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 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.

These acceptance sampling plans for variables are given in terms of the percent or proportion of product in a lot or batch that depart from some requirement. The general terminology used within the document will be given in terms of percent of nonconforming units or number of nonconformities, since these terms are likely to constitute the most widely used criteria for acceptance sampling.

A2. DEFINITIONS AND TERMINOLOGY

For the purpose of this American National Standard, the definitions given in ISO 3534-2 and the following definitions apply. The definitions and terminology employed in this standard are in accord with ISO 3534-2 *Statistics—Vocabulary and symbols—Part 2: Applied Statistics.*

A2.1 Acceptance Quality Limit (AQL): The AQL is the quality level that is the worst tolerable product average when a continuing series of lots is submitted for acceptance sampling.

NOTE
The use of the abbreviation AQL to mean Acceptable Quality Level is no longer recommended.

A2.2 Defect: Nonfulfillment of a requirement related to an intended or specified use [ISO 9000]. (See ISO 3534-2)

NOTE 1
The distinction between the concepts defect and nonconformity is important as it has legal connotations, particularly those associated with product liability issues. Consequently the term defect should be used with extreme caution.

NOTE 2
The intended use by the customer can be affected by the nature of the information, such as operating or maintenance instructions, provided by the customer.

A2.3 Inspection by Variables: Inspection by measuring the magnitude(s) of the characteristic(s) of an item. (See ISO 3534-2)

A2.4 Lot Size: The number of items in a lot.

A2.5 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 from the lot, before a decision as to acceptability or rejectability of a lot can be made.

A2.6 Nonconformity: Nonfulfillment of a requirement [ISO 9000]. (See ISO 3534-2)

NOTE
See notes to defect (A2.2)

A2.7 Sampling Plan: A specific plan which states the sample size(s) to be used and the associated criteria for accepting the lot.

NOTE
The sampling plan does not contain the rules on how to take the sample.

A2.8 Sampling Scheme: A combination of sampling plans with rules for changing from one plan to another.

NOTE
Some schemes have switching rules for automatic change to tightened inspection plans or reduced inspection plans or change to 100 percent inspection.

A2.9 Switching Rule: Instruction within an acceptance sampling scheme for changing from one acceptance sampling plan to another of greater or lesser severity of sampling based on demonstrated quality level (See ISO 3534-2)

EXAMPLE
Normal, tightened, reduced inspection or discontinuation of inspection are examples of severity of sampling.

A2.10 Specification Limit: Limiting value stated for a characteristic. (See ISO 3534-2)

A3. PERCENT NONCONFORMING

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

A4. ACCEPTANCE QUALITY LIMIT

A4.1 Acceptance Quality Limit. The acceptance quality limit (AQL) represents a nominal value expressed in terms of percent nonconforming specified for a single quality characteristic. Certain numerical values of AQL ranging from .10 to 10.00 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 Note on the Meaning of AQL. The concept of AQL only applies when an acceptance sampling scheme with rules for switching between normal, tightened, and reduced inspection and discontinuance of sampling inspection is used. These rules are designed to encourage suppliers to have process averages consistently better than the AQL. If suppliers fail to do so, there is a high probability of being switched from normal inspection to tightened inspection where lot acceptance becomes more difficult. Once on tightened inspection, unless corrective action is taken to improve product quality, it is very likely that the rule requiring discontinuance of sampling inspection will be invoked.

Although individual lots with quality as bad as the AQL can be accepted with fairly high probability, the designation of an AQL does not suggest that this is necessarily a desirable quality level. The AQL is a parameter of the sampling scheme and should not be confused with a process average, which describes the operating level of a manufacturing process. It is expected that the product quality level will be less than the AQL to avoid excessive non-accepted lots.

The sampling plans in this standard are so arranged that the probability of lot acceptance at the designated AQL depends upon sample size, being generally higher for large samples than for small samples for a given AQL. To determine the specific protection to the consumer at a given AQL, it is necessary to refer to the operating characteristic curves (which are provided in this standard) of the corresponding scheme and its constituent plans.

The AQL alone does not describe the protection to the consumer for individual lots or batches, but more directly relates to what is expected from a series of lots or batches provided the provisions of this standard are satisfied.

