and also the maximum allowable percent defectives M_U and M_L, corresponding to the AQL values for the upper and lower specification limits, respectively.

(3) Select at random the sample of n units from the lot; inspect and record the measurement of the quality characteristic on each unit in the sample.

(4) Compute the sample mean $\bar{X}$.

(5) Compute the quality indices $Q_U = (U-\bar{X})v/\sigma$ and $Q_L = (\bar{X}-L)v/\sigma$.

(6) Determine the estimated lot percent defectives p_U and p_L, corresponding to the percent defectives above the upper and below the lower specification limits. Also determine the combined percent defective $p = p_U + p_L$.

(7) If all three of the following conditions:

(a) p_U is equal to or less than M_U.

(b) p_L is equal to or less than M_L.

(c) p is equal to or less than the larger of M_L and M_U.

are satisfied, the lot meets the acceptability criteria; otherwise, the lot does not meet the acceptability criteria. If either Q_L or Q_U or both are negative, then the lot does not meet the acceptability criteria.

[4] See Example D-3 for a complete example of this procedure.
[5] See Example D-4 for a complete example of this procedure.

EXAMPLE D-3

Example of Calculations

Double Specification Limit

Variability Known

One AQL Value for Both Upper and Lower Specification Limit Combined

Example The specified maximum and minimum yield points for certain steel castings are 67,000 psi and 58,000 psi, respectively. A lot of 500 items is submitted for inspection. Inspection Level IV, normal inspection, with AQL = 1.5% is to be used. The variability σ is known to be 3,000 psi. From Tables A-2 and D-3 it is seen that a sample of size 10 is required. Suppose the yield points of the sample specimens are:

62,500; 60,500; 68,000; 59,000; 65,500;
62,000; 61,000; 69,000; 58,000; 64,500;

and compliance with the acceptability criterion is to be determined.

Line	Information Needed	Value Obtained	Explanation
1	Sample Size: n	10	
2	Known Variability: σ	3,000	
3	Sum of Measurements: ΣX	630,000	
4	Sample Mean $\bar{X}$: $\Sigma X/n$	63,000	630,000/10
5	Factor: v	1.054	See Table D-3
6	Upper Specification Limit: U	67,000	
7	Lower Specification Limit: L	58,000	
8	Quality Index: $Q_U = (U-\bar{X})v/\sigma$	1.41	(67,000-63,000)1.054/3,000
9	Quality Index: $Q_L = (\bar{X}-L)v/\sigma$	1.76	(63,000-58,000)1.054/3,000
10	Est. of Lot Percent Def. Above U: p_U	7.93%	See Table D-5
11	Est. of Lot Percent Def. Below L: p_L	3.92%	See Table D-5
12	Total Est. Percent Def. in Lot: $p = p_U + p_L$	11.85%	7.93% + 3.92%
13	Max. Allowable Percent Def.: M	3.63%	See Table D-3
14	Acceptability Criterion: Compare $p = p_U + p_L$ with M	11.85% > 3.63%	See Para. D11.4

The lot does not meet the acceptability criterion, since $p = p_U + p_L$ is greater than M.

EXAMPLE D-4

Example of Calculations

Double Specification Limit

Variability Known

Different AQL Values for Upper and Lower Specification Limits

Example The specified maximum and minimum yield points for certain steel castings are 67,000 psi and 58,000 psi, respectively. A lot of 500 items is submitted for inspection. Inspection Level IV, normal inspection with AQL = 1% for the upper and AQL = 2.5% for the lower specification limit is to be used. The variability σ is known to be 3,000 psi. From Tables A-2 and D-3 it is seen that a sample of size 11 corresponding to the sample size code letter, J, and the AQL value of 2.5% is required. Suppose the yield points of the sample specimens are:

62,500; 60,500; 64,000; 59,000; 65,500;
62,000; 61,000; 60,631; 68,000; 62,000; 63,000

and compliance with the acceptability criteria is to be determined.

Line	Information Needed	Value Obtained	Explanation
1	Sample Size: n	11	
2	Known Variability: σ	3,000	
3	Sum of Measurements: ΣX	678,131	
4	Sample Mean $\bar{X}$: $\Sigma X/n$	61,648	678,131/11
5	Factor: v	1.049	See Table D-3
6	Upper Specification Limit: U	67,000	
7	Lower Specification Limit: L	58,000	
8	Quality Index: $Q_U = (U-\bar{X})v/\sigma$	1.87	(67,000-61,648)1.049/3,000
9	Quality Index: $Q_L = (\bar{X}-L)v/\sigma$	1.28	(61,648-58,000)1.049/3,000
10	Est. of Lot Percent Def. Above U: p_U	3.07%	See Table D-5
11	Est. of Lot Percent Def. Below L: p_L	10.03%	See Table D-5
12	Total Est. Percent Def. in Lot: $p = p_U + p_L$	13.10%	3.07% + 10.03%
13	Max. Allowable Percent Def. Above U: M_U	2.59%	See Table D-3
14	Max. Allowable Percent Def. Below L: M_L	5.60%	See Table D-3
15	Acceptability Criteria: (a) Compare p_U with M_U	3.07% > 2.59%	See Para. D12.2.2(7)(a)
	(b) Compare p_L with M_L	10.03% > 5.60%	See Para. D12.2.2(7)(b)
	(c) Compare p with M_L	13.10% > 5.60%	See Para. D12.2.2(7)(c)

The lot does not meet the acceptability criteria, since 15(a), (b) and (c) are not satisfied; i.e., $p_U > M_U$, $p_L > M_L$, and $p > M_L$.

