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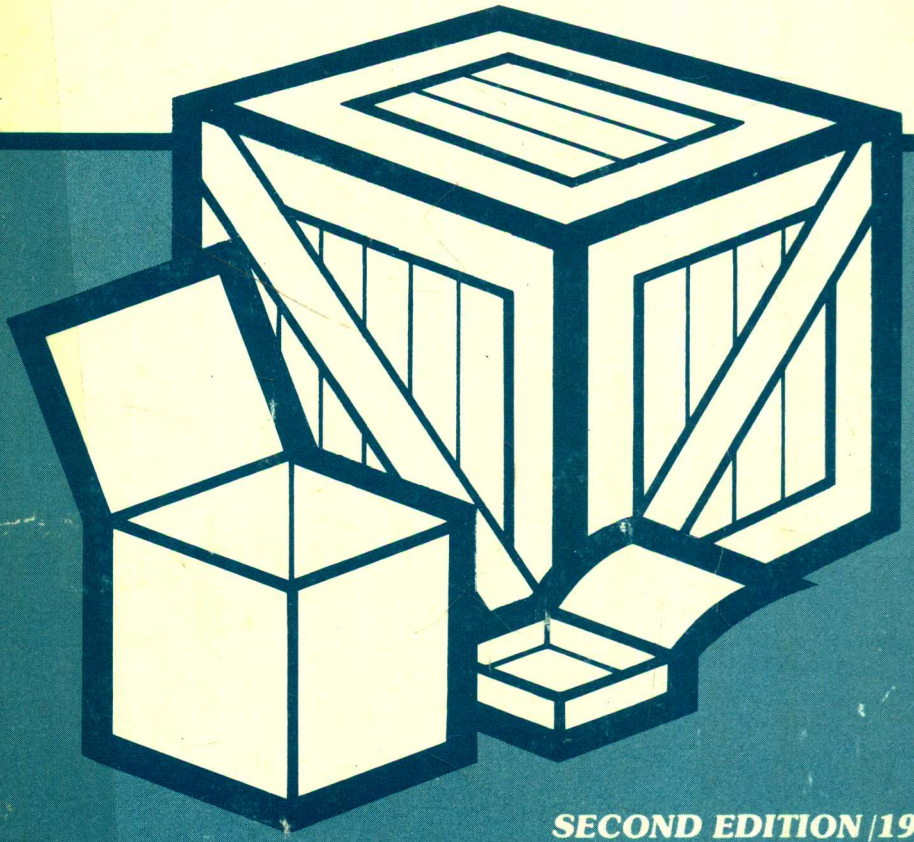
PACKAGING



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FACTS ABOUT

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In the serial designations prefixed to the following titles, the number following the dash indicates the year of original issue as tentative or of adoption as standard or, in the case of revision, the year of last revision. Thus, standards adopted or revised during the year 1984 have as their final number 84. A letter following this number indicates more than one revision during that year, that is 84a indicates the second revision in 1984, 84b the third revision, etc. Standards that have been reapproved without change are indicated by the year of last reapproval in parentheses as part of the designation number, for example (1984). A superscript epsilon indicates an editorial change since the last revision or reapproval—$\epsilon 1$ for the first change, $\epsilon 2$ for the second change, etc.

D 4169-86$^{\epsilon 1}$	Practice for Performance Testing of Shipping Containers and Systems
E 96-80$^{\epsilon 1}$	Test Methods for Water Vapor Transmission of Materials
E 685-79	Practice for Testing Fixed-Wavelength Photometric Detectors Used in Liquid Chromatography

RELATED MATERIAL

T 410	Grammage of Paper and Paperboard (Weight Per Unit Area)
T 411	Thickness (Caliper) of Paper and Paperboard
T 414	Internal Tearing Resistance of Paper
T 423	Folding Endurance of Paper (Schopper Type Tester)
T 810	Bursting Strength of Corrugated and Solid Fiberboard

Designation: C 149 – 86

Standard Method of
THERMAL SHOCK TEST ON GLASS CONTAINERS[1]

This standard is issued under the fixed designation C 149; 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.

1. Scope

1.1 This method covers the determination of the relative resistance of commercial glass containers (bottles and jars) to thermal shock and is intended to apply to all types of glass containers that are required to withstand sudden temperature changes (thermal shock) in service such as in washing, pasteurization, or "hot pack" processes, or in being transferred from a warm to a colder medium or *vice versa*.

