Designation: D 3715/D3715M – 98 (Reapproved 2004)

Standard Practice for Quality Assurance of Pressure-Sensitive Tapes[1]

This standard is issued under the fixed designation D 3715/D3715M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.
This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This practice contains uniform quality assurance provisions for pressure-sensitive tapes and establishes sampling plans and procedures for acceptance inspection.

1.2 *Limitations*:

1.2.1 This practice only includes procedures for when an upper or a lower specification limit is given. It does not provide for double, both minimum and maximum, specification limits.

NOTE 1—When double specification limits are given (applies to variables testing only), use may be made of Table C-3 and Example C-3 of ANSI/ASQC Z1.9.

1.2.2 The variables sampling plans apply to a single quality characteristic. Having obtained the sample and the responses to the physical property tests, acceptance is determined on one quality characteristic at a time. The process is repeated for each additional characteristic.

1.2.3 The variables sampling plans require that the response to each quality characteristic is normally distributed either directly or by transformation. If this is not known, the potential user of this practice should seek the counsel of someone with sufficient understanding of statistical techniques to provide that information.

1.3 The values stated in either SI or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system must be used independently, without combining values in any way.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 996 Terminology of Packaging and Distribution Environments

2.2 *ANSI/ASQC Standards:*

ANSI/ASQC A2 Terms, Symbols, and Definitions for Acceptance Sampling[3]

ANSI/ASQC A3 Quality Systems Terminology[4]

ANSI/ASQC Q94 Quality Management and Quality System Elements—Guidelines[4]

ANSI/ASQC Z1.4 Sampling Procedures and Tables for Inspection by Attributes[4]

ANSI/ASQC Z1.9 Sampling and Tables for Inspection by Variables for Percent Defective

3. Terminology

3.1 *Definitions*—General terms in this practice are defined in Terminology D 996, ANSI/ASQC A2, and ANSI/ASQC A3.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *acceptability criterion*—the comparison made between a factor, number, or constant found in the sampling plan and the examination or test result information from a single quality characteristic to determine if the lot should be accepted or rejected. For inspection by attributes the acceptability criterion is a comparison with the acceptability constant found in Table 1.

3.2.2 *acceptable quality level (AQL)*—a nominal value expressed in terms of percent defective or defects per hundred units, whichever is applicable, specified for a given group of defects of a product (see ANSI/ASQC A2).

3.2.3 *defect*—any nonconformance of the unit of product to specified requirements; it is classified according to its seriousness.

3.2.4 *defects per hundred units—of any given quantity of units of product*, is the number of defects contained therein divided by the total number of units of product, the quotient multiplied by one hundred (one or more defects being possible in any unit of product). Expressed as an equation:

$$\text{Defects per hundred units} = \frac{\text{number of defects} \times 100}{\text{number of units inspected}} \quad (1)$$

[1] This practice is under the jurisdiction of ASTM Committee D10 on Packaging, and is the direct responsibility of Subcommittee D10.14 on Tape and Labels.

Current edition approved April 10, 1998. Published March 1999. Originally published as D 3715 – 78. Last previous edition D 3715 – 93ε1.

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

[3] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

[4] Available from American Society for Quality (ASQ), 310 West Wisconsin Ave., Milwaukee, WI 53203.

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TABLE 1 Sampling Plans for Inspection by Variables[A] (Variability Unknown—Single Specification Limit)