TABLE D-3

Master Table for Normal and Tightened Inspection for Plans Based on Known Variability
(Double Specification Limit and Form 2—Single Specification Limit)

Sample size code letter	Acceptable Quality Levels (normal inspection)																				
	.04			.065			.10			.15			.25			.40			.65		
	n	M	v	n	M	v	n	M	v	n	M	v	n	M	v	n	M	v	n	M	v
B	↓			↓			↓			↓			↓			↓			↓		
C																					
D													↓			↓			2	1.28	1.414
E													2	.310	1.414	2	.510	1.414	3	1.94	1.225
F										3	.369	1.225	3	.568	1.225	3	.959	1.225	4	1.88	1.155
G	3	.079	1.225	3	.114	1.225	4	.290	1.155	4	.399	1.155	4	.681	1.155	5	1.09	1.118	5	1.76	1.118
H	4	.111	1.115	4	.161	1.155	5	.296	1.118	5	.445	1.118	6	.721	1.095	6	1.14	1.095	7	1.75	1.080
I	5	.130	1.118	6	.230	1.095	6	.321	1.095	6	.478	1.095	7	.756	1.080	8	1.14	1.069	8	1.80	1.069
J	6	.145	1.095	6	.234	1.095	7	.343	1.080	7	.507	1.080	8	.791	1.069	9	1.18	1.061	10	1.79	1.054
K	7	.141	1.080	7	.226	1.080	8	.330	1.069	9	.469	1.061	9	.760	1.061	10	1.14	1.054	11	1.73	1.049
L	8	.153	1.069	8	.243	1.069	9	.351	1.061	10	.494	1.054	11	.768	1.049	12	1.15	1.045	13	1.74	1.041
M	10	.141	1.054	11	.217	1.049	11	.326	1.049	12	.461	1.045	13	.721	1.041	14	1.08	1.038	16	1.62	1.003
N	14	.138	1.038	15	.211	1.035	16	.308	1.033	17	.438	1.031	19	.673	1.027	21	1.00	1.025	23	1.51	1.023
O	19	.134	1.027	20	.207	1.026	22	.296	1.024	23	.423	1.023	25	.655	1.021	27	.980	1.019	30	1.47	1.017
P	27	.129	1.019	30	.193	1.017	31	.283	1.017	34	.397	1.015	37	.615	1.014	40	.921	1.013	44	1.39	1.012
Q	37	.130	1.014	40	.196	1.013	42	.285	1.012	45	.402	1.011	49	.620	1.010	54	.920	1.009	59	1.39	1.009
	.065			.10			.15			.25			.40			.65			1.00		
	Acceptable Quality Levels (tightened inspection)																				

All AQL and table values are in percent defective.

↓ Use first sampling plan below arrow, that is, both sample size as well as M value. When sample size equals or exceeds lot size, every item in the lot must be inspected.

TABLE D-3—Continued

Master Table for Normal and Tightened Inspection for Plans Based on Known Variability
(Double Specification Limit and Form 2—Single Specification Limit)

Sample size code letter	Acceptable Quality Levels (normal inspection)																				
	1.00			1.50			2.50			4.00			6.50			10.00			15.00		
	n	M	v	n	M	v	n	M	v	n	M	v	n	M	v	n	M	v	n	M	v
B	▼			▼			▼			▼			▼			▼			▼		
C	2	2.73	1.414	2	3.90	1.414	2	6.11	1.414	6	9.27	1.414	3	17.74	1.225	3	24.22	1.225	4	33.67	1.155
D	2	2.23	1.414	2	3.00	1.414	3	7.56	1.225	3	10.79	1.225	3	15.60	1.225	4	22.97	1.155	4	31.01	1.155
E	3	2.76	1.225	3	3.85	1.225	4	6.99	1.155	4	9.97	1.155	5	15.21	1.118	5	20.80	1.118	6	28.64	1.095
F	4	2.58	1.155	4	3.87	1.155	5	6.05	1.118	5	8.92	1.118	6	13.89	1.095	7	19.46	1.080	8	26.64	1.069
G	6	2.57	1.095	6	3.77	1.095	7	5.83	1.080	8	8.62	1.069	9	12.88	1.061	11	17.88	1.049	12	24.88	1.045
H	7	2.62	1.080	8	3.68	1.069	9	5.68	1.061	10	8.43	1.054	12	12.35	1.045	14	17.36	1.038	16	23.96	1.033
I	9	2.59	1.061	10	3.63	1.054	11	5.60	1.049	13	8.13	1.041	15	12.04	1.035	17	17.05	1.031	20	23.43	1.026
J	11	2.57	1.049	12	3.61	1.045	13	5.58	1.041	15	8.13	1.035	18	11.88	1.029	21	16.71	1.025	24	23.13	1.022
K	12	2.49	1.045	14	3.43	1.038	15	5.34	1.035	18	7.72	1.029	20	11.57	1.026	24	16.23	1.022	27	22.63	1.019
L	14	2.51	1.038	15	3.54	1.035	18	5.29	1.029	20	7.80	1.026	23	11.56	1.023	27	16.27	1.019	31	22.57	1.017
M	17	2.35	1.031	19	3.28	1.027	22	4.98	1.024	25	7.34	1.021	39	10.93	1.018	35	15.61	1.016	38	21.77	1.013
N	25	2.19	1.021	28	3.05	1.018	32	4.68	1.016	36	6.95	1.014	42	10.40	1.012	49	14.87	1.010	56	20.90	1.009
O	33	2.12	1.016	36	2.99	1.014	42	4.55	1.012	48	6.75	1.011	55	10.17	1.009	64	14.58	1.008	75	20.48	1.007
P	49	2.00	1.010	54	2.82	1.009	61	4.35	1.008	70	6.48	1.007	82	9.76	1.006	95	14.09	1.005	111	19.90	1.005
Q	65	2.00	1.008	71	2.82	1.007	81	4.34	1.006	93	6.46	1.005	109	9.73	1.005	127	14.02	1.004	147	19.84	1.003
	1.50			2.50			4.00			6.50			10.00			15.00					
	Acceptable Quality Levels (tightened inspection)																				