1.2 *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 whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Document

2.1 *ASTM Standard:*

C 224 Method of Sampling Glass Containers[2]

3. Apparatus

3.1 The apparatus shall consist essentially of a basket for holding the glassware upright, two tanks, one containing hot water and one containing cold water, and an automatically timed means for immersing and transferring the basket of bottles from the hot to the cold bath. A suitable type of apparatus is illustrated in Fig. 1.[3]

3.2 A device shall be provided to maintain the temperature of the baths within ±2°F (1.1°C) of the specified temperatures. Indicating controllers that control the heating of the hot water and the cooling of the cold water are recommended. Otherwise dial thermometers should be attached and the temperatures controlled manually.

3.3 The capacity of each tank shall be at least 1 gal (3.8 L) for each 1 lb (0.45 kg) of glass tested.

4. Sampling

4.1 Methods of sampling a minimum lot from a group of containers of a given type are given in Method C 224, for the various situations to which it may apply.

5. Procedure

5.1 Adjust the temperatures of the baths so that the cold bath is at 70°F (21°C) and the hot bath is at a temperature hotter than the cold bath by a specified differential. (In most cases this differential will be 75°F (42°C) for the first immersion (Note).) Fill, or partially fill, the basket, with empty bottles, and when the temperatures of the baths are within ±2°F (1.1°C) of those specified immerse the basket in the hot bath in such a manner that the bottles become completely filled with hot water, allow to soak for 5 min, transfer to the cold bath, and immerse for 30 s, and then remove from the cold bath. Control the 5-min immersion in the hot bath within 10 s, and the time of transfer from the hot to the cold bath shall be 15 ± 1 s. During the test, protect the apparatus from drafts in a sheltered area. Observe the number of containers failing in the test by individual inspection of each.

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[1] This method is under the jurisdiction of ASTM Committee C-14 on Glass and Glass Products and is the direct responsibility of Subcommittee C14.07 on Glass Containers.

Current edition approved Jan. 31, 1986. Published March 1986. Originally published as C 149 – 39 T. Last previous edition C 149 – 77[ε1].

[2] *Annual Book of ASTM Standards*, Vol 15.02.

[3] Detailed drawings of satisfactory apparatus for this method are available at a nominal cost from ASTM Headquarters. Order Adjunct No. 12-301490-00.

NOTE—If a cold bath temperature other than 70°F (21°C) is used, the specified differential may be decreased (increased) by 1°F (0.5°C) for each increase (decrease) of 10°F (5.6°C) above (below) the recommended cold bath temperature.

5.2 Use one of the following test procedures depending upon the purpose of the test.

5.2.1 *Pass Test*—Apply the test at a predetermined differential. This "pass test" is sufficient for the routine testing of samples from continuous production in a manufacturer's plant.

5.2.2 *Progressive Test (to a Predetermined Percentage of Breakage)*—Where it may be desirable to conduct the test as a measurement test, the test described in 5.1 may be repeated, the temperature differential being increased, stepwise, by uniform increments (usually 5 or 10°F (2.8 or 5.6°C) each step) by increasing the temperature of the hot water bath, until the predetermined percentage of containers is broken.

5.2.3 *Progressive Test (Total)*—As an alternative to the progressive test described in 5.2.2, the progressive test may be continued until all of the containers fail.

5.2.4 *High-Level Test*—A single test at a predetermined differential sufficiently high to break a portion of the sample may be made.

6. Report

6.1 Report the following information:

6.1.1 Report of method of sampling (see Method C 224),

6.1.2 Number of containers from each mold included in the sample,

6.1.3 Time of transfer used,

6.1.4 Results of test (use one of the following depending on the kind of test):

6.1.4.1 For the "pass test" in accordance with 5.2.1: (*1*) Temperature differential used, and (*2*) Number of containers that failed in the test.

6.1.4.2 For the "progressive test" in accordance with 5.2.2: (*1*) Differential at which the first failure occurred and number of containers that failed at that differential, and (*2*) Differential required to cause failure of the predetermined percentage of the sample, interpolated to the nearest 1°F (0.5°C).

6.1.4.3 For the "progressive test" in accordance with 5.2.3: (*1*) Differentials used in test and number of containers that failed at each differential, and (*2*) Average differential of failure (corrected for the size of the temperature increment or step used by subtracting one half of the increment; for example, 2.5°F (1.4°C) for a 5°F (3°C) increment).

6.1.4.4 For the "high-level test" in accordance with 5.2.4: (*1*) Differential used in the test, and (*2*) Number of containers that failed at that differential.

7. Precision and Bias

7.1 Statements regarding either precision or bias of the thermal shock test results are not possible because suitable thermal shock reference test materials are not available.

