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Standard Practice for Sampling of Plastics[1]

This standard is issued under the fixed designation D 1898; 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 is primarily a statement of principles to guide purchasers of plastic materials purchased under specifications to prepare sampling plans that will describe sampling procedures and that will enable them to determine within practical limits whether or not the products meet the specifications.

1.2 The same principles may be used to guide the preparation of specifications in quantitative terms.

1.3 Some of the same principles may be used to determine the actual quality of a product, including its average and variation above and below that average, with respect to a particular property.

1.4 Since the design of probability sampling depends upon the ultimate use of the samples and the resulting data, consideration must be given to the intended inspection of the samples. Hence, the design of plans for examination and testing of samples for both their attributes and their variables is included.

1.5 This practice is intended for general guidance when little information is available on the variability of the material and of the method of inspection. In some cases, quality control chart methods may be substituted for the procedures herein. In any event, a statistician should be consulted if difficulty is encountered in applying the recommendations herein to the design of a specific sampling problem.

1.6 There is no intent to guide the *disposition* of material that is found to be off-specification by sampling and inspection; disposition is a contractual matter.

1.7 The following outline is presented to facilitate use of this practice:

1.8 The values stated in SI units are to be regarded as the standard.

1.9 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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:*

E 122 Practice for Choice of Sample Size to Estimate the Average Quality of a Lot or Process[2]

2.2 *Military Standards:*[3]

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes

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

3. Significance and Use

3.1 The purpose of the sample may be as follows:

3.1.1 To estimate properties of a lot or shipment, such as the percentage of some constituent, the fraction of the items that fail to meet a specific requirement, the average weight or property of an item, or the quality or total weight of the shipment, or simple identity.

3.1.2 To dispose of the lot or shipment rationally, without the intermediate step of the formation of an estimate.

3.1.3 To define new materials in terms of their properties.

3.1.4 To provide material for evaluation of a test method.

4. General Philosophy

4.1 Sampling is a means employed to meet the problem of estimating the quality of a lot from the inspection of only part

[1] This practice is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.13 on Statistical Techniques.

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[2] *Annual Book of ASTM Standard*, Vol 14.02.

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

of the lot. When 100 % inspection ("screening") of a lot is performed, sampling does not apply.

4.2 The inspection of the sample or portion according to a sampling plan results in an estimation of properties, hence, an uncertainty which can be expressed for a given sampling plan in terms of an operating characteristic curve. Each such curve, that is, for a given acceptable quality level, can be used to obtain two numerical quantities: α, the seller's risk, and β, the purchaser's risk. An example is given in Appendix X2.

4.3 The acceptable quality level (AQL) provides assurance to the producer that good material will seldom be rejected. There is a large probability that quality that is close to and slightly better than the AQL will be accepted (X2.2.1, Note X2.1). Consequently the seller is well protected against rejection of submitted lots of material from a process that is at the AQL or slightly above it. The operating characteristic curve is a graph of the risks that are taken in sampling inspection plotted as a function of incoming lot quality. Any of several units such as average, median, or coefficient of variation, can be used to establish the seller's and purchaser's risks. The unit most frequently used for this purpose is the arithmetic average.

4.4 An immediate question which arises in approaching the sampling of a given lot is that of selecting the number of units to be sampled, that is, defining the sampling plan. A sample of relatively small size will generally be adequate for a large lot. For a small lot, however, a relatively large sample is required for reliable estimation of properties. Such a sample is often uneconomical, and a compromise must then be found between the cost of an adequate sample and its inspection, and the risk entailed in the less certain information from a smaller sample. Actually, such a balance should always be sought in statistical practice so that the value of the information to be obtained from a given program is commensurate with the cost of obtaining the information. This practice includes in Appendix X2 and Appendix X3 some specific directions for choosing the number of units to be sampled. This has proved useful in extensive use in certain seller-purchaser relationships.

NOTE 1—Some detailed procedures for setting up the numerical features of a sampling plan for a particular characteristic of a material will also be found in Practice E 122.

4.5 In the early stages of experience with a material, the required sample quantity for an isolated lot is generally calculated while considering the lot as an entity. Considerable advantage is often gained in evaluating a series of shipments of similar material by regarding their manufacture as a whole. This is generally done after there is some assurance that the manufacturing process is under control, as by the application of control chart methods.[4]

4.6 If the sampling plan is to be designed to help establish whether a lot meets the requirements of a material specification, it is imperative that the specification be formulated carefully.[5]

5. Sampling for Attributes

5.1 The quality of plastic materials or products is judged in part by the frequency of occurrence of their attributes, that is, properties or conditions which may or may not be present in a given sample. Examples include visual defects, contamination, and success or failure in meeting dimensional or test specifications. Probability sampling should be employed to assess the actual frequency, provided that a small number of undesirable attributes can be tolerated.