A4.3 Specifying AQLs. 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 nonconforming 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.”

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.

A5.1.2 Lot Size. The lot size 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 code letter depends on the inspection level and the lot size. There are five inspection levels: Special Levels S3, S4, and General Levels I, II, and III. Unless otherwise specified, Inspection Level II shall be used. However, Inspection Level I may be specified when less discrimination is needed, or Level III may be specified for greater discrimination. Levels S3 and S4 may be used when relatively small sample sizes are necessary and large sampling risks can or must be tolerated. The sample size code letter applicable to the specified inspection level and for lots of given size shall be obtained from Table A-2.

A7.2 Drawings of Samples. Units of the sample shall be selected at random without regard to their quality.

A8. NORMALITY ASSUMPTION

This standard assumes the underlying distribution of individual measurements to be normal in shape. Failure of this assumption to be valid will affect the OC curves and probabilities based on these curves. In particular it will affect the estimate of percent nonconforming calculated from the mean and standard deviation of the distribution. The assumption should be verified prior to use of this standard.

A variety of statistical tests and graphical techniques are available for this purpose. A person knowledgeable in statistics should be consulted who can advise whether the distribution appears suitable for sampling by variables.

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

A9.2.1 Select the variables sampling plan in accordance with Section B, C, or D.

A9.2.2 Select the attributes sampling plan from ANSI Z1.4 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 A9.2.1 (Additional sample items may be drawn, as necessary, to satisfy the requirements for sample size of the attributes sampling plan. Count as a nonconforming unit each sample item falling outside of specification limit(s).)

A9.3 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 ANSI/ASQ Z1.4.

A9.3.1 If Condition A is not satisfied, proceed in accordance with the attributes sampling plan to meet Condition B.

A9.3.2 If Condition B is not satisfied, the lot does not meet the acceptability criterion.

A10. NORMAL, TIGHTENED, AND REDUCED INSPECTION

A10.1 Initiation of Inspection. Normal inspection will be used at the start of inspection unless otherwise directed by the responsible authority.

A10.2 Continuation of Inspection. Normal, tightened, or reduced inspection shall continue unchanged on successive lots or batches except where the following switching procedures require change.

A10.3 Switching Procedures.

A10.3.1 Normal to Tightened. When normal inspection is in effect, tightened inspection shall be instituted when two out of five consecutive lots or batches have been rejected on original inspection (that is, ignoring resubmitted lots or batches for this procedure).

A10.3.2 Tightened to Normal. When tightened inspection is in effect, normal inspection shall be instituted when five consecutive lots or batches have been considered acceptable on original inspection.

A10.3.3 Normal to Reduced. When normal inspection is in effect, reduced inspection shall be instituted providing that all of the following conditions are satisfied:

a. The preceding 10 lots or batches have been on normal inspection and none has been rejected; and
b. Production is at a steady rate; and
c. Reduced inspection is considered desirable by the responsible authority and is permitted by the contract or specification.

A10.3.4 Reduced to Normal. When reduced inspection is in effect, normal inspection shall be instituted if any of the following occur on original inspection:

a. A lot or batch is rejected; or
b. Production becomes irregular or delayed; or
c. Other conditions warrant that normal inspection shall be instituted.

A10.4 Discontinuation of Inspection. If the cumulative number of lots not accepted in a sequence of consecutive lots on tightened inspection reaches 5, the acceptance procedures of this standard shall be discontinued. Inspection under the provisions of this standard shall not be resumed until corrective action has been taken. Tightened inspection shall then be used as if A10.3.1 had been invoked.

Table A-1
AQL Conversion Table

For specified AOL values falling within these ranges			Use this AQL value
–	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	0.669	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

Table A-2[1]
Sample Size Code Letters[2]

Lot Size			Inspection Levels				
			Special		General		
			S3	S4	I	II	III
2	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	50	B	B	C	D	F
51	to	90	B	B	D	E	G
91	to	150	B	C	E	F	H
151	to	280	B	D	F	G	I
281	to	400	C	E	G	H	J
401	to	500	C	E	G	I	J
501	to	1,200	D	F	H	J	K
1,201	to	3,200	E	G	I	K	L
3,201	to	10,000	F	H	J	L	M
10,001	to	35,000	G	I	K	M	N
35,001	to	150,000	H	J	L	N	P
150,001	to	500,000	H	K	M	P	P
500,001	and	over	H	K	N	P	P

[1]The theory governing inspection by variables depends on the properties of the normal distribution and, therefore, this method of inspection is only applicable when there is reason to believe that the frequency distribution is normal.