7.2 Method precision is within ±2°F (±1.11°C). Method bias is within ±2°F (±1.11°C).

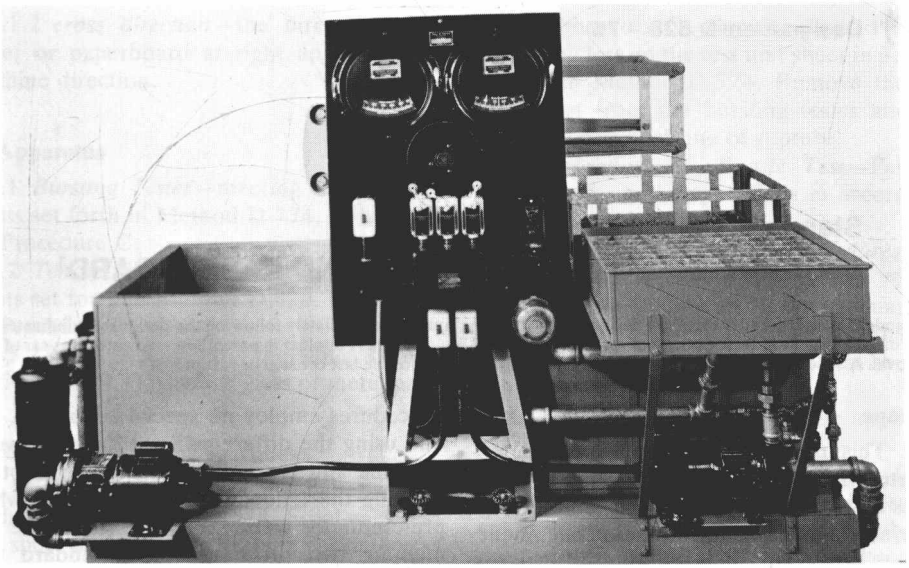

FIG. 1 Automatic Thermal Shock Testing Machine

Designation: D 528 – 76

Standard Test Method for MACHINE DIRECTION OF PAPER AND PAPERBOARD[1]

This standard is issued under the fixed designation D 528; 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.

1. Scope

1.1 This method covers four procedures for determining the machine direction of most grades of paper and paperboard, embodying the principle that machine direction alignment of fibers results in:

1.1.1 Cross-direction shrinkage to produce curl with axis in machine direction,

1.1.2 Higher cross-direction tear,

1.1.3 Higher tensile strength in machine direction, and

1.1.4 Higher stiffness in machine direction.

1.2 Application of the procedures in this method to certain grades of paper, such as sheets laminated to film, creped papers, extensible papers (where it is not unusual for the machine direction tensile to be relatively low and the stretch to be relatively high) and papers reinforced with textile materials, may result in unreliable determinations.

2. Applicable Documents

2.1 *ASTM Standards:*

D 585 Methods for Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard, or Related Product[2]

D 774 Test Method for Bursting Strength of Paper[2]

D 828 Test Method for Tensile Breaking Strength of Paper and Paperboard[2]

2.1 *TAPPI Standard:*

T 409 Machine Direction of Paper[3]

3. Summary of Method

3.1 This method describes four physical procedures for determining the machine direction of paper and paperboard. Two of the procedures employ no special apparatus, the one using the difference in stiffness between machine and cross directions, and the other utilizing the tendency of paper to curl when preferentially wetted on one side. The remaining two procedures use standard test equipment, a tensile tester in one case and a bursting tester in the other.

4. Significance

4.1 From the standpoint of use requirements, the determination of the machine direction of paper is essential where creasing is required, such as the folding of pages in books and pamphlets, or when scoring or creasing is performed as for cut-outs and folders.

4.2 Determination of machine direction is necessary, in many instances, before further testing can be done. For example, machine direction must be known when determining brightness, gloss, tear, tensile and folding endurance.

5. Definitions

5.1 The two major directions of paper or paperboard are defined as:

5.1.1 *machine direction* – the direction of a paper or paperboard corresponding or parallel to the direction of flow of the stuff on the paper machine.

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[1] This method is under the jurisdiction of ASTM Committee D-6 on Paper and Paper Products and is the direct responsibility of Subcommittee D06.92 on Test Methods.

Current edition approved Oct. 29, 1976. Published January 1977. Originally published as D 528-39T. Last previous edition D 528-63 (1970).

[2] *Annual Book of ASTM Standards*, Vol 15.09.

[3] Available from the Technical Association of the Pulp and Paper Industry, One Dunwoody Park, Atlanta, Ga. 30341.

5.1.2 *cross direction*—the direction of a paper or paperboard at right angles to the machine direction.