Lot Size (100-m²[yd²] Units)			Sample Size	Acceptable Quality Levels (Normal Inspection)							Sample Size	Acceptable Quality Levels (Reduced Inspection)					
				.65	1.00	1.50	2.50	4.00	6.50	10.00		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*
1	to	300	3	I	↓	↓	0.587	0.502	0.401	0.296	3	I	0.587	0.502	0.401	0.296	0.178
301	to	500	4	I	0.651	0.598	0.525	0.450	0.364	0.276	3	I	0.587	0.502	0.401	0.296	0.178
				↓								I					
501	to	800	5	0.663	0.614	0.565	0.498	0.431	0.352	0.272	3	I	0.587	0.502	0.401	0.296	0.178
801	to	1 300	7	0.613	0.569	0.525	0.465	0.405	0.336	0.266	3	↓	0.587	0.502	0.401	0.296	0.178
1 301	to	3 200	10	0.755	0.703	0.650	0.579	0.507	0.424	0.341	4	0.598	0.525	0.450	0.364	0.276	0.176
3 201	to	8 000	15	0.792	0.738	0.684	0.610	0.536	0.452	0.368	5	0.565	0.498	0.431	0.352	0.272	0.184
8 001	to	22 000	25	0.815	0.779	0.723	0.647	0.571	0.484	0.398	7	0.525	0.465	0.405	0.336	0.266	0.189
				1.00	1.50	2.50	4.00	6.50	10.00	15.00							
				Acceptable Quality Levels (tightened inspection)													

[A]This table contains information extracted from Tables A-2 (inspection level I), C-1, and C-2 from ANSI/ASQC Z1.9.
↓ = Use the first sampling plan below arrow including the larger sample size and the *k* value.
k = Acceptability constant.

3.2.5 *defective unit*—a unit of product that contains one or more defects.

3.2.6 *end item*—the actual product or commodity being sold under the material specification. It is in its most complete form and may be either packed for shipping or at a production stage just preceding packing. It may or may not be the same as the unit of product defined in 3.2.17.

3.2.7 *end-item examination*—the inspection of the roll of tape for those characteristics which are either easily discernible by visual inspection or can be simply measured by a hand rule (such as width). All characteristics of this type are considered as attributes.

3.2.8 *end-item testing*—the inspection of the unit of product that involves measurement of physical properties on a continuous scale. All characteristics of this type are considered as variables.

3.2.9 *inspection*—the process of measuring, examining, testing, gaging, or otherwise comparing the unit of product with the applicable requirements (see ANSI/ASQC A2).

3.2.10 *inspection by attributes*—inspection whereby either the unit of product is classified simply as defective or nondefective or the number of defects in the unit of product is counted, with respect to a given requirement or set of requirements (see ANSI/ASQC A2).

3.2.11 *inspection by variables*—inspection wherein a specified quality characteristic on a unit of product is measured on a continuous scale, such as pounds, inches, feet per second, etc., and a measurement is recorded (see ANSI/ASQC A2).

3.2.12 *inspection lot*—a collection of units of product from which a sample is drawn and inspected to determine compliance with the acceptability criteria.

3.2.13 *material specification*—that document covering a product or set of products and specifying the parameters that define the product(s) (see ANSI/ASQC A3).

3.2.14 *percent defective*—the number of defective units of product contained therein, divided by the total number of product, the quotient multiplied by one hundred (a unit being considered defective if it contains one or more defects). Expressed as an equation:

$$\text{Percent defective} = \frac{\text{number of defective units} \times 100}{\text{number of units inspected}} \quad (2)$$

3.2.15 *quality characteristic—for inspection*, that characteristic of a unit of product that is actually measured to determine conformance with a given requirement.

3.2.16 *specification limit(s)*—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.

3.2.17 *unit of product*—the entity of product inspected in order to determine its measurable quality characteristic. For this practice the unit of product will usually be a roll of tape. The unit of product may or may not be the same as the unit of purchase, supply production, or shipment. It is also called sample unit in this practice.

4. Significance and Use

4.1 The quality of a tape product is determined by the quality systems of the tape producer, including all processes involved in the engineering and production of the product. It is recommended that appropriate sections of ANSI/ASQC Q94 be included in a producer's quality systems. This practice does not intend to standardize these systems. A producer's reputation, a producer's certification of conformance, or evidence of a producer's quality systems are often sufficient to ensure a purchaser or user of a consistent quality. Acceptance sampling is useful when an objective basis of contract or specification conformance is desired.