NOTE 2—If the presence of a given attribute is unacceptable, all the lot must be inspected, and statistical techniques do not apply.

5.2 The quality of a lot with respect to attributes is evaluated by inspection. The sampling plans for such an evaluation are conveniently expressed in tabular and graphic forms (Appendix X2). The selection of AQL's for a given material is traditionally a contractual matter. Factors in determining the number of samples to be taken from a lot include the size of the lot and the degree and level of inspection.

5.3 Attributes may be evaluated by examination or by testing.

5.4 *Sampling for Examination* presents fewer problems. Examination generally is nondestructive and hence less costly. Contamination of molding powder, bubbles in sheets, fisheyes in film, warp and twist in extruded shapes, and dimensions by go and no-go gages fall in this category. Because of their subjective nature, it is difficult to put firm numbers on visual defects and contamination for a plastics material specification. Once the specification has been established, however, a sufficient number of samples for a good statistical evaluation of a lot can generally be examined at reasonable cost.

5.5 *Sampling for Physical and Chemical Tests* must be planned while keeping in mind that the tests are often time-consuming and destructive of the sample. The cost tends to limit the number of tests that will be performed. Tests include the determination of particle size and of moisture of molding powder, measurement of properties such as tensile strength, hardness, and deflection temperature, and measurements of color and transparency. For many of these tests, specimens must be cut or molded. The manipulations and calculations may require considerable time for each sample.

5.6 The definition of the sampling unit is important, since it affects the size of the sample. The conception of the sampling unit should also take into account the intended use of the material. For instance, a single bubble may seriously impair the usefulness of a large sheet of glazing material that is to be used in its entirety in military aircraft. If the sheet is to be cut into 152-mm (6-in.) portholes, however, more defects could presumably be tolerated because they can be marked and then avoided in the cutting.

6. Sampling for Variables

6.1 The ultimate object of sampling for variables is to estimate the average value of a property of the material that can be measured on a continuous scale and the variability of the property, with a desired degree of confidence. Such a procedure can be used to obtain data for establishing a specification, as well as for comparing a new lot with a specification.

6.2 In working against a specification for a variable, the concept of AQL is useful because it reduces to tabular and graphic forms the choice of sample size (that is, the number of

[4] See the *ASTM Manual on Quality Control of Materials, STP 15-C*, Am. Soc. Testing Mats. (1951).

[5] See *Form and Style for ASTM Standards*, available from ASTM Headquarters.

units from the lot to be drawn into the sample) that is necessary in order to minimize the risk of accepting substandard material.

6.3 In both inspection for attributes by means of tests, and in inspection for variables, values measured in tests are the ultimate bases for judgment of quality, that is, both types of inspection are intended to ensure that the percent defective is less than a certain value. The difference lies in that, in the first instance, the individual test results, or perhaps an average for each sampling unit, are used in deciding acceptance or rejection. In inspection for variables, however, the range (spread) of the group of measurements is also important. The estimated standard deviation, derived from the measurements, is multiplied by a factor from tables, and the resulting product is then subtracted from the average. The corrected average is used for comparison with a minimum specification value. (When the specification is a maximum limit, the product is added to the average.) This means, as one result, that a lot of product having a relatively poor average value, but a narrow range of values for a certain property, may be accepted as meeting a specification, while another lot having a better average but greater variation may be unacceptable. This puts a premium on consistent performance, which is probably more economical in the long run for everyone concerned.

6.4 In setting up a plan for sampling for variables, it must be remembered that it is generally easier to attain a desired degree of assurance for the average value than for its standard deviation. This can easily be demonstrated by an experiment which involves drawing numbers truly at random from a bowl. In general, it takes a very few trials in order to establish a reasonable value for the average number. It takes many more samples to arrive at a good estimate of the standard deviation of the average. This would be equally true for a plastic molding powder that happened to be quite heterogeneous with respect to some property, for example, if the moisture content varied from one particle to another. If random sampling were achieved, a good idea of the average moisture could be obtained from a few samples. It would require considerably more to establish the actual variability.