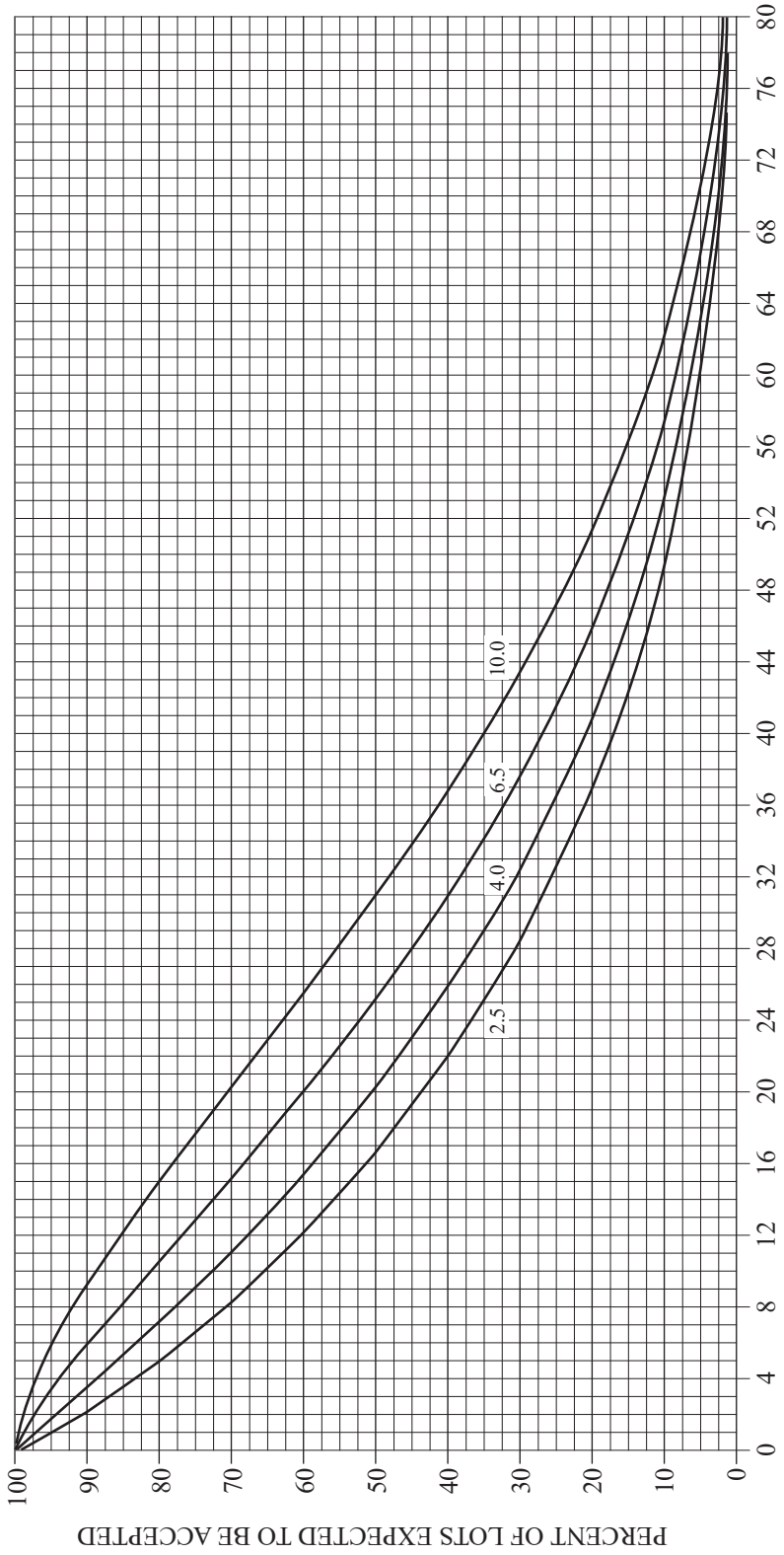
[2]Sample size code letters given in body of table are applicable when the indicated inspection levels are to be used.