4.2 The intention of this practice is to provide a reasonably simple document which can be used by both the buyer and seller of pressure-sensitive tape to determine if the product offered for sale meets some predetermined specification for the product. This practice offers the procedures for determining the size of the sample to be inspected and the criteria for determining whether the lot (amount of material offered for sale) should be accepted or rejected. This practice draws from and is based on both ANSI/ASQC Z1.4 and ANSI/ASQC Z1.9.

4.3 Two forms of sampling plans are included: sampling by attributes and sampling by variables. Sampling by attributes is

used for end-item examination and both are used where appropriate for end-item testing. Sampling by attributes has the advantage of simplicity while sampling by variables has the advantage of costing less for the equivalent assurance of the correctness of decisions.

4.3.1 Sampling plans for inspection by attributes (see Table 2), should be used for end-item examination (see 5.3).

4.3.2 Sampling plans for inspection by variables (see Table 1 and 5.4), should be used for end-item testing except as indicated in 5.4.1.2(a).

4.4 Use of this practice assumes that a specification defining one or more quality characteristics exists. It is suggested that buyer and seller agree on acceptable quality levels (AQL) from within the choices shown in the tables of this practice.

4.5 When conditions warrant switching from normal to tightened or reduced inspection, the appropriate sampling plans are available in Table 1 and Table 2. The decision to switch should be agreed upon between the buyer and the seller. When lots are rejected under normal inspection it is usual to go to tightened inspection. No change in AQL is made, but the assurance of making the correct decision is improved usually by the sampling plan calling for a larger sample size. Reduced inspection is a switch from normal inspection made when some number of lots, usually 10, passes in consecutive order. Switching should move from reduced to normal and from normal to tightened or from tightened to normal without skipping an intermediate step.

5. Procedure

5.1 Where it can be demonstrated that a supplier's quality control system provides a similar degree of assurance as that obtained through the use of this practice, the supplier may use that system in place of the system described herein. In case of conflict, the system described in this practice shall be used.

5.2 Where applicable, inspection (examination or testing) at some prior stage of manufacture, for example in-process or raw material, can be used instead of inspection of the end item. An example of this might be the use of the tensile strength test performed at the raw material testing stage rather than on the end item.

5.3 *End-Item Examination*:

5.3.1 *Sampling*:

5.3.1.1 *Lot Size*, for the purpose of determining the sample size, shall be expressed in units of rolls for examination under 5.3.2.1-5.3.2.3 inclusive, and shall consist of all the tape material presented for examination at one time. The material shall be of the same type, class, and color, manufactured by the same process, from the same components, at one plant by one manufacturer under the same conditions.

5.3.1.2 *Sample Size*—The number of units of product (rolls of tape) to be examined shall be found in Table 2 under sample size. Use the sampling plans for normal inspection unless tightened or reduced inspection has been specifically agreed upon.

5.3.1.3 The following table illustrates the AQLs that have commonly been used with the examinations found in 5.3.2. The graduation follows traditional levels of importance for the attributes collected together in the tables given in 5.3.2.1, 5.3.2.2, and 5.3.2.3. Table 2 illustrates only these AQLs.

Examination Paragraph	AQL, %
5.3.2.1	2.5
5.3.2.2	4.0
5.3.2.3	10.0

5.3.2 *Examination*—Examine in accordance with the defects listed in 5.3.2.1, 5.3.2.2 and 5.3.2.3 and AQLs set forth in the table in 5.3.1.3 when sampled from the shipment. No more than two rolls, randomly selected, shall be drawn from any one shipping container from each lot of material for each type and color of tape offered for inspection for visual and dimensional characteristics.

NOTE 2—The same rolls of tape shall be used for examination under 5.3.2.1-5.3.2.3 inclusive, and these examinations should be made concurrently.

5.3.2.1 *Major Defects*—The sample unit for this examination shall be one roll.

Examine	Major Defect
Form	Not type, class, or grade specified.
	Adhesive side not wound on inside of roll, unless otherwise specified.
Backing	Not colored or transparent, as specified.