All AQL and table values are in percent defective.

▼ Use first sampling plan below arrow, that is, both sample size as well as M value. When sample size equals or exceeds lot size, every item in the lot must be inspected.

TABLE D-4

Master Table for Reduced Inspection for Plans Based on Known Variability
(Double Specification Limit and *Form 2—Single Specification Limit*)

Sample size code letter	Acceptable Quality Levels																				
	.04			.065			.10			.15			.25			.40			.65		
	n	M	v	n	M	v	n	M	v	n	M	v	n	M	v	n	M	v	n	M	v
B	↓			↓			↓			↓			↓			↓			↓		
C																					
D																					
E																					
F																			2	2.73	1.414
G																2	1.28	1.414	2	2.23	1.414
H										2	.310	1.414	2	.510	1.414	3	1.94	1.225	3	2.76	1.225
I							3	.369	1.225	3	.568	1.225	3	.959	1.225	4	1.88	1.155	4	2.58	1.155
J							3	.369	1.225	3	.568	1.225	3	.959	1.225	4	1.88	1.155	4	2.58	1.155
K	3	.114	1.225	4	.290	1.155	4	.399	1.155	4	.681	1.155	5	1.09	1.118	5	1.76	1.118	6	2.57	1.095
L	4	.161	1.155	5	.296	1.118	5	.445	1.118	6	.721	1.095	6	1.14	1.095	7	1.75	1.080	7	2.62	1.080
M	4	.161	1.155	5	.296	1.118	5	.445	1.118	6	.721	1.095	6	1.14	1.095	7	1.75	1.080	7	2.62	1.080
N	6	.230	1.095	6	.321	1.095	6	.478	1.095	7	.756	1.080	8	1.14	1.069	8	1.80	1.069	9	2.59	1.061
O	6	.234	1.095	7	.343	1.080	7	.507	1.080	8	.791	1.069	9	1.18	1.061	10	1.79	1.054	11	2.57	1.049
P	11	.217	1.049	11	.326	1.049	12	.461	1.045	13	.721	1.041	14	1.08	1.038	16	1.62	1.033	17	2.35	1.031
Q	15	.211	1.035	16	.308	1.033	17	.438	1.031	19	.673	1.027	21	1.00	1.025	23	1.51	1.023	25	2.19	1.021

All AQL and table values are in percent defective.

↓ Use first sampling plan below arrow, that is, both sample size as well as M value. *When sample size equals or exceeds lot size, every item in the lot must be inspected.*

TABLE D-4—Continued

Master Table for Reduced Inspection for Plans Based on Known Variability
(Double Specification Limit and Form 2—Single Specification Limit)

Sample size code letter	Acceptable Quality Levels																	
	1.00			1.50			2.50			4.0			6.5			10.00		
	n	M	v	n	M	v	n	M	v	n	M	v	n	M	v	n	M	v
B		↓			↓			↓			↓			↓			↓	
C																		
D																		
E																		
F	2	3.90	1.414	2	6.11	1.414	2	9.27	1.414	3	17.74	1.225	3	24.22	1.225	4	33.67	1.225
G	2	3.00	1.414	3	7.56	1.225	3	10.79	1.225	3	15.60	1.225	4	22.97	1.155	4	31.01	1.155
H	3	3.85	1.225	4	6.99	1.155	4	9.97	1.155	5	15.21	1.118	5	20.80	1.118	6	28.64	1.095
I	4	3.87	1.155	5	6.05	1.118	5	8.92	1.118	6	13.89	1.095	7	19.46	1.080	8	26.64	1.069
J	4	3.87	1.155	5	6.05	1.118	5	8.92	1.118	6	13.89	1.095	7	19.46	1.080	8	26.64	1.069
K	6	3.77	1.095	7	5.83	1.080	8	8.62	1.069	9	12.88	1.061	11	17.88	1.049	12	24.88	1.045
L	8	3.68	1.069	9	5.68	1.061	10	8.43	1.054	12	12.35	1.045	14	17.36	1.038	16	23.96	1.033
M	8	3.68	1.069	9	5.68	1.061	10	8.43	1.054	12	12.35	1.045	14	17.36	1.038	16	23.96	1.033
N	10	3.63	1.054	11	5.60	1.049	13	8.13	1.041	15	12.04	1.035	17	17.05	1.031	20	23.43	1.026
O	12	3.61	1.045	13	5.58	1.041	15	8.13	1.035	18	11.88	1.029	21	16.71	1.025	24	23.13	1.022
P	19	3.28	1.027	22	4.98	1.024	25	7.34	1.021	29	10.93	1.018	33	15.61	1.016	38	21.77	1.013
Q	28	3.05	1.018	32	4.68	1.016	36	6.95	1.014	42	10.40	1.012	49	14.87	1.010	56	20.90	1.009