6. Apparatus

6.1 *Bursting Tester*—meeting the requirements set forth in Method D 774, to be used for Procedure C.

6.2 *Tensile Tester*—meeting the requirements set forth in Method D 828, to be used for Procedure D.

6.3 *Other Apparatus*—Indelible pencil (optional for 9.1), shallow glass or metal pan.

7. Sampling and Test Specimens

7.1 Obtain a sample of the paper in accordance with Method D 585. From each test unit sheet of the sample prepare specimens as follows:

7.1.1 *Procedure A*—For purposes of identification, draw a line through adjacent parts of the paper and the specimen to be cut. Cut circular specimens approximately 50 mm in diameter or square specimens approximately 50 mm on a side. For square specimens, the sides of the specimen must be cut parallel to the sides of the test unit sheet.

7.1.2 *Procedures B and D*—Cut two test specimen strips 15 by 250 mm. Cut them at right angles to each other and parallel to the edges of the test unit sheet.

7.1.3 *Procedure C*—Use the test unit sheet as received.

8. Procedures

8.1 *Procedure A*—Float a specimen on tap water in a pan and note or mark with an indelible pencil, the final axis of curl. Observe the curl before water penetrates completely through the specimen.

8.2 *Procedure B—Bend*—Place two specimen strips together, one on top of the other, making sure they are aligned at one end. Grasp the two between the thumb and forefinger and hold them so that they are free to bend of their own weight. Repeat, placing the bottom specimen on top. Note which specimen bends more when it is placed on the bottom.

8.3 *Procedure C—Bursting Test*—Perform a bursting test on the test unit sheet in accordance with Method D 774. Remove the test unit sheet from the bursting tester and observe the principal line of rupture.

8.4 *Procedure D—Tensile Test*—Perform tensile tests on the specimens in accordance with Method D 828.

8.5 *Recommendations for Procedures*:

8.5.1 Procedures A and C are recommended when the test unit is not in square cut sheet form or where it is not certain that the edges of the test unit are parallel to the machine and cross directions.

8.5.2 Procedure A may not be applicable to unsized papers.

8.5.3 A modification of Procedure D can be also used where the test unit is not square cut or where it is not certain that the edges of the test unit are parallel to the machine and cross directions. Cut consecutive test specimens at 0, 30, 60, 90, 120, and 150 deg from an arbitrarily selected reference line. The specimen having the greatest tensile strength can be considered to have its length parallel to the machine direction. This will not apply to extensible papers.

9. Interpretation of Results

9.1 The axis of curl in Procedure A will be parallel to the machine direction of paper. Papers with a high degree of dried-in strain may first exhibit an axis of curl in the cross direction. After strain relaxation, the curl axis changes and parallels the machine direction.

9.2 The specimen in Procedure B cut with its length parallel to the cross direction, will bend more because of the lesser cross-direction stiffness and will, when on the bottom, fall away from the specimen cut with its length parallel to the machine direction.

9.3 The principal line of rupture in Procedure C (with approximately perpendicular fractures at either end) will be perpendicular to the machine direction.

NOTE—The bursting test is convenient for papers with a normal distribution of tensile and stretch characteristics; however, there are numerous exceptions to this. The principal line of rupture is parallel to the direction with the higher stretch. In those papers where there is no significant difference

in the stretch for the two directions, the rupture tends to be more random and less positive.

9.4 The specimen in Procedure D, cut with its length in the machine direction, will normally have the greater tensile strength and the lesser stretch.

Designation: D 585 – 86

Standard Method for SAMPLING AND ACCEPTING A SINGLE LOT OF PAPER, PAPERBOARD, FIBERBOARD, OR RELATED PRODUCT[1]

This standard is issued under the fixed designation D 585; 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.

1. Scope

1.1 This method covers a procedure for obtaining a sample to represent a lot of paper or paperboard, fiberboard, or related product, including converted paper products (all hereafter referred to as *paper*).

1.2 Prior to purchase, there should be agreement between buyer and seller on the size of the lot to be sampled (5.1), on details of the sampling procedure, the required physical and chemical properties, dimensional tolerances, etc., and the test methods to be employed.

1.3 Appendixes X1 and X2, which provide useful, statistical criteria for accepting individual lots of paper on the basis of the number of defective test units, can assist the buyer and the seller in selecting an agreed-upon sampling and acceptance procedure.