TABLE 2 Sampling Plans for Inspection by Attributes[A]

Lot Size in Number of Rolls	Normal Inspection				Tightened Inspection				Reduced Inspection			
	Sample Size	AQL			Sample Size	AQL			Sample Size	AQL		
		2.5	4.0	10		2.5	4.0	10		2.5	4.0	10
		Ac Re	Ac Re	Ac Re		Ac Re	Ac Re	Ac Re		Ac Re	Ac Re	Ac Re
2–15	2	|Ch	|Co	|Ch	2	|Ch	|Ch	|Ch	2	|Ch	|Co	|Ch
16–50	3	|Co	0 1	|Co	3	|Ch	|Co	|Ch	2	|Co	0 1	|Co
51–150	5	0 1	|Cu	1 2	5	|Ch	0 1	|Ch	2	0 1	|Cu	0 2
		|Cu				|Co	|Ch	|Co		|Cu		
151–500	8		|Co	2 3	8	0 1	|Ch	1 2	3		|Co	1 3
501–3200	13	|Co	1 2	3 4	13	|Ch	|Co	2 3	5	|Co	0 2	1 4
3201–35 000	20	1 2	2 3	5 6	20	|Ch	1 2	3 4	8	0 2	1 3	2 5
						|Co						
35 001–500 000	32	2 3	3 4	7 8	32	1 2	2 3	5 6	13	1 3	1 4	3 6
500 001 and over	50	3 4	5 6	10 11	50	2 3	3 4	8 9	20	1 4	2 5	5 8

[A]This table is based on Tables I, II-A, II-B, and II-C of ANSI/ASQC Z1.4 using an inspection level of S-3.
|Co = Use first sample plan below arrow. If sample size equals or exceeds lot or batch size, do 100 % inspection.
|Cu = Use first sample plan above arrow.
Ac = Acceptance number.
Re = Rejection number.

	Tape does not consist of the specified backing (if one is specified).
Unwinding of rolls	When unwound, tape sticks together to the extent that unrolling causes tearing or injury to the surface of the backing; adhesive separates from the backing; adhesive material removes color coating or printing from back of adjacent layer.
Liner	Missing, when specified. Breaking; delaminates.
Width of tape	Varies from specified width more than allowable specified tolerance.
Length of tape	Varies from specified length more than allowable specified tolerance. (Length to be determined in relaxed state.)
Cores	Inside diameter less than 76.2 mm [3 in.] or more than 79.4 mm [3 1/16 in.] or not other specified dimension. Core crushed, broken, mutilated, or collapsed.

5.3.2.2 *Intermediate Defects*—The sample unit for this examination shall be one roll.

Examine	Intermediate Defect
Workmanship	Adhesive coat not evenly and smoothly applied over the entire area of the backing, as specified; any bare spots, lumps, or foreign particles. Holes, tears, cuts, cracks, or sharp creases; edges not clean cut, nicked, gouged, broken, uneven, sticky, or not straight. Tapes not securely laminated; layer separated; presence of blisters (reinforced tapes only). Telescoping of roll.
Unwinding of rolls	Roll not continuous more than allowable number of splices per roll; splices separate on unwinding.
Core	Identification markings omitted, incorrect, incomplete, illegible, or not as specified.

5.3.2.3 *Minor Defects*—The sample unit for this examination shall be one roll.

Examine	Minor Defect
Tape on rolls	Rolls not evenly and uniformly wound; not wound on either paper fiber or plastic core; core not same width as tape.
Unwinding of rolls	Does not unwind evenly and uniformly without raveling (where applicable). Tape wound unevenly causing wrinkles or creases within the roll.
	Minor Defect
	Splices not evenly and neatly made (not trimmed, loose ends, edges ragged). Note—A mill splice in cloth backing shall not be considered a splice when properly coated. Splice adheres to adjacent layers of tape.