All AQL and table values are in percent defective.

↓ Use first sampling plan below arrow, that is, both sample size as well as M value. When sample size equals or exceeds lot size, every item in the lot must be inspected.

TABLE D-5

Table for Estimating the Lot Percentage Defective for Plans Based on Known Variability[1]

Q_U or Q_L		Q_U or Q_L		Q_U or Q_L		Q_U or Q_L		Q_U or Q_L		Q_U or Q_L		Q_U or Q_L		Q_U or Q_L		Q_U or Q_L		Q_U or Q_L		Q_U or Q_L		Q_U or Q_L		Q_U or Q_L		Q_U or Q_L		Q_U or Q_L		Q_U or Q_L	
.00	50.000																														
.01	49.601	.26	39.743	.51	30.503	.76	22.363	1.01	15.625	1.26	10.383	1.51	06.552	1.76	03.920	2.01	02.222	2.26	01.191	2.51	00.604	2.76	00.289	3.01	00.131	3.26	00.056	3.51	00.022	3.76	00.008
.02	49.202	.27	39.358	.52	30.153	.77	22.065	1.02	15.386	1.27	10.204	1.52	06.426	1.77	03.836	2.02	02.169	2.27	01.160	2.52	00.587	2.77	00.280	3.02	00.126	3.27	00.054	3.52	00.022	3.77	00.008
.03	48.803	.28	38.974	.53	29.806	.78	21.770	1.03	15.151	1.28	10.027	1.53	06.301	1.78	03.754	2.03	02.118	2.28	01.130	2.53	00.570	2.78	00.272	3.03	00.122	3.28	00.052	3.53	00.021	3.78	00.008
.04	48.405	.29	38.591	.54	29.460	.79	21.476	1.04	14.917	1.29	09.853	1.54	06.178	1.79	03.673	2.04	02.068	2.29	01.101	2.54	00.554	2.79	00.264	3.04	00.118	3.29	00.050	3.54	00.020	3.79	00.008
.05	48.006	.30	38.209	.55	29.116	.80	21.186	1.05	14.686	1.30	09.680	1.55	06.057	1.80	03.593	2.05	02.018	2.30	01.072	2.55	00.539	2.80	00.256	3.05	00.114	3.30	00.048	3.55	00.019	3.80	00.007
.06	47.608	.31	37.828	.56	28.774	.81	20.897	1.06	14.457	1.31	09.510	1.56	05.938	1.81	03.515	2.06	01.970	2.31	01.044	2.56	00.523	2.81	00.248	3.06	00.111	3.31	00.047	3.56	00.019	3.81	00.007
.07	47.210	.32	37.448	.57	28.434	.82	20.611	1.07	14.231	1.32	09.342	1.57	05.821	1.82	03.438	2.07	01.923	2.32	01.017	2.57	00.508	2.82	00.240	3.07	00.107	3.32	00.045	3.57	00.018	3.82	00.007
.08	46.812	.33	37.070	.58	28.096	.83	20.327	1.08	14.007	1.33	09.176	1.58	05.705	1.83	03.362	2.08	01.876	2.33	00.990	2.58	00.494	2.83	00.233	3.08	00.104	3.33	00.043	3.58	00.017	3.83	00.006
.09	46.414	.34	36.693	.59	27.760	.84	20.045	1.09	13.786	1.34	09.012	1.59	05.592	1.84	03.288	2.09	01.831	2.34	00.964	2.59	00.480	2.84	00.226	3.09	00.100	3.34	00.042	3.59	00.017	3.84	00.006
.10	46.017	.35	36.317	.60	27.425	.85	19.766	1.10	13.567	1.35	08.851	1.60	05.480	1.85	03.216	2.10	01.786	2.35	00.939	2.60	00.466	2.85	00.219	3.10	00.097	3.35	00.040	3.60	00.016	3.85	00.006
.11	45.620	.36	35.942	.61	27.093	.86	19.489	1.11	13.350	1.36	08.692	1.61	05.370	1.86	03.144	2.11	01.743	2.36	00.914	2.61	00.453	2.86	00.212	3.11	00.094	3.36	00.039	3.61	00.015	3.86	00.006
.12	45.224	.37	35.569	.62	26.763	.87	19.215	1.12	13.136	1.37	08.534	1.62	05.262	1.87	03.074	2.12	01.700	2.37	00.889	2.62	00.440	2.87	00.205	3.12	00.090	3.37	00.038	3.62	00.015	3.87	00.005
.13	44.828	.38	35.197	.63	26.435	.88	18.943	1.13	12.924	1.38	08.379	1.63	05.155	1.88	03.005	2.13	01.659	2.38	00.866	2.63	00.427	2.88	00.199	3.13	00.087	3.38	00.036	3.63	00.014	3.88	00.005
.14	44.433	.39	34.827	.64	26.109	.89	18.673	1.14	12.714	1.39	08.226	1.64	05.050	1.89	02.938	2.14	01.618	2.39	00.842	2.64	00.415	2.89	00.193	3.14	00.084	3.39	00.035	3.64	00.014	3.89	00.005