1.4 *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:*

D 528 Test Method for Machine Direction of Paper and Paperboard[2]

D 725 Method for Identification of Wire Side of Paper[3]

2.2 *ISO Standard:*

ISO 186 Paper and Board–Sampling for Testing[4]

2.3 *Military Standards:*

MIL-STD-105D Sampling Procedures and Tables for Inspection by Attributes[5]

MIL-STD-414 Sampling Procedure and Table for Inspection by Variables for Percent Defective[5]

3. Description of Terms Specific to This Standard

3.1 *lot,* a quantity of paper of a single type, grade, grammage, thickness, and composition, about which it is desired to make a judgment (usually as to conformance to specification) by examining or testing a small fraction called the sample.

3.2 *sample,* a specified number of test units selected in accordance with a prescribed procedure to represent the lot.

3.3 *test unit,* an area of paper sufficient to obtain a single adequate set of test results for all the properties to be measured.

3.4 *test specimen,* a test unit, or a portion of a test unit, upon which (for a specified property) a single test determination is to be made.

NOTE 1—A detailed description of the appropriate specimen should be found in the applicable test method or the specification. A specimen may consist of several pieces of paper, as in a multiple-ply tear test, or a single

[1] This method is under the jurisdiction of ASTM Committee D-6 on Paper and Paper Products and is the direct responsibility of Subcommittee D06.04 on Precision and Sampling.

Current edition approved Aug. 29, 1986. Published October 1986. Originally published as D 585 – 40 T. Last previous edition D 585 – 74 (1982)$^{\epsilon 1}$.

[2] *Annual Book of ASTM Standards,* Vol 15.09.

[3] Discontinued, see *1979 Annual Book of ASTM Standards,* Part 20.

[4] Available from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

[5] Available from Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120.

area of paper may be used in whole or part consecutively for several tests. For example, a grammage specimen, which may have been used previously for detecting spots or a dirt count, may subsequently be cut for use as a tension specimen. This last may be used simultaneously for tensile breaking strength, elongation at break, and tensile energy absorption. A "multiple observation" may be involved when the uniformity of a specimen is of interest.

3.5 *test determination,* (*a*) the process of carrying out the series of operations specified in the test method whereby one or more readings (observations) are made on a test specimen and the observations combined to obtain the value of a property of the test specimen, or (*b*) the value obtained by the process.

3.6 *test result,* the value of a property associated with one test unit of the sample by carrying out the complete protocol of the test method, the value being (as specified in the test method) either a single test determination or the average or other specified combination of a specified number of test determinations.

4. Significance and Use

4.1 If a lot of paper is to be accepted or rejected on the basis of a series of tests made on the paper, it is important to sample the paper in a way that will give a test result that is representative of the lot of paper.

5. Establishing the Lot

5.1 *General Considerations*—Avoid grouping together as a lot batches of paper likely to differ significantly from each other in raw materials or manufacture. If the shipment is small or consists of a large number of batches, it may be uneconomical or impracticable to form lots conforming with the definition (3.1). If this is the case, divide the shipment into portions, to be designated "sublots," in which each portion conforms to the definition of *lot.* Before starting the sampling, obtain a complete understanding of the paper to be sampled, including the composition and size of lots and sublots, rolls, skids, etc.

5.2 *Location of Sampling:*

5.2.1 *Sampling at the Paper Mill*—When paper is to be delivered in large rolls or skids, if agreed, have the sample taken at the paper mill and delivered to the purchaser for examination and testing. Include in the purchase agreement a definition of the number of rolls or skids constituting a lot and details of the sampling procedure to ensure compliance with the rules in selecting the sample in accordance with Section 6. Especially indicate whether the sample was taken from mill reels or from the finished rolls or skids.

5.2.2 *Sampling in Transit or Warehouse*—It may be necessary to take a sample at a dock or warehouse en route between the supplier and the purchaser, especially for international shipments or in referee sampling for testing. Sampling in transit or warehouse can be quite expensive and should be avoided whenever possible, because of the problem of resealing. Arranging to inspect the shipment prior to unloading is recommended on inspection in transit. Establish the size of each lot and determine which rolls or skids will be sampled, and arrange to sample and reseal the rolls or skids as they are loaded or unloaded to minimize additional handling. Obtain the sample in accordance with Section 6.

5.2.3 *Sampling After Receipt*—This type of sampling has the obvious disadvantage of delaying evaluation of the shipment and of providing the least favorable conditions for disposal of a rejected lot. Other considerations are the same as above for sampling in transit.