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)

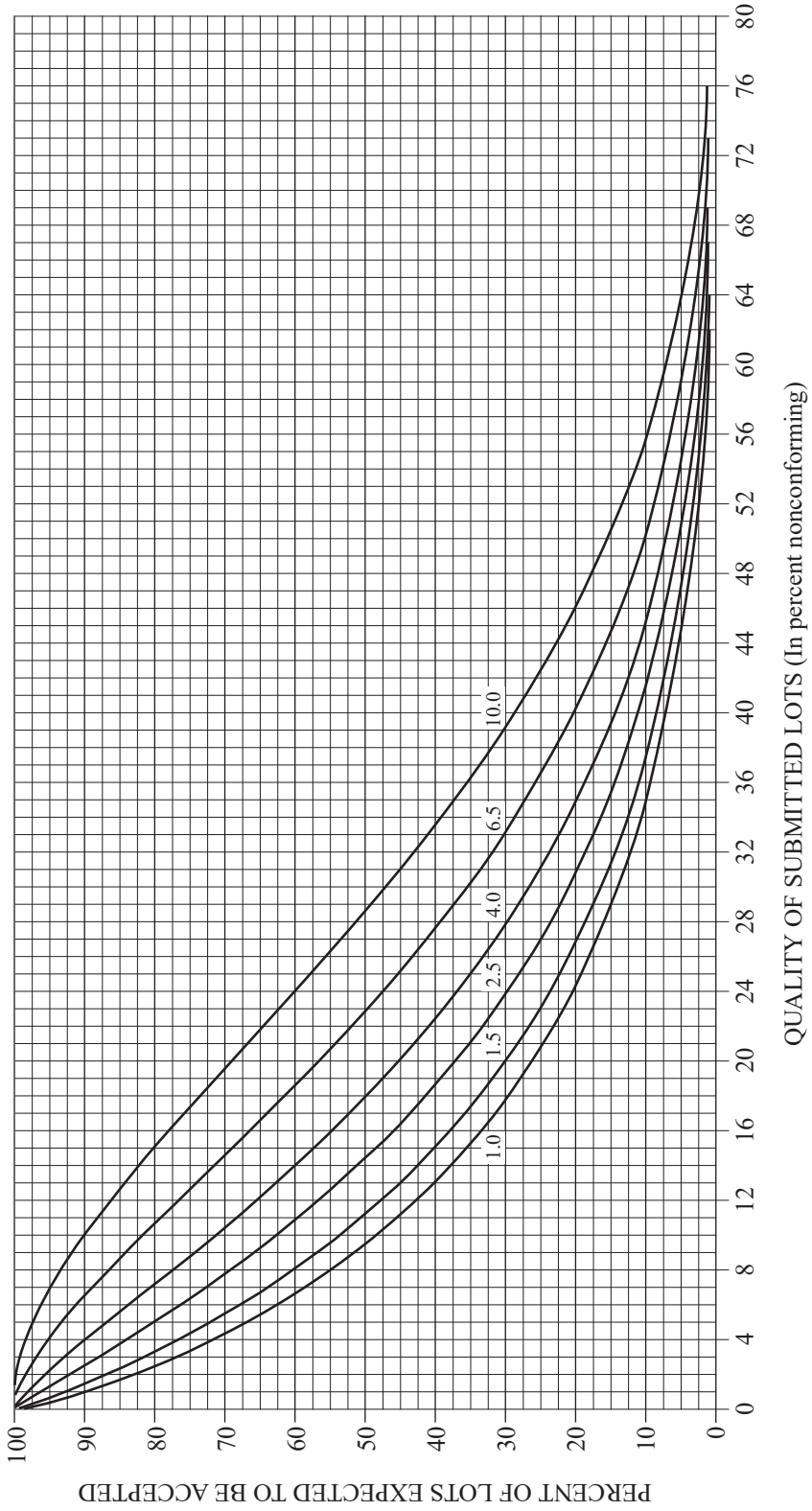


NOTE: Figures on curves are acceptance quality limits (AQLs) for normal inspection. The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