6.5 Detailed plans for sampling for variables, suggested for wide applicability, will be found in Appendix X3.

7. Means and Standard Deviations

7.1 In evaluating the results of measurements of a variable property of a material, several calculations should be made. It is common practice to perform a series of measurements on the material and to calculate the arithmetic mean or average of the series, $\bar{X}$, for comparison with the specification.

7.2 Even in the most careful measurements, a certain amount of variability or dispersion will be encountered. This must also be reported in order to allow meaningful comparisons of the values. For the purpose of this practice, the most useful numerical expression of this variability is an estimate of the standard deviation, *s*, of the individual values, calculated as follows:

$$s = \sqrt{(\Sigma(X_i - \bar{X})^2/(n-1)} \quad (1)$$

where:

s = estimated standard deviation,
X_i = value of a single observation,
$\bar{X}$ = arithmetic means of a set of observations, and
n = number of observations in the set.

The reliability of the mean can now be estimated.

7.3 The condition of the average and the standard deviation can also lead to an estimation of the "confidence limits" of the average, provided that only random errors influence the measurements. In order to achieve narrow confidence limits, a large number of determinations must be made. This is seldom realized in practice because of economic considerations of the cost of repeated measurements. Hence, it becomes necessary to report also the numbers of measurements made in arriving at the stated average. Then, confidence limits can be calculated from tables of Student's "*t*" values.

7.4 Sampling may be designed simply to obtain such information as the above on a new material or test method. This information is then applied to make decisions on the quality of subsequent lots of the material.

8. Comparison of Sampling Plans

8.1 Table 1 shows the sample sizes (number of units of product or specimens) and the qualities of lots (in percent defective) that would be accepted 90 and 10 % of the time under three methods of inspection. Inspection Method A is inspection by means of attributes under Military Standard MIL-STD-105 at Inspection Level II. Method B is inspection by means of variables, with variability unknown, under Military Standard MIL-STD-414 at Inspection Level IV. Method C is inspection by means of variables, with variability known, under Military Standard MIL-STD-414 at Inspection Level IV. The plans shown are for lot sizes of 500 and 10 000 units subjected to "normal" single inspection under AQL's of 1.0 and 6.5 % defective. Table 1 is presented to show the following:

8.1.1 Smaller sample sizes are needed for the same degree of discrimination for Method B than for Method A, and for

TABLE 1 Comparison of Sampling Plans
(Sample size and quality of lots accepted.)

Lot Size Units	Code Letter	Number of Units Sampled								
		Method A (II)			Method B (IV)			Method C (IV)		
		(*a*)	(*b*)	(*c*)	(*a*)	(*b*)	(*c*)	(*a*)	(*b*)	(*c*)
AQL = 1.0% Defective										
500	H	50	(1.07)	(9.53)	25	(1.2)	(8.0)	9	(1.2)	(8.0)
10 000	L	200	(1.58)	(4.64)	75	(1.3)	(4.2)	25	(1.3)	(4.2)
AQL = 6.5 % Defective										
500	H	50	(7.56)	(2.4)	25	(7.2)	(21.0)	15	(7.2)	(21.0)
10 000	L	200	(9.34)	(14.1)	75	(7.5)	(14.7)	42	(7.5)	(14.7)

Example—Using Method A at AQL = 1.0 on a lot size of 500, a sample size (*a*) of 50 is required. Under this plan, 90 % of lots containing 1.07 % (*b*) defective material would be accepted, but only 10 % of lots containing 9.53 % (*c*) defective material would be accepted.

Method C (variability known) than for Method B (variability unknown).

8.1.2 Because of larger sample size, greater discrimination (the power to separate good lots from bad) can be obtained by inspecting large lots than by inspecting small lots, provided that the large lots are reasonably homogeneous. However, increased discrimination in inspecting small lots may be obtained by using a higher inspection level, that is, larger sample if the increased cost of inspection is considered justified. This change is made by substituting a code letter later in the alphabet.

8.1.3 Inspection Level IV of Military Standard MIL-STD-414 is roughly equivalent in discrimination to Inspection Level II of Military Standard MIL-STD-105.

8.1.4 Under these plans the seller's risk (the risk of having good lots rejected) varies little between the several sampling plans. The chief difference in the plans is the difference in the purchaser's risk (the risk of accepting bad lots).