.15	44.038	.40	34.458	.65	25.785	.90	18.406	1.15	12.507	1.40	08.076	1.65	04.947	1.90	02.872	2.15	01.578	2.40	00.820	2.65	00.402	2.90	00.187	3.15	00.082	3.40	00.034	3.65	00.013	3.90	00.005
.16	43.644	.41	34.090	.66	25.463	.91	18.141	1.16	12.302	1.41	07.927	1.66	04.846	1.91	02.807	2.16	01.539	2.41	00.798	2.66	00.391	2.91	00.181	3.16	00.079	3.41	00.032	3.66	00.013	3.91	00.005
.17	43.251	.42	33.724	.67	25.143	.92	17.879	1.17	12.100	1.42	07.780	1.67	04.746	1.92	02.743	2.17	01.500	2.42	00.776	2.67	00.379	2.92	00.175	3.17	00.076	3.42	00.031	3.67	00.012	3.92	00.004
.18	42.858	.43	33.360	.68	24.825	.93	17.619	1.18	11.900	1.43	07.636	1.68	04.648	1.93	02.680	2.18	01.463	2.43	00.755	2.68	00.368	2.93	00.169	3.18	00.074	3.43	00.030	3.68	00.012	3.93	00.004
.19	42.465	.44	32.997	.69	24.510	.94	17.361	1.19	11.702	1.44	07.493	1.69	04.551	1.94	02.619	2.19	01.426	2.44	00.734	2.69	00.357	2.94	00.164	3.19	00.071	3.44	00.029	3.69	00.011	3.94	00.004
.20	42.074	.45	32.636	.70	24.196	.95	17.106	1.20	11.507	1.45	07.353	1.70	04.457	1.95	02.559	2.20	01.390	2.45	00.714	2.70	00.347	2.95	00.159	3.20	00.069	3.45	00.028	3.70	00.011	3.95	00.004
.21	41.683	.46	32.276	.71	23.885	.96	16.853	1.21	11.314	1.46	07.215	1.71	04.363	1.96	02.500	2.21	01.355	2.46	00.695	2.71	00.336	2.96	00.154	3.21	00.066	3.46	00.027	3.71	00.010	3.96	00.004
.22	41.294	.47	31.918	.72	23.576	.97	16.602	1.22	11.123	1.47	07.078	1.72	04.272	1.97	02.442	2.22	01.321	2.47	00.676	2.72	00.326	2.97	00.149	3.22	00.064	3.47	00.026	3.72	00.010	3.97	00.004
.23	40.905	.48	31.561	.73	23.270	.98	16.354	1.23	10.935	1.48	06.944	1.73	04.182	1.98	02.385	2.23	01.287	2.48	00.657	2.73	00.317	2.98	00.144	3.23	00.062	3.48	00.025	3.73	00.010	3.98	00.003
.24	40.517	.49	31.207	.74	22.965	.99	16.109	1.24	10.749	1.49	06.811	1.74	04.093	1.99	02.330	2.24	01.255	2.49	00.639	2.74	00.307	2.99	00.139	3.24	00.060	3.49	00.024	3.74	00.009	3.99	00.003
.25	40.129	.50	30.854	.75	22.663	1.00	15.866	1.25	10.565	1.50	06.681	1.75	04.006	2.00	02.275	2.25	01.222	2.50	00.621	2.75	00.298	3.00	00.135	3.25	00.058	3.50	00.023	3.75	00.009	4.00	00.003

[1] Values tabulated are read in percent.

Part III

ESTIMATION OF PROCESS AVERAGE AND CRITERIA FOR REDUCED AND TIGHTENED INSPECTION

D13. ESTIMATION OF PROCESS AVERAGE

The average percent defective, based upon a group of lots submitted for original inspection, is called the process average. Original inspection is the first inspection of a particular quantity of product submitted for acceptability as distinguished from the inspection of product which has been resubmitted after prior rejection. The process average shall be estimated from the results of inspection of samples drawn from a specified number of preceding lots for the purpose of determining severity of inspection during the course of a contract in accordance with paragraph D14.3. Any lot shall be included only once in estimating the process average. The estimate of the process average is designated by $\bar{p}_U$ when computed with respect to an upper specification limit, by $\bar{p}_L$ when computed with respect to a lower specification limit, and by $\bar{p}$ when computed with respect to a double specification limit.