5.4 *End-Item Testing*:

5.4.1 *Sampling*:

5.4.1.1 *Lot Size*—The lot size for the purpose of determining the number of units of product to be sampled for testing, shall be expressed in terms of 100-m^2[100-yd^2] units and shall consist of all tape of the same type, class, and color manufactured by the same process, from the same components at one time, at one plant, by one manufacturer, under the same conditions within a biweekly period; maximum size shall be ten thousand 100-m^2[100-yd^2] units. Table 3 is for use in converting number of rolls to number of 100-m^2[100-yd^2] units. The unit of product shall be the amount of tape required to perform all of the tests required one time. This may be one or more rolls depending on whether the material specification required whole rolls for aging or more than one width of tape to perform certain required tests.

5.4.1.2 *Sample Size*—The number of units of product to be tested shall be found in Table 1 under sample size, entering the table with the lot size. Use the sampling plans for normal inspection unless tightened or reduced inspection has been specifically agreed upon. (See Table 3 to convert number of rolls to lot size in 100-m^2[100-yd^2] units.) In the event the inspection lot does not contain rolls of tape of the width required for test samples, the manufacturer shall supply tape of the required widths to be used as test samples. This additional tape shall be taken from the same manufacturing lot(s) as the tape undergoing inspection. When the requirement for a physical property test is a word description (not a numerical minimum or maximum) the sampling plans for inspection by attributes (Table 2) shall be used. In this case, enter Table 2 with the lot size expressed in 100-m^2[100-yd^2] units as found in 5.4.1.1 instead of the lot expressed in number of rolls. See the following example:

(a) *Example*—Physical property test with objective requirements stated and no numerical limits: The requirement for weathering is that the tape shall exhibit no curling at the edges, blistering or separation from the panel. An AQL of 4.0 % is specified in the material specification. Paragraph 5.4.1.2 requires that these requirements be considered as attributes and that the sampling plans of Table 2, normal inspection, should be used. The paragraph states to convert the lot size (10 000 rolls, 66 m [72 yd] in length by 48 mm [2 in.] in width) to

TABLE 3 Conversion of Number of Rolls to Lot Size in 100-m^2[100-yd^2] Units

Role length, yd	Tape width in. ½	¾	1	2	Lot Size in 100-yd^2 Units
72	1 to 30 000	1 to 20 000	1 to 15 000	1 to 7 500	1 to 300
	30 001 to 50 000	20 001 to 33 333	15 001 to 25 000	7 501 to 12 500	301 to 500
	50 001 to 80 000	33 334 to 53 333	25 001 to 40 000	12 501 to 20 000	501 to 800
	80 001 to 130 000	53 334 to 86 667	40 001 to 65 000	20 001 to 32 500	801 to 1 300
	130 001 to 320 000	86 668 to 213 333	65 001 to 160 000	32 501 to 80 000	1 301 to 3 200
	320 001 to 800 000	213 334 to 533 333	160 001 to 400 000	80 001 to 200 000	3 201 to 8 000
	800 001 to 2 200 000	533 334 to 1 466 667	400 001 to 1 100 000	200 001 to 550 000	8 001 to 22 000
60	1 to 36 000	1 to 24 000	1 to 18 000	1 to 9 000	1 to 300
	36 001 to 60 000	24 001 to 40 000	18 001 to 30 000	9 001 to 15 000	301 to 500
	60 001 to 96 000	40 001 to 64 000	30 001 to 48 000	15 001 to 24 000	501 to 800
	96 001 to 156 000	65 001 to 104 000	48 001 to 78 000	24 001 to 39 000	801 to 1 300
	156 001 to 384 000	104 001 to 256 000	78 001 to 192 000	39 001 to 96 000	1 301 to 3 200
	385 001 to 960 000	256 001 to 640 000	192 001 to 480 000	96 001 to 240 000	3 201 to 8 000
	960 001 to 2 640 000	640 001 to 1 760 000	480 001 to 1 320 000	240 001 to 660 000	8 001 to 22 000