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)



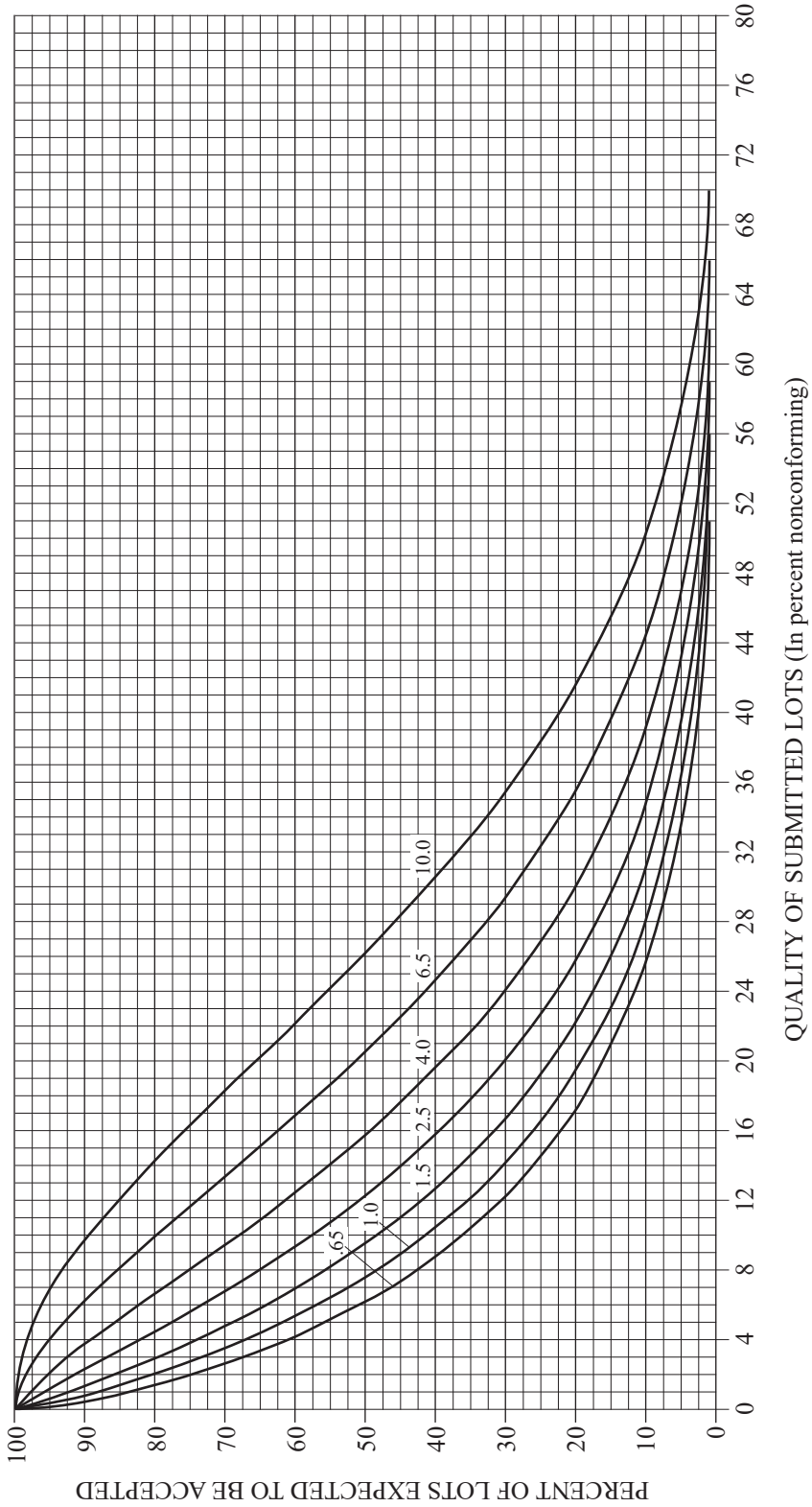
NOTE: Figures on curves are acceptance quality limits (AQLs) for normal inspection. The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