5.3 *Representativeness of the Sample*—The test units of the sample usually cannot be taken at random from anywhere within a large roll or skid, but must be taken near the outer layers so as not to destroy the roll or skid. If such test units are regularly taken at the paper mill (5.2.1) and a reasonably uniform quality of production is being maintained, then the test units will, in the long run, be quite representative of average production, even though not randomly selected and therefore not "representative" from a statistical viewpoint. Such test units, however, taken when the lot is in transit or warehouse (5.2.2) or after receipt (5.2.3), cannot be said with certainty to be representative of the shipment; for example, rolls shipped to a customer may have been selected because their outer layers met the customer's specification, with no knowledge as to whether properties vary from the outer layers to the core of the roll. Such test units therefore may be neither random nor "representative," but they are all that is available "to represent" the lot, which experience shows they do fairly well unless nonuniform manufacture or aging has occurred.

6. Selecting the Sample

6.1 Determine the area of paper required for each test unit (see 3.3) and the number of test

units required. Take a sample consisting of the required number of test units in accordance with a predetermined procedure, designed to eliminate deliberate selection of any particular area of paper (see X1.5), and as far as practicable, conforming to the following rules:

6.1.1 *Rule 1: Take test units in proportion to the sizes of the sublots*—When a lot divides naturally into sublots consisting of discrete quantities such as carloads, pallet loads, rolls, etc., or when certain portions of the lot differ from one another and are segregated as "sublots" (5.1), take the test units in such a way that the number of test units taken from a given sublot is proportional to the size of the sublot.

6.1.2 *Rule 2: Take the test units so that each area of paper in the lot or sublot has an equal probability of being selected*—It is recognized that difficulties of handling may not permit the taking of test units from locations scattered throughout the lot, but this should be done to the greatest practicable extent.

6.1.3 *Rule 3: Take test units indiscriminately*—Take the units without regard to their condition or quality but do not sample the outermost sheets of a roll or skid. Also do not sample from inner sheets that have been damaged by handling, abrasion, etc., unless it is evident that similarly damaged areas occur throughout the lot.

6.2 *Compliance with Rules 2 and 3* may be assured in accordance with the following procedure: Divide the lot or sublot into "locations" (carloads, skids, cartons, etc.) in such a way that each location contains an equal quantity of paper. Assign a number to each location and select the locations to be sampled by drawing numbers at random from a hat or from a table or random numbers. Next assign and select the sublocations or areas within a location by the same procedure. In order to minimize handling during sampling, observe the precautions of Section 5.

6.2.1 When test units are to be taken from *small rolls, reams, bundles, cartons or shipping containers* of completed paper products, divide the lot or sublot into "locations," etc., and proceed as described above.

6.2.2 When test units are to be taken from *large rolls or skids*, divide the lot or sublot into "locations" and "sublocations" no smaller than a roll or unopenable skid (see 6.3.2), assign and select numbers as described above, then proceed as described in 6.3.

NOTE 2—In ISO and British Standards, the word *reel* is used for a continuous sheet or board wound on a core and the word *roll* for the same when wound without a core. In the United States, the distinction is between the "reel" at the end of the paper machine and the "rolls" (with or without the cores) made therefrom.

6.3 *Large Rolls or Skids:*

6.3.1 When taking a test unit from a *large roll* remove all damaged layers from the outside of the roll and, in addition, discard at least three undamaged layers for sheets having a nominal grammage of less than 250 g/m^2 or at least one undamaged layer for heavier sheets. Cut the roll across its full width and to a sufficient depth to enable the requisite number of sheets to be taken. Let the cut sheets fall to each side and remove the roll.

6.3.2 When taking a test unit from a *skid or roll that may not be opened* at the time of sampling, cut a window 300 by 450 mm or larger if larger test specimens are required. Cut the window with its longer side in the machine direction when this is known, or if not known, mark "Direction Unknown" or determine the machine direction using Test Method D 528 and mark whether the machine direction is the short dimension or long dimension. For paper that has been sheeted simultaneously from several rolls, take a sufficient number of adjacent sheets to assure representation of all the rolls used. Cut the sheets to sufficient depth to enable the requisite number of sheets to be taken and remove them. Remove all outside sheets that are damaged and, in addition, discard at least the three outermost undamaged sheets for paper having a nominal grammage less than 250 g/m^2 or at least one outmost undamaged sheet of heavier paper. Vary the position of the window at random among the skids or rolls from which test units are to be drawn, making sure that the sides of the window are parallel to those of the skid or to the roll edge and axis.

6.3.3 In either of the above, if a test for *moisture content* is to be made, it may be necessary to discard considerably more than three undamaged sheets of paper and one undamaged sheet of board. In one case reported in the literature,[6] it was necessary to discard 40 sheets of manila board to obtain the moisture content of the major

[6] Yezek, M., "Some Aspects of Moisture Measurement in Paper and Paperboard," *TAPPI* 41 (8): 193A (1958).

portion of the roll.