D13.1 Abnormal Results. The results of inspection of product manufactured under conditions not typical of usual production shall be excluded from the estimated process average.

D13.2 Computation of the Estimated Process Average. The estimated process average is the arithmetic mean of the estimated lot percent defective computed from the sampling inspection results of the preceding ten (10) lots or as may be otherwise designated. In order to estimate the lot percent defective, the quality indices Q_U and/or Q_L shall be computed for each lot. These are: $Q_U = (U-\bar{X})v/s$ and $Q_L = (\bar{X}-L)v/s$. (See paragraph D11.2.)

D13.2.1 Single Specification Limit.[6] The estimated lot percent defective shall be determined from Table D-5 for the plans based on known variability. The quality index Q_U shall be used for the case of an upper specification limit or Q_L for the case of a lower specification limit. Table D-5 is entered with Q_U or Q_L and the corresponding estimated lot percent defective p_U or p_L, respectively, is read from the table. The estimated process average $\bar{p}_U$ is the arithmetic mean of the individual estimated lot percent defectives p_U's. Similarly, the estimated process average $\bar{p}_L$ is the arithmetic mean of the individual estimated lot percent defectives p_L's.

D13.2.2 Double Specification Limit. The estimated lot percent defective shall be determined from Table D-5 for the plans based on variability known. The quality indices Q_U and Q_L shall be computed. Table D-5 is entered separately with Q_U and Q_L and the corresponding p_U and p_L are read from the table. The estimated lot percent defective is $p = p_U + p_L$. The estimated process average $\bar{p}$ is the arithmetic mean of the individual estimated lot percent defectives p's.

D13.2.3 Special Case. If the quality index Q_U or Q_L is a negative number, then Table D-5 is entered by disregarding the negative sign. However, in this case the estimated lot percent defective above the upper limit or below the lower limit is obtained by subtracting the percentage found in the table from 100%.[7]

D14. NORMAL, TIGHTENED, AND REDUCED INSPECTION

This Standard establishes sampling plans for normal, tightened, and reduced inspection.

D14.1 At Start of Inspection. Normal inspection shall be used at the start of inspection unless otherwise designated.

D14.2 During Inspection. During the course of inspection, normal inspection shall be used when inspection conditions are such that tightened or reduced inspection is not required in accordance with paragraphs D14.3 and D14.4.

D14.3 Tightened Inspection. Tightened inspection shall be instituted when the estimated process average computed from the

[6] When Form 1—Single Specification Limit is used for the acceptability criterion, the estimate of lot percent defective p_U or p_L is not obtained; in order to estimate the process average, it is necessary to complete paragraphs D6.2 and D6.3 of Form 2.

[7] For example, if $Q_U = -.50$ and $Q_L = 1.60$, then $p_U = 100\% - 30.854\% = 69.146\%$, $p_L = 5.48\%$ and $p = 69.146\% + 5.48\% = 74.626\%$.

preceding ten (10) lots (or such other number of lots designated) in accordance with paragraph D13.2 is greater than the AQL, and when more than a certain number T of these lots have estimates of the percent defective exceeding the AQL. The T-values are given in Table D-6 when the process average is computed from 5, 10, or 15 lots.[8] Normal inspection shall be reinstated if the estimated process average of lots under tightened inspection is equal to or less than the AQL.

D14.4 Reduced Inspection. Reduced inspection may be instituted provided that all of the following conditions are satisfied:

Condition A. The preceding ten (10) lots (or such other number of lots designated) have been under normal inspection and none has been rejected.

Condition B. The estimated percent defective for each of these preceding lots is less than the applicable lower limit shown in Table D-7.

Condition C. Production is at a steady rate.

Normal inspection shall be reinstated if any one of the following conditions occurs under reduced inspection:

Condition D. A lot is rejected.

Condition E. The estimated process average is greater than the AQL.

Condition F. Production becomes irregular or delayed.

Condition G. Other conditions as may warrant that normal inspection should be reinstated.

D14.5 Sampling Plans for Tightened or Reduced Inspection. Sampling plans for tightened and reduced inspection are provided in Section D, Parts I and II.

[8] If the sample size code letter is not the same for all samples used, the entry in Table D-6 is determined by the sample size code letter corresponding to the smallest sample size used in any of the lots included in the estimation of the process average.