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)



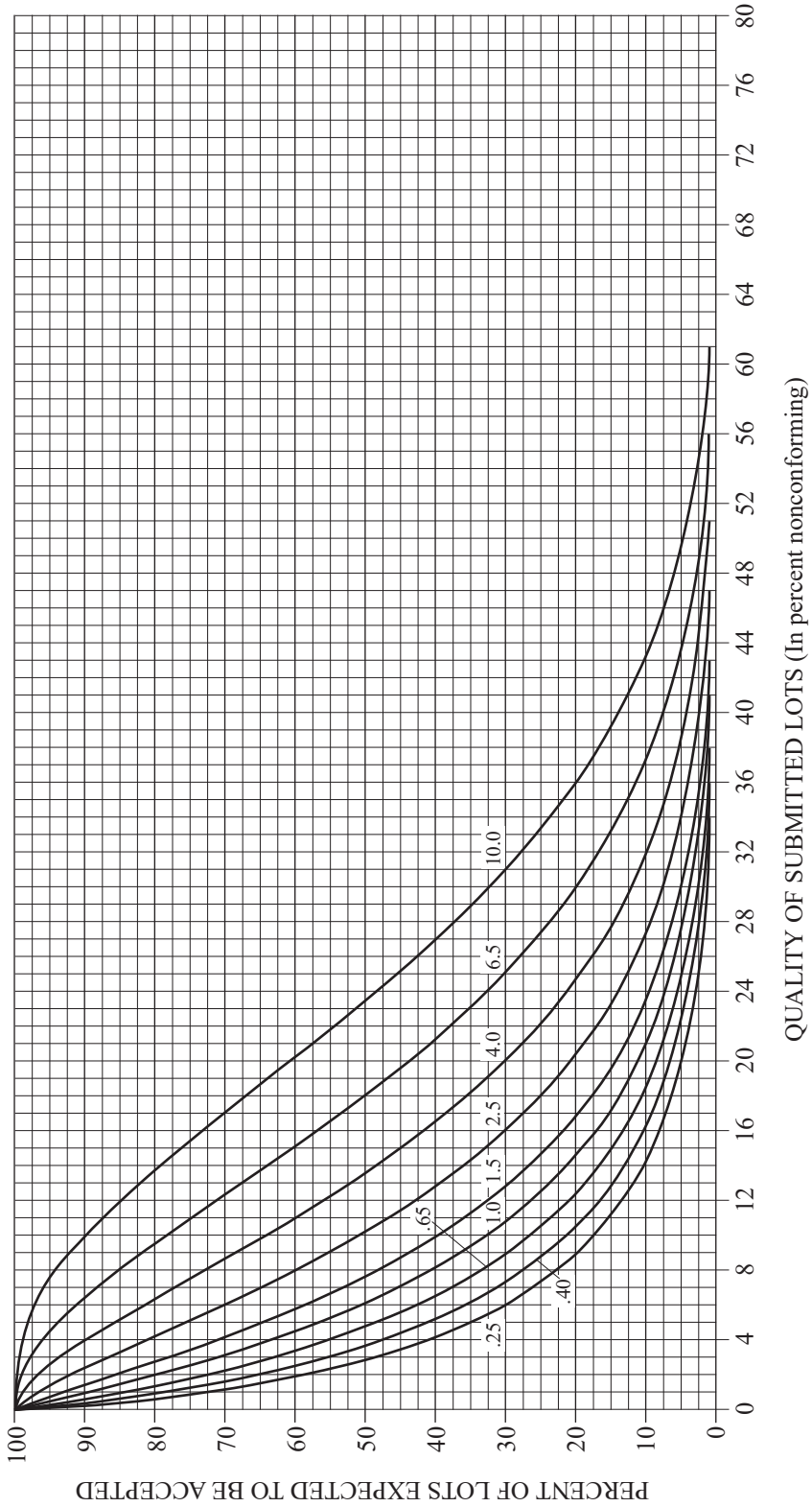
NOTE: Figures on curves are acceptance quality limits (AQLs) for normal inspection. The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

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 and known variability are essentially equivalent)