7. Care of Samples

7.1 Keep the test units smooth and flat, except for transporting, when it may be better to ship the test unit in a tube. Protect the sample from exposure to direct sunlight, moisture of the hands, contact with liquids or other harmful influences such as extremes of temperature or humidities above 58 % relative humidity. Consult the product specification and the test methods for directions as to any precautions to be taken or special handling necessary.

8. Cutting and Marking

8.1 Trim test units with their edges parallel to the machine and cross directions. Avoid watermarks or creases for other than grammage determinations; also avoid any unusual flaws or blemishes that might subsequently affect the test results. Mark test units for identification, for example, the locations from which they were taken, and, if needed, their machine direction (see Test Method D 528) and top side (see Method D 725).

9. Sampling Report

9.1 When required, give a brief description of the shipment or lot and the sampling including:

9.1.1 Type and grade of paper or paperboard with a reference to the specification, if available.

9.1.2 Form in which purchased (that is, dimensions of rolls or sheets; packaging; etc., if not covered in the product specification).

9.1.3 Total quantity (usually weight or area), or purchase order number, or both.

9.1.4 Lot number or other identification of specific lot sampled (if divided into sublots, identification or description of sublots).

9.1.5 Date of sampling.

9.1.6 Location of sampling (mill, warehouse, in transit, etc.).

9.1.7 Description and enumeration of any portions of the shipment excluded from sampling because of damage.

9.1.8 Deviations from the specified sampling procedure if it was found to be not reasonably possible to follow the prescribed directions.

9.1.9 Authority requesting the sample (if appropriate).

APPENDIXES

(Nonmandatory Information)

X1. Useful Acceptance Plans

X1.1 *Individual Lot Acceptance*—The appropriate sampling-acceptance plan provided in Appendix X2 is to be used only for individual lot acceptance when no other plan has been specified and this method has been referenced. A plan that is tailored to the specific paper product, grade, type of defects, and use, etc., is preferable to a general plan. However, the general plans provided in Appendix X2 are considered to be a good compromise between the costs of testing and the risks of wrong decisions, and are applicable to a wide range of paper products.

X1.2 The acceptance plans given in Appendix X2 are called "attribute" acceptance plans because a test unit fails if it fails to conform to one or more of the requirements for which it is tested and acceptance of the lot is based on an acceptably low number of units failing.

X1.3 ISO 186 uses an engineered sampling plan to determine the lot average, with 5 % of the shipping units sampled but with a minimum of 5 and a maximum of 20.

X1.4 Maltenfort and Boedecker[7] describe a "variables" acceptance plan in which acceptance is based on the average of the values obtained for the test units and the variability among these values.

X1.5 Deliberate nonrepresentative or semirepresentative selection of rolls or skids for sampling may be desirable to emphasize expected stock problems. The plan uses the bills of lading to select skids or rolls at the beginning and near the end of the run, then randomly through the run but stressing front and back positions. These are the areas from which production problems may be expected to arise. This approach is nonrandom, not statistical, but may be more economical when extremes and not averages are sought.

X1.6 When a continuing series of lots is being obtained from the same manufacturer, other plans (such as, MIL-STD 105D and MIL-STD 414) are likely to be more efficient as they can provide for increasing or reducing inspection as experience with that manufacturer indicates.

X2. Attribute Plans for Single-Lot Acceptance

X2.1 *Assumptions:*

X2.1.1 Since a lot is presumed to be reasonably

[7] Maitenfort, G. G., and Boedeker, R. E., "Sampling of Paper and Paper Products," *Industrial Quality Control* 14(11): 19(1958).

homogeneous (3.1), the plans presented below assume homogeneity and therefore provide only for acceptance or rejection of the lot as a whole. If the lot is not homogeneous, a test on one test unit of the sample might be so far off specification as to make at least the corresponding part of the lot unacceptable even though the proportion of off-specification test units would be so small as to indicate the whole lot should be accepted. Provision should be made for this situation in advance, for example, by calling for rejection of the lot as a whole because of its excess nonhomogeneity or by requiring complete screening (that is, testing of each part and rejecting substandard parts) if nonhomogeneity is found.

X2.1.2 The plans are based also on the assumption that the properties of a test unit drawn from the outer layers or sheets (6.3) or at random (in 6.2.1) are identical with the properties throughout the roll, skid, ream, carton, etc., from which the test unit was taken. While this assumption is obviously not true, if the lot or sublot is reasonably uniform and the rules for selecting the sample are carefully followed, the acceptance plans will generally provide a satisfactory level of protection.

