

The information and data contained in this document were prepared by a technical committee of the Association. The committee and the Association assume no liability or responsibility in connection with the use of such information or data, including but not limited to any liability under patent, copyright, or trade secret laws. The user is responsible for determining that this document is the most recent edition published.

CAUTION:

This Test Method may include safety precautions which are believed to be appropriate at the time of publication of the method. The intent of these is to alert the user of the method to safety issues related to such use. The user is responsible for determining that the safety precautions are complete and are appropriate to their use of the method, and for ensuring that suitable safety practices have not changed since publication of the method. This method may require the use, disposal, or both, of chemicals which may present serious health hazards to humans. Procedures for the handling of such substances are set forth on Material Safety Data Sheets which must be developed by all manufacturers and importers of potentially hazardous chemicals and maintained by all distributors of potentially hazardous chemicals. Prior to the use of this method, the user must determine whether any of the chemicals to be used or disposed of are potentially hazardous and, if so, must follow strictly the procedures specified by both the manufacturer, as well as local, state, and federal authorities for safe use and disposal of these chemicals.

Machine direction of paper and paperboard

1. Scope

1.1 This Standard Practice describes several procedures for determining the machine direction of most grades of paper and paperboard. Most of the procedures embody the principle that fibers tend to be aligned in the machine direction of the sheet, and this alignment produces observable effects. However, the extent of restraint used in drying can be very important in determining machine direction.

1.2 Application of the procedures in this Standard Practice 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, usually result in unreliable determinations. Tearing resistance and folding endurance may be used to determine machine direction for paper known to have been made on a cylinder machine. Tearing resistance should not be used for paper made on a fourdrinier machine, and folding endurance should be used only as specified in Section 7.7.

1.3 During manufacture of paper, cross flows coming from the headbox and the forming section may cause preferential alignment of fibers at an angle to the machine direction. Since the procedures in Section 7.11 are affected by fiber orientation, differences as great as 15° may be expected for sheets of uncertain orientation.

2. Summary

This method describes several procedures for determining the machine direction of paper and paperboard. Some of these procedures employ standard test equipment; others require only the simplest of apparatus.

3. Significance

3.1 The determination of the machine direction of paper is essential for the correct folding of pages in books and pamphlets and for scoring and creasing of folders, labels, and cartons.

3.2 Determination of machine direction is necessary, in many instances, to properly report and identify tested properties. For example, identification of the machine direction is required to correctly determine and report directional brightness, gloss, tear, tensile properties, folding endurance, edge crush, coefficient of friction, and bending properties.

4. Definitions

- 4.1 The two directions of paper or paperboard are defined as:
- 4.1.1 *Machine direction*, the direction of a paper or paperboard corresponding or parallel to the direction of flow of the stock along the paper machine.
- 4.1.2 *Cross direction*, the direction of a paper or paperboard at right angles to the machine direction.

5. Apparatus

- 5.1 *Bursting tester*, meeting the specification set forth in TAPPI T 403 “Bursting Strength of Paper.”
- 5.2 *Tensile tester*, meeting the specifications set forth in TAPPI T 494 “Tensile Breaking Properties of Paper and Paperboard (Using Constant Rate of Elongation Apparatus).”
- 5.3 *Tearing resistance tester*, meeting the specifications set forth in TAPPI T 414 “Internal Tearing Resistance of Paper.”
- 5.4 *Folding endurance tester*, meeting the specifications set forth in TAPPI T 423 “Folding Resistance of Paper (Schopper Type Tester)” or TAPPI T 511 “Folding Endurance of Paper (MIT Tester).”
- 5.5 *Drying oven or desiccator*.
- 5.6 *Other equipment*, indelible pencil, shallow glass or metal pan, microscope.

6. Sampling and test specimens

6.1 Obtain a sample of the paper in accordance with TAPPI T 400 “Sampling and Accepting a Single Lot of Paper, Paperboard, Containerboard, or Related Product.” From each test unit of the sample prepare specimens as follows:

- 6.1.1 *For Procedures 7.1 and 7.8*: for purposes of identification, draw a line through adjacent parts of the paper and the specimen to be cut, the line to be visible on both paper and specimen. Cut circular specimens approximately 25 mm in diameter or square specimens approximately 25 mm on a side. For square specimens, the sides of the specimen must be cut parallel to the sides of the test unit sheet.
- 6.1.2 *For Procedures 7.2, 7.4, and 7.7*: cut two test specimen strips 15 × 250 mm. Cut them at right angles to each other and parallel to the edges of the test unit sheet.
- 6.1.3 *For Procedures 7.3, 7.5, and 7.9*: use the test unit sheet as is.
- 6.1.4 *For Procedure 7.6*: cut the required plies (T 414) 63 mm long in the tearing direction and 75 mm wide. Cut one set of plies with the tear direction parallel to the long edges of the test unit sheet, and another set at right angles to this direction.
- 6.1.5 *For procedure 7.11*: cut square samples at least 230 mm on a side with one axis cut parallel to the known machined edge.

7. Procedures and interpretations of observations

7.1 *Axis of curl procedure*. Induce curl in a square or circular specimen by floating the specimen on tap water in a pan, or moisten with a sponge one side of each of two test strips cut at right angles to each other. Observe the curl before water penetrates completely through the specimen(s). 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. The axis of curl will be parallel to the machine direction of the paper. Note or mark with an indelible pencil the axis of curl. This procedure may give misleading results with papers with high polar angles.

NOTE 1: Paper which absorbs water readily should not be exposed to the water for more than a few seconds. This procedure is generally not suitable for highly absorbent or unsized papers.

7.2 *Bend procedure*. Place the two specimen strips together, one on top of the other, making sure they are aligned. At one end grasp the two specimens between the thumb and forefinger and hold them horizontally so that they are free to bend of their own weight. Repeat, placing the bottom specimen on top. Observe which specimen bends more when it is placed on the bottom. The specimen 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.