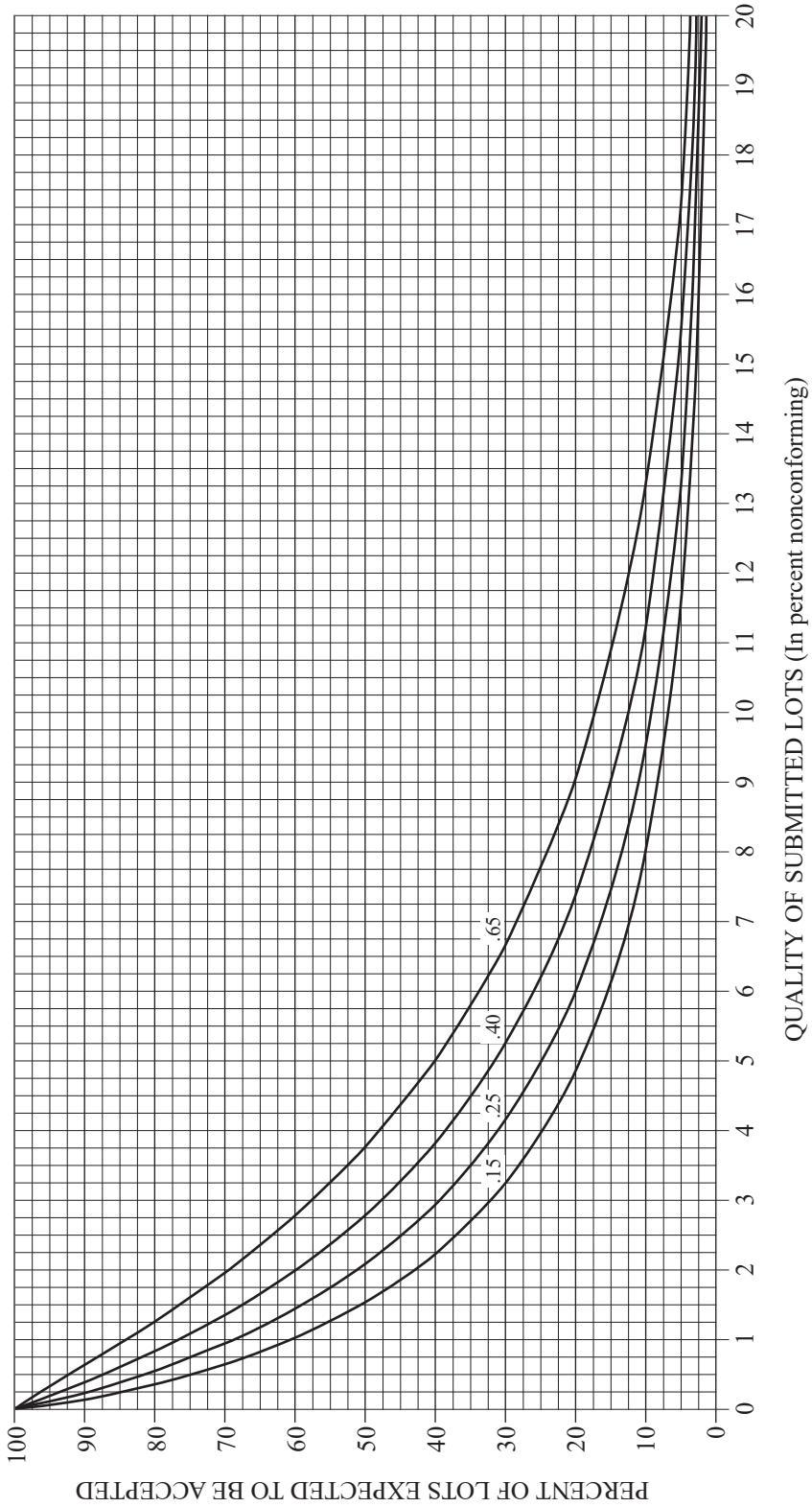
NOTE: Figures on curves are acceptance quality limits (AQLs) for normal inspection. The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.

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)



NOTE: Figures on curves are acceptance quality limits (AQLs) for normal inspection. The values of the percent of lots expected to be accepted are valid only when measurements are selected at random from a normal distribution.