X2.2 *Application of Plans:*

X2.2.1 *Plan I*—For individual lots composed of large rolls that cannot be unwound or skids (pallets) that cannot be opened at the time of sampling (6.3.2).

X2.2.2 *Plan II*—For individual lots composed of small rolls (as tapes, toweling), reams, bundles, cartons, or shipping containers from which test units may be selected at random.

X2.2.3 *Plan III*—For "noncritical" chemical tests for individual lots composed as in X2.3.1 or X2.3.2.

NOTE X1—As used herein, *noncritical* means tests for which variability within the lot is of little or no significance and therefore the amount of testing called for by Plan I or II could not be justified.

X2.3 *Acceptance Definitions:*

X2.3.1 *Lot Size:*

X2.3.1.1 *Plan I*—The lot size (N) is the number of rolls or skids of which the lot (3.1) is composed.

X2.3.1.2 *Plan II*—The lot size (N) is the number of small rolls, reams, bundles, cartons, or shipping containers of which the lot is composed, as appropriate for the test to be made. When a choice is possible (as in testing a property of the paper in a roll when an equal number of rolls are packed in each carton), select the unit (roll or carton) on which lot size is based so that the lot size will be greater than 25.

X2.3.1.3 *Plan III*—As for Plan I or II, as appropriate.

X2.3.2 *Sample Size*—The number of test units (3.3) of which the sample (3.2) for test is composed, determined from lot size in accordance with Tables X2.1, X2.2, or X2.3.

X2.3.3 *Acceptance*—A lot is either accepted or rejected as a whole on the basis of tests carried out on the sample. Each test unit of the sample is separately evaluated.

X2.3.4 *Defective Test Unit*—A test unit that fails to conform to one or more of the requirements for which it has been tested.

X2.3.5 *Acceptance Number*—A number used in connection with a sampling plan (Tables X2.1, X2.2, or X2.3), such that if the number of defective test units in the sample is less than or equal to this number, the lot should be passed for the properties tested.

X2.3.6 *Rejection Number*—A number used in connection with a sampling plan (Tables X2.1, X2.2, or X2.3), such that if the number of defective test units in the sample is greater than or equal to this number, the lot should be rejected.

X2.4 *Level of Protection*—If the above assumptions are true, the plans provide the following:

X2.4.1 *Protection to Producer*—The lot will be accepted with a probability of at least 95 % if the proportion of the defective items contained in it does not exceed 2.5 %.

X2.4.2 *Protection to Consumer*—The lot will be rejected with a probability of at least 90 % if the proportion of the defective items contained in it reaches 16 to 32 % in Plan I, 19 to 68 % in Plan II, and 37 to 68 % in Plan III, the smaller figure in each case applying to the largest lot size.

X2.5 *Instructions for The Use of Tables X2.1, X2.2, and X2.3.*

X2.5.1 Select Table X1 or Table X2 according to the composition of the lot (X2.3.1 and X2.3.2).

X2.5.2 Locate the lot size (X2.4.1) in the first column of the selected table. The sampling and acceptance criteria to be used are those given on the line corresponding to this lot size.

X2.5.3 Take a first sample consisting of the number of test units equal to the number in the column headed *n*. Sample according to the rules for selecting a sample to represent a lot (6.1), including in each test unit enough additional material for noncritical chemical tests (X2.5.10 to X2.5.13).

X2.5.4 Subject each of the n test units of this sample to the appropriate number of test determinations for each of the required test properties. For noncritical chemical tests follow instructions in X2.5.10 to X2.5.13.

X2.5.5 Record the number of defective units thus found.

X2.5.6 *First Sample Criteria:*

X2.5.6.1 If the number from X2.5.5 does not exceed the number in column *Ac*, the lot should be considered to meet the requirements relating to the properties tested.

X2.5.6.2 If the above number equals or exceeds the number in column *Re*, the lot should be considered as having failed to meet the requirements of the detail specification.

X2.5.6.3 If the above number exceeds the acceptance number (*Ac*) but is less than the rejection number (*Re*), proceed to the next step.

X2.5.7 Take a second sample equal in size to the first so that the total number of test units in the first and second sample is n_t. Again take this sample in accordance with the rules for selecting a sample to represent a lot.

X2.5.8 Follow X2.5.4 and X2.5.5, and compute the total number of defective test units in the two samples.

X2.5.9 *Total Sample Criteria:*

X2.5.9.1 If the number in X2.5.8 does not exceed the number in Ac_t, the lot is considered to meet the