GENERAL SAMPLING PROCEDURES

9. Scope

9.1 A general sampling procedure may be outlined, both for random and stratified sampling, followed by specific directions for handling the physical nature of various plastic materials. Once the precise purpose of the sampling plan has been decided in terms of attributes or variables and the level of quality it is desired to attain, then one may proceed to formulate a specific procedure, possibly as follows:

9.1.1 Decide on the size of the sampling unit. This decision may be obvious from the nature of the lot, for example, in a lot of ten drums of a plastic molding powder of a single grade and color, known to be uniform within drums, the drums are the sampling units. This decision may have already been made in arriving at the desired purpose and AQL.

9.1.2 Count the number of units in the lot.

9.1.3 Designate, as by labeling, the sequential units in the lot.

9.1.4 Deduce, from the number of units and the sampling plan, the numbers of units to be sampled (demonstration graphs and tables in Appendix X2 and Appendix X3).

9.1.5 Designate the actual units that are to be samples. For choice between random and stratified sampling, see 10.1 and 11.1.

9.1.6 Perform the sampling of these units.

9.1.7 Deliver the samples, properly identified, for inspection where the calculation will be performed and the report made.

9.1.8 Ascertain the quality of the data or lot, from the report, for further action.

10. Random Sampling (Unstratified Material)

10.1 Randomness is achieved when every part of the lot has an equal chance of being drawn into the sample in the first and in successive sampling operations. To permit random sampling, all units in the lot shall be designated.

NOTE 3—Random does not have the connotation of haphazard. A random sample ensures that repeat tests will provide the same result, within the sampling error of a normal distribution, if the distribution is normal.

10.1.1 Choose numbers in sequence or other serial code so that sampling by random numbers may be employed.

10.1.2 If possible, this sequence shall be in direct relation to order of manufacture, packaging, or filling of the package, for example, later units and strata in units shall have higher numbers, extruded shapes shall be numbered in unit areas, or lengths from end to end. Therefore, where possible, the manufacturer should code every package consecutively.

10.1.3 When a large quantity of material is contemporary, for example, the transverse direction of a wide extruded sheet, also make designations of subdivisions of this width, in sequence from one side to the other for each time interval in the machine direction.

10.2 If serial codes other than sequential numerals are normally applied to the units, the user can readily construct an equivalent table of random items, once the code is related to numerals, for example, the code sequence 1A, 2A, 3A, 1B, 2B, 3B,—could become 1, 2, 3, 4, 5, 6,—before randomizing. Although subsequent sampling and testing of the numbered units will be in random fashion, recording of such a "location designation" of each unit will still make it possible to reconstruct time and position trends of unit properties for process studies if desired.

10.3 Random sampling of the numbered units is accomplished by use of a table of random numbers. If the total number of units in the lot from which samples are to be taken is exactly 10, or 100, or 1000, use random numbers from 1 to 10, 1 to 100, or 1 to 1000, respectively. In the more likely cases of other totals, use the actual total to prepare a new table of random numbers from the next higher table; for example, for a total of 15, calculate from a table of random numbers from 1 to 100. Books of tables of random numbers are available.[6]

10.4 In practice, application of random numbers may be simplified. For example, where the actual use of random number tables is inconvenient, random numbers may be selected in advance and provided in envelopes for use as needed. In the selection of material from sheets, templates with random cutouts can be used. Random numbers may also be found by successive throws of a 20-sided die.

10.5 Since it is vital that every significant unit in the lot have an equal chance to be represented among the final samples, it is important that no unit (or part of it) be omitted from the numbering scheme unless it is also to be omitted from ultimate use of the material, for example, because of visible contamination or other obvious reasons for off quality. Thus, the edge of a sheet may be omitted from the sampling pattern only if it is also to be trimmed off before use.

10.6 With regard to material in the central parts of sheets, lengths of pipe, and the like, the precaution against deliberate omission from the sampling pattern applies primarily to the preliminary or occasional experiments which are designed to establish the variability of the material. Economy generally dictates against sampling such central portions, but a correction must then be applied to the data if the material is known to be nonuniform.

10.7 In evaluation of the over-all quality of a lot, of course,

[6] Rand Corp., *A Million Random Digits*, The Free Press, Glencoe, IL (1955).

it is imperative that all the samples of random choice be used, regardless of individual quality, unless they are to be discarded from the lot because of off-color or contamination.

10.8 Samples from a lot of molding powder should not be blended together before testing, if information about the variability within the lot is desired. Only the average quality of the lot can be deduced from a blend. If such blending is performed, the presence in the lot of portions of poor quality may not be detected.

NOTE 4—Systematic sampling, by sampling every *n*th unit, may be justified if it has been shown that the period of significant variation is very short or very long compared to the sampling interval.