100-m^2[100-yd^2] units (400) and enter Table 2 with this number instead of the number of rolls in the lot. This results in a sampling plan calling for a sample size of 13. Note that with a lot size of four hundred 100-m^2[100-yd^2] units, Table 2 shows a downward arrow at the intersection of the column headed by AQL of 4.0 and the row for lot size 151 to 500. This arrow means that the sampling plan in the row below is to be used including the sample size shown in that row. After weathering, it is found that the test for one of the 13 rolls exhibits lifting (curling) at the edges. This is a failure for that roll. None of the other rolls shows this failure nor do any of the rolls exhibit blistering or separation from the panel. The acceptability criterion is to compare the number of defective rolls (one) with the acceptance and rejection numbers for the sampling plan. This sampling plan shows an acceptance number (Ac) of 1 and a rejection number (Re) of 2. Since the number of defective samples (1) is less than the rejection number (2) we accept the lot, at least with respect to the quality characteristic of weathering.

5.4.2 *Testing*—The end item should be tested in accordance with the requirements of the material specification. Only one test specimen should be selected from each unit of product for each test except where the test method specifically requires more than one specimen. In the latter case, the value used to represent any single unit of product for that quality characteristic should be the one specified to be reported in the test method.

6. Determination of Acceptability

6.1 *End-Item Examination*—The following example explains how to use the results of each examination paragraph with the acceptability criterion to determine the acceptability of the lot:

6.1.1 A lot containing 57 000 rolls is examined for major defects in accordance with 5.3.2.1. The sample size is 32 rolls (see Table 2, normal inspection). The examination disclosed that 3 of the 32 rolls are found to have at least one of the major defects listed in 5.3.2.1. The balance of 29 rolls show none of the listed defects. The sampling plan (Table 2) for this lot size at an AQL of 2.5 shows an acceptance number (Ac) of 2 and a rejection number (Re) of 3. The acceptability criterion is to compare the number of defective rolls (3) with these numbers. If the number of defective rolls is less than or equal to the acceptance number, accept the lot (at least with respect to this examination paragraph). If the number of defective rolls is equal to or greater than the rejection number, reject the lot. In this example, reject the lot. No further examination would be necessary. If 2 or fewer defective rolls had been found, the lot would be accepted with respect to 5.3.2.1. Then, examine the 32 rolls according to 5.3.2.2 and follow the same procedure as for 5.3.2.1, except use the number of defective rolls found during the previous examinations and the acceptance and rejection number appropriate to the sampling plan with an AQL of 4.0. If the lot fails to meet the acceptability criterion, reject it. If it meets, proceed to 5.3.2.3 and repeat the process as before with the number of defective rolls found during such examination and acceptance and rejection numbers appropriate to an AQL of 10.0.

6.2 *End-Item Testing*—The degree of conformance of a quality characteristic with respect to a single specification limit should be judged by the quantity $(U - \bar{X})/\bar{R}$ or $(\bar{X} - L)/\bar{R}$.

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

In this practice, $\bar{R}$ is the average of several subgroup ranges. The subgroups are formed as follows: First, notice in Table 1 that there are three sample sizes (10, 15, and 25) which are divisible by 5, and for which the quotient is a whole number greater than 1. These are the only sample sizes which can be broken into subgroups. For these sample sizes the subgroups are formed by segregating the data into groups of 5 data points. Use the first five to be obtained as the first subgroup. The order in which the data were achieved must be retained. The next 5 data points become the second subgroup and so on until there are 2, 3, or 5 subgroups for the sample sizes of 10, 15, and 25 respectively. The range of a subgroup is the difference between the largest and the smallest measurement in a subgroup.

6.2.2 In 6.2.5, Example 1, the data are shown in two rows. The first five data points are in the first row beneath the discussion paragraph and form the first subgroup whose range (*R1*) is 34 − 24 = 10. The second subgroup is the next 5 data points which are on the second row (*R2* = 7). In Line 4 of the calculation, $\bar{R}$ is computed. The general form for the calculation of $\bar{R}$ is to divide the sum of the individual subgroup ranges by the number of subgroups. In this case $\bar{R} = (10 + 7)/2$.