TABLE D-6 Variability Known

Values of *T* for Tightened Inspection

Sample size code letter	Acceptable Quality Levels (in percent defective)														Number of Lots
	.04	.065	.10	.15	.25	.40	.65	1.0	1.5	2.5	4.0	6.5	10.0	15.0	
B	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
C	*	*	*	*	*	*	*	3 5 6	3 5 6	3 5 7	3 6 7	4 7 9	4 7 9	4 7 10	5 10 15
D	*	*	*	*	*	*	3 4 6	3 5 6	3 5 6	4 6 8	4 6 9	4 7 9	4 7 10	4 7 10	5 10 15
E	*	*	*	*	2 4 5	3 4 6	3 5 7	3 6 7	3 6 8	4 6 9	4 7 9	4 7 10	4 7 10	4 8 11	5 10 15
F	*	*	*	3 5 6	3 5 7	3 5 7	4 6 8	4 6 8	4 6 8	4 7 9	4 7 9	4 7 10	4 7 10	4 8 11	5 10 15
G	3 4 6	3 4 6	3 5 7	3 5 7	3 6 7	4 6 8	4 6 8	4 7 9	4 7 9	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	5 10 15
H	3 5 6	3 5 7	3 6 7	3 6 8	4 6 8	4 6 9	4 7 9	4 7 9	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	5 10 15
I	3 5 7	4 6 8	4 6 8	4 6 8	4 6 9	4 7 9	4 7 9	4 7 9	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	5 10 15
J	3 6 8	4 6 8	4 6 8	4 6 8	4 6 9	4 7 9	4 7 9	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
K	4 6 8	4 6 8	4 6 9	4 6 9	4 7 9	4 7 9	4 7 10	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
L	4 6 8	4 6 9	4 6 9	4 7 9	4 7 9	4 7 10	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
M	4 6 9	4 7 9	4 7 9	4 7 9	4 7 10	4 7 10	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
N	4 7 9	4 7 9	4 7 10	4 7 10	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
O	4 7 10	4 7 10	4 7 10	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15

*There are no sampling plans provided in this Standard for these code letters and AQL values.

TABLE D-6—Continued **Variability Known**

Values of T for Tightened Inspection

Sample size code letter	Acceptable Quality Levels (in percent defective)														Number of Lots
	.04	.065	.10	.15	.25	.40	.65	1.0	1.5	2.5	4.0	6.5	10.0	15.0	
P	4 7 10	4 7 10	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 12	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15
Q	4 7 10	4 7 10	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	4 8 11	5 10 15

The top figure in each block refers to the preceding 5 lots, the middle figure to the preceding 10 lots and the bottom figure to the preceding 15 lots.

Tightened inspection is required when the number of lots with estimates of percent defective above the AQL from the preceding 5, 10, or 15 lots is greater than the given value of T in the table, and the process average from these lots exceeds the AQL.

All estimates of the lot percent defective are obtained from Table D-5.

TABLE D-7 Variability Known

Limits of Estimated Lot Percent Defective for Reduced Inspection

Sample size code letter	Acceptable Quality Levels														Number of Lots
	.04	.065	.10	.15	.25	.40	.65	1.0	1.5	2.5	4.0	6.5	10.0	15.0	
B	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
C	*	*	*	*	*	*	*	.011 .109 .209	.027 .222 .558	.077 .542 1.253	.205 1.217 2.592	1.645 4.496 6.50	3.226 7.912 10.00	7.714 14.291 15.00	5 10 15
D	*	*	*	*	*	*	.005 .050 .144	.011 .109 .290	.027 .222 .558	.369 1.248 2.145	.769 2.354 3.850	1.645 4.496 6.50	4.386 8.849 10.00	7.714 14.291 15.00	5 10 15
E	*	*	*	*	.001 .009 .029	.002 .021 .064	.045 .197 .384	.088 .357 .669	.166 .622 1.124	.637 1.643 2.50	1.225 2.924 4.00	2.937 5.697 6.50	5.154 9.330 10.00	9.479 15.00 ▲	5 10 15
F	*	*	*	.005 .025 .056	.010 .052 .110	.021 .100 .204	.098 .309 .522	.178 .528 .867	.313 .874 1.394	.846 1.880 2.50	1.560 3.250 4.00	3.325 5.958 6.50	6.114 9.806 10.00	10.436 15.00 ▲	5 10 15
G	.001 .004 .010	.001 .008 .018	.007 .029 .055	.013 .049 .090	.026 .093 .167	.078 .217 .347	.147 .385 .602	.322 .718 1.00	.533 1.139 1.50	1.136 2.141 2.50	2.166 3.698 4.00	4.045 6.342 6.50	7.093 10.00 ▲	11.478 15.00 ▲	5 10 15
H	.002 .009 .018	.004 .017 .033	.013 .041 .071	.022 .067 .114	.057 .147 .227	.103 .252 .382	.223 .478 .65	.375 .773 1.00	.677 1.270 1.50	1.326 2.277 2.50	2.403 3.831 4.00	4.453 6.50 ▲	7.502 10.00 ▲	12.054 15.00 ▲	5 10 15
I	.004 .014 .025	.011 .031 .051	.018 .051 .082	.030 .081 .129	.070 .164 .244	.142 .298 .40	.252 .508 .65	.457 .847 1.00	.778 1.346 1.50	1.461 2.359 2.50	2.643 3.942 4.00	4.719 6.50 ▲	7.786 10.00 ▲	12.427 15.00 ▲	5 10 15
J	.006 .018 .030	.011 .031 .051	.023 .058 .090	.038 .092 .140	.082 .177 .25	.158 .313 .40	.298 .549 .65	.516 .892 1.00	.853 1.394 1.50	1.562 2.412 2.50	2.758 3.987 4.00	4.909 6.50 ▲	8.055 10.00 ▲	12.693 15.00 ▲	5 10 15
K	.008 .021 .033	.014 .036 .056	.028 .064 .096	.051 .108 .15	.091 .188 .25	.171 .326 .40	.317 .564 .65	.540 .908 1.00	.910 1.427 1.50	1.641 2.449 2.50	2.891 4.00 ▲	5.009 6.50 ▲	8.205 10.00 ▲	12.848 15.00 ▲	5 10 15

*There are no sampling plans provided in this Standard for these code letters and AQL values.