11. Sampling Stratified Materials

11.1 It may be known or suspected that the value of a property of the material varies in a nonrandom fashion throughout the lot, for example, because of stratification or size segregation. Stratified sampling should then be employed. Divide the lot into a number of real or imaginary sections or strata, and sample every such division. In the ultimate calculation, the average property for the lot must take into account the relative sizes of the strata, if they vary in size, by appropriate weighting of the data. Exercise great caution in the application of the MIL-STD plans to stratified sampling.

11.2 Stratified sampling is generally employed in studies of sampling to determine the presence of any persistent bias in the property with time or direction (for example, size segregation within a drum of molding powder) which might preclude the application of random sampling.

11.3 Stratified sampling is recommended when compositing, since few materials are completely homogeneous. If a composite is prepared from a statified material, each stratum should be sampled in an amount proportionate to its size.

SPECIFIC SAMPLING PROCEDURES

12. Scope

12.1 Depending on the physical form of a plastic material, the degree of uniformity that may have been imposed upon a lot before shipment (for example, blending of 4500 kg (10 000 lb) of molding powder before packaging in drums), and the size of the lot, various specific approaches to the sequential numbering of the sampling units in the lots and the subsequent sampling may be employed.

13. Sampling Molding Powder (Fluff, Pellets, Cubes)

13.1 *In Small Packages*:

13.1.1 The packages shall be the sampling units. Number the packages in the lot serially.

13.1.2 Choose the total number of packages to be used in sampling from considerations given above or in Practice E 122 for the most critical test to be run on the material.

13.1.3 Using random numbers, obtain numbers to indicate all the packages that are to be sampled.

13.1.4 Take a sample from each package designated in 13.1.3.

NOTE 5—*Quantity of Sample*—If more than one type of inspection is to be run on the sample, be sure to take enough sample for all such inspections from the package and make it uniform by blending. The gross quantity of sample taken from one unit should preferably be approximately twice that estimated to be required for the tests that are to be made. This allowance is made in order to permit repeat tests without resampling, in cases where the terms of retesting do not require fresh samples or samples from units not previously sampled.

NOTE 6—*Sample Handling*—In opening packages for purposes of sampling, make certain that no contamination enters from scale, paint, shattered heads, torn liners, or other causes. Transfer each sample to a clean, dry container, capable of being tightly closed. The container must not react with nor otherwise contaminate the sample. Constructions of sheet metal, glass, or many plastic materials are generally suitable, but do not assume inertness of the container in the absence of certain knowledge. Cap liners may be attacked. Do not subject the container subsequently to any conditions that may alter the properties of the sample before testing.

13.2 *In Drums*:

13.2.1 Number the drums in the lot serially.

13.2.2 Choose the total number of drums to be sampled from considerations given above or in Practice E 122, for the most critical test to be run on the material.

13.2.3 Using random numbers, obtain numbers to designate all the drums that are to be sampled to achieve the total number designated in 13.2.2.

13.2.4 If nonuniformity of material within the drum is unlikely to occur, or to affect any of the test results if it does occur, take a grab sample 50 to 100 mm (2 to 4 in.) below the surface from each package designated in 13.2.3 (Note 5 and Note 6).

13.2.5 If nonuniformity of material within the drum is likely to affect the test result, number ten strata of equal height from bottom to top of each drum to be sampled. Choose the total number of strata to be sampled within a drum as in 13.2.2. Obtain the numbers of the strata to be sampled using random numbers. Take a grab sample from each stratum to be sampled (Note 5, Note 6, and Note 7).

NOTE 7—*Stratification and Size Segregation of Molding Powder*—Drums of molding powder in transit, and frequently during packing at the manufacturer's plant, become shaken down. Frequently dense compaction occurs, so that only a few ounces of material would fall out if the container were inverted. The few coarse particles not bound in the mass show plainly on the top surface, giving the impression that the fines have sunk and the coarse particles risen. Sieve analysis of samples taken just under the surface, and throughout the drum, ordinarily fails to disclose segregation.

13.3 *In Bulk* (packages containing more than 100 kg (220 lb), balloons, carloads wherein access can be had to all parts of the container):

13.3.1 Devise a sampling unit such that there will be approximately 100 equal such units in a bulk package or lot. This will give approximately 45 kg (100 lb) per unit in a 4500-kg (10 000-lb) lot. Each sampling unit should have approximately the same height, width, and depth dimensions. The units should be numbered serially in a logical fashion throughout the bulk package, for example, in a row from left to right across the top at the back, then similarly in the next top row toward the front, and finally repeated in similar rows for the next row down from the top.