6.2.3 In 6.2.6, Example 2, the sample size is 4, so only 4 measurements will be used in the calculations. In this case there can be only one subgroup. A similar situation occurs when the sample size is 3, 5, or 7 since not more than one complete subgroup can be formed containing 5 measurements in any of these cases. In these cases, the average range ($\bar{R}$) is the same as the range of the group (*R*). Thus, on Line 4 of the calculation in Example 2, $\bar{R}$ is shown as having the same value as the single group range (*R*).

6.2.4 Compare the quantity $(U - \bar{X})/\bar{R}$ or $(\bar{X} - L)/\bar{R}$ with the acceptability constant *k* found in Table 1. 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. Repeat this comparison for each quality characteristic.

6.2.5 *Example 1*—Lower specification limit *L* is given. Compute the quantity $(\bar{X} - L)/\bar{R}$ and compare it with *k*.

6.2.5.1 A lot of 75 000 rolls 66 m by 24 mm [72 yd by 1 in.] wide (equals fifteen hundred 100-m^2[100-yd^2] units) from Table 1 is tested for peel adhesion for which the minimum requirement is 27 N/100 [25 oz/in.] of width. The sample size (Table 1) is 10, so 10 rolls of tape will represent the sample. The material specification cites an AQL of 4.0.

6.2.5.2 The values obtained from the 10 rolls arranged into two subgroups in the order of performing the test with the

range for each subgroup $R1$ and $R2$ are:

27 31 34 24 29 (R1 = 34 − 24 = 10)
28 32 31 34 35 (R2 = 35 − 28 = 7)

6.2.5.3 Determine compliance with the acceptability criterion as follows:

Line	Information Needed	Value Obtained	Explanation
1	Sample size: n	10	...
2	Sum of measurements: ΣX	305	...
3	Sample mean $\bar{X}$: $\Sigma X/n$	30.5	...
4	Average range $\bar{R}$: ΣR/number of subgroups	8.5	(10 + 7)/2
5	Specification limit (lower): L	25	...
6	The quantity: $(\bar{X} - L)/\bar{R}$	0.65	(30.5 − 25)/8.5
7	Acceptability constant: k	0.507	see Table 1 (normal inspection)
8	Acceptability criterion: compare $(\bar{X} - L)/\bar{R}$ with k	0.65 > 0.507	see 6.2.4

The lot does meet the acceptability criterion for the adhesion tests, since $(\bar{X} - L)/\bar{R}$ is greater than k.

6.2.6 *Example 2*—Upper specifications limit U is given. Compute the quantity $(U - \bar{X})/\bar{R}$ and compare it with k.

6.2.6.1 A lot size of 20 000 rolls 66 m by 24 mm [72 yd by 1 in.] wide (equals four hundred 100-m^2[100-yd^2] units from Table 3) gives a sample size of 4 (Table 1). The test for unwind has a maximum requirement of 70 N/100 [4.0 lb/in.] of width. The material specification cites an AQL of 2.5. The test results were: 3.9, 4.0, 3.9, 3.3 ($\bar{R} = R$ therefore 4.0 − 3.3 = 0.7 = $\bar{R}$) (see 6.2.3).

6.2.6.2 Determine compliance with the acceptability criterion as follows:

Line	Information Needed	Value Obtained	Explanation
1	Sample size: n	4	...
2	Sum of measurements: ΣX	15.1	...
3	Sample mean $\bar{X}$: $\Sigma X/n$	3.77	15.1/4
4	Average range $\bar{R}$:Σ R/number of subgroups	0.7	One subgroup so $\bar{R}$ = R
5	Specification limit (Upper): U	4.0	...
6	The quantity: $(U - \bar{X})/\bar{R}$	0.33	(4.0–3.77)/0.7
7	Acceptability constant: k	0.525	see Table 1 (normal inspection)
8	Acceptability criterion: Compare $(U - \bar{X})/\bar{R}$ with k	0.33 < 0.525	see 6.2.4

The lot does not meet the acceptability criterion, since $(U - \bar{X})/\bar{R}$ is less than k. This lot should be rejected on the basis of this failure.

7. Keywords

7.1 pressure-sensitive tape; quality assurance; sampling

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