TABLE D-7—Continued

Variability Known

Limits of Estimated Lot Percent Defective for Reduced Inspection

Sample size code letter	Acceptable Quality Levels														Number of Lots
	.04	.065	.10	.15	.25	.40	.65	1.0	1.5	2.5	4.0	6.5	10.0	15.0	
L	.009 .023 .036	.017 .040 .060	.032 .069 .10	.056 .113 .15	.107 .203 .25	.193 .344 .40	.348 .586 .65	.581 .934 1.00	.934 1.440 1.50	1.732 2.486 2.50	2.960 4.00 ▲	5.131 6.50 ▲	8.328 10.00 ▲	13.017 15.00 ▲	5 10 15
M	.012 .027 .039	.023 .048 .065	.038 .076 .10	.064 .121 .15	.120 .214 .25	.211 .357 .40	.383 .608 .65	.627 .959 1.00	1.010 1.475 1.50	1.821 2.50 ▲	3.093 4.00 ▲	5.310 6.50 ▲	8.516 10.00 ▲	13.238 15.00 ▲	5 10 15
N	.017 .032 .04	.030 .054 .065	.049 .086 .10	.080 .134 .15	.146 .232 .25	.251 .382 .40	.435 .635 .65	.705 .994 1.00	1.113 1.50 ▲	1.959 2.50 ▲	3.272 4.00 ▲	5.546 6.50 ▲	8.822 10.00 ▲	13.588 15.00 ▲	5 10 15
O	.020 .035 .04	.035 .058 .065	.058 .092 .10	.091 .141 .15	.161 .241 .25	.272 .392 .40	.467 .648 .65	.750 1.00 ▲	1.168 1.50 ▲	2.041 2.50 ▲	3.386 4.00 ▲	5.685 6.50 ▲	8.990 10.00 ▲	13.801 15.00 ▲	5 10 15
P	.024 .037 .04	.041 .062 .065	.066 .087 .10	.103 .147 .15	.180 .249 .25	.299 .40 ▲	.505 .65 ▲	.803 1.00 ▲	1.239 1.50 ▲	2.132 2.50 ▲	3.509 4.00 ▲	5.852 6.50 ▲	9.192 10.00 ▲	14.034 15.00 ▲	5 10 15
Q	.027 .039 .04	.045 .064 .065	.071 .099 .10	.110 .15 ▲	.191 .25 ▲	.316 .40 ▲	.528 .65 ▲	.834 1.00 ▲	1.278 1.50 ▲	2.188 2.50 ▲	3.583 4.00 ▲	5.949 6.50 ▲	9.312 10.00 ▲	14.173 15.00 ▲	5 10 15

All AQL and table values are in percent defective.

▲Use the first figure in direction of arrow and corresponding number of lots. In each block the top figure refers to the preceding 5 lots, the middle figure to the preceding 10 lots, and the bottom figure to the preceding 15 lots.

Reduced inspection may be instituted when every estimated lot percent defective from the preceding 5, 10, or 15 lots is below the figure given in the table. In addition, all other conditions for reduced inspection, in Part III of Section D, must be satisfied.

All estimates of the lot percent defective are obtained from Table D-5.

APPENDIX D

Definitions

Symbol	Read	Definitions
n		Sample size for a single lot.
$\bar{X}$	X bar	Sample mean. Arithmetic mean of sample measurements from a single lot.
σ	Sigma	Known variability. The predetermined variability of the quality characteristic which will be used with the variability known acceptability plans.
U		Upper specification limit.
L		Lower specification limit.
k		The acceptability constant given in Tables D-1 and D-2.
v		A factor used in determining the quality indices when using the known variability acceptability plan. The v values are given in Tables D-3 and D-4.
Q_U	Q sub U	Quality Index for use with Table D-5.
Q_L	Q sub L	Quality Index for use with Table D-5.
p_U	p sub U	Sample estimate of the lot percent defective above U from Table D-5.
p_L	p sub L	Sample estimate of the lot percent defective below L from Table D-5.
p		Total sample estimate of the lot percent defective $p = p_U + p_L$.
M		Maximum allowable percent defective for sample estimates given in Tables D-3 and D-4.
M_U	M sub U	Maximum allowable percent defective above U given in Tables D-3 and D-4. (For use when different AQL values for U and L are specified.)
M_L	M sub L	Maximum allowable percent defective below L given in Tables D-3 and D-4. (For use when different AQL values for U and L are specified.)
$\bar{p}$	p bar	Sample estimate of the process percent defective, i.e., the estimated process average.
$\bar{p}_U$	p bar sub U	The estimated process average for an upper specification limit.
$\bar{p}_L$	p bar sub L	The estimated process average for a lower specification limit.
T		The maximum number of estimated process averages which may exceed the AQL given in Table D-6. (For use in determining application of tightened inspection.)
<	Less than	Less than.
>	Greater than	Greater than.
Σ	Sum of	

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