13.3.2 Choose the total number of units to be used in sampling as described in 13.1.2.

13.3.3 Obtain the numbers of the unit to be sampled, using random numbers.

13.3.4 Take a grab sample from each unit designated in 13.3.3 (Note 5, Note 6, and Note 7).

13.4 *In Bulk*, when access can be had to all contents of the container only as it is emptied and total time of emptying is known:

13.4.1 Devise a "sampling time interval" such that there will be approximately 100 such equal intervals numbered in sequence, in the process of emptying the bulk package at a constant rate of moving the material.

13.4.2 Choose the total number of intervals to be used in sampling as described in 13.1.2.

13.4.3 Obtain the numbers of intervals to be sampled, using random numbers. Arrange these numbers in increasing order.

13.4.4 As the bulk package is emptied, take a grab sample of material passing a fixed point during each time interval determined in 13.4.3 (Note 5, Note 6, and Note 7).

13.5 *In Bulk*, when access can be had to all contents of container as it is emptied and total time of emptying is unknown or prolonged. Take samples at ten random intervals selected for the first 40 h of use, then every such interval + 40 h thereafter, until the lot is consumed.

14. Sampling Fabricated Stock Shapes

14.1 *Sheets, Flat Film, Slit Tubing*:

14.1.1 Lay out on the sheet a rectangular pattern of unit areas of a size chosen so that uniformity within the unit is likely.

14.1.2 Number these units serially, first back to front (in the strip of areas at the extreme left) across the width of the sheet, then across the next width and similarly down the length of the sheet, moving from left to right.

14.1.3 Choose the total number of units to be sampled (13.1.2).

14.1.4 Obtain the numbers of the units to be sampled using random numbers or by the use of a latin square.[7]

14.1.5 Remove the units of area indicated by number in 14.1.4 for later sample cutting, or cut samples from the units directly. If the substrate is very likely to be uniform, use only units near one or both ends.

14.2 *Blocks*—Lay out unit volumes in rectangular coordinates in three dimensions, then apply the random sampling procedure in 14.1.

14.3 *Blown Film, Rods, Tubes, and Pipe of Large Circumference*:

14.3.1 Lay out unit areas around the circumference.

14.3.2 Number, choose, and sample the unit areas as in 14.1.

14.4 *Rods and Tubes of Small Circumference, Tapes, Strips, Beams, Monofilament, Rope, Insulated Wire and Cable, and Other Extruded Shapes*:

14.4.1 Number units of length from one end to the other.

14.4.2 Choose and sample the unit lengths as in 14.1.

15. Molded Items and Groups of Test Specimens

(as prepared in large quantities for developmental and interlaboratory testing)

15.1 Number each specimen as a unit, preferably in order of preparation (molding).

15.2 Choose and sample the numbered specimens as described in 14.1.

16.

[7] Dixon, W. J., and Massey, F. J., *Introduction to Statistical Analysis*, McGraw-Hill Book Co. (1951).

APPENDIXES

(Nonmandatory Information)

X1. GLOSSARY Precision and Bias

Sampling Plans make use of the theory of probability to combine a suitable method for deciding upon the sample size with an appropriate procedure for summarizing the test results so that inferences may be drawn and risks calculated from the test results by the theory of probability. For any given set of conditions there will usually be several possible plans, all valid, but differing in speed, simplicity, and cost.

Shipment, *n*—The total material of given type and grade obtained from one manufacturer in a delivery or some convenient time interval; it may represent one or more batches.

Batch, *n* A unit of manufacture or "run" as produced.

Lot, *n*—A specific quantity of similar material or collection of similar units from a common source; the quantity offered for inspection and acceptance at any one time. A lot might comprise a shipment, batch, or smaller quantity.

Unit (Sampling Unit)—One of the number of similar articles, parts, specimens, lengths, areas (package, drum), etc., of a material or product.

AQL (Acceptable Quality Level)— A quality of product (expressed as percent defective), such that a lot having this percent defective will have a probability of rejection equal to α. An ideal sampling and inspection plan would accept all lots of this or better quality and reject all lots of lower quality. Any practical plan can only approach this ideal.

α—The seller's risk, that is, the probability of rejecting a lot that is actually acceptable.

β—The purchaser's risk, that is, the probability of accepting a lot that is actually unacceptable.