

CORRECTION – JULY 2014

An editorial correction has been incorporated into this version of T 412.
The reference in Section 1.2 should have been to Section 8.5, not 7.5.

T 414 om-12

OFFICIAL STANDARD – 1926
TENTATIVE STANDARD – 1964
OFFICIAL TEST METHOD - 1982
REVISED – 1988
WITHDRAWN – 1997
REINSTATED (OFFICIAL METHOD) – 1998
REVISED – 2004
REVISED – 2012
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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.

Internal tearing resistance of paper (Elmendorf-type method)

1. Scope

1.1 This method measures the force perpendicular to the plane of the paper required to tear multiple plies through a specified distance after the tear has been started using an Elmendorf-type tearing tester. It does not measure edge-tear resistance. The measured results may be used to calculate the approximate tearing resistance of a single sheet. It is not suitable for single-ply tear testing.

1.2 For highly directional boards and papers, prepare specimens according to T 496 “Specimen Preparation for Cross Directional Internal Tearing Resistance for Paper, Paperboard and Related Materials.” See section 8.5.

1.3 Caution is recommended in interpreting results from weakly bonded sheets, especially those containing lightly refined long-fibered chemical pulps. The low rate of tear when multiple plies are torn simultaneously may produce erroneously high results (1).

2. Summary

Multiple sheets of the sample material are torn together through a fixed distance by means of the pendulum of an Elmendorf-type tearing tester. The work done in tearing is measured by the loss in potential energy of the pendulum. The instrument scale is calibrated to indicate the average force exerted when a certain number of plies are torn together (work done divided by the total distance torn).

3. Significant test variables

3.1 Several Elmendorf-type tearing testers are available and in use throughout the world, principally those of Australian, British, German, Swedish, and United States manufacture. In addition, testing practices also vary, as is

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reflected in the related methods for these countries or others listed in 11.3. Instruments and practices in use vary in at least three major respects:

3.1.1 The first difference is in the design of the pendulum sector. Instruments conforming to the requirements specified under Section 4 have a deep cutout in the pendulum sector to prevent friction between the specimen and the pendulum. The oldest model, without the deep cutout, permitted the specimen to come in contact with the sector during the test and gave values significantly higher than those obtained using conforming instruments. The magnitude of difference in values, which have been observed (2) to be as much as 10%, varies as a function of instrument and different types and grammages of paper.

3.1.2 The second difference is in the design of the specimen clamps which, together with the structural characteristics of the paper which govern the nature of the tear with respect to its splitting tendencies during the test, can have an appreciable influence on the mode of tearing and may result in significant differences (3). The procedure described in Section 7.3 reduces this effect. The clamp designs used by some manufacturers may vary even for their own models. Instruments are available with pneumatically activated grips; their use minimizes variations due to differences in clamping pressures exerted by manually tightened grips.

3.1.3 The third difference results from a combined variation in testers and testing practices. As measured tearing resistance increases or decreases for different types of paper, it may become so large or so small as to be outside the practical range of the instrument. This problem may be overcome by changing the number of plies tested at one time. The tearing length must never be varied in an effort to alter the pendulum capacity.

3.2 The foregoing, together with other lesser differences in design details between instruments or testing practices, preclude specifying a tearing instrument and method that would give essentially the same test results when using Elmendorf instruments of different design and manufacture. Even for one specific model, some procedural variables such as the number of plies torn may alter the test values calculated on a single sheet basis substantially. Hence, by necessity, this reference method must be arbitrary and is limited to the described procedure used with instruments conforming to all of the requirements specified under Section 4.

4. Apparatus

4.1 Elmendorf tearing tester (4-6), with a cut-out as shown in Fig. 1, which prevents the specimen from coming in contact with the pendulum sector during the test, and having the following elements:

4.1.1 A stationary clamp; a movable clamp carried on a pendulum formed by a sector of a circle free to swing on a ball bearing; a knife mounted on a stationary post for starting the tear; means for leveling the instrument; means for holding the pendulum in a raised position and for releasing it instantaneously; and means for registering the maximum arc through which the pendulum swings when released.

4.1.1.1 The registering means may consist of a graduated scale mounted on the pendulum, a pointer mounted on the same axis as the pendulum with constant friction just sufficient to stop the pointer at the highest point reached by the swing of the sector, and an adjustable pointer stop for setting the zero of the instrument.

4.1.1.2 The pointer and scale may be replaced by a digital readout unit which gives readings of equivalent accuracy and precision (7).

4.1.2 With the pendulum in its initial position ready for a test, the clamps are separated by an interval of 2.8 ± 0.3 mm and are so aligned that the specimen clamped in them lies in a plane parallel to the axis of the pendulum, the plane making an angle of $27.5 \pm 0.5^\circ$ with the perpendicular line joining the axis and the horizontal line formed by the top edges of the clamping jaws. The distance between the axis and the top edges of the clamping jaws is 102.7 ± 0.1 mm. The clamping surface in each jaw is at least 25 mm wide and 15.9 ± 0.1 mm deep.

NOTE 1: Instruments commonly available in the United States are usually equipped with 36 ± 1 mm wide jaws. Instruments may be equipped with jaws as narrow as 25 mm. Testing has shown that the effect of jaw width on test results is statistically insignificant. It is recommended, however, that the test specimen length be adjusted to match jaw width. See Note 3 4.

4.1.3 The instrument measures the energy (work done) used by the pendulum in tearing the test specimen. To convert to average tearing force, the energy is divided by the total distance through which the force is applied. This division may be accomplished by the electronics in digital read-out instruments so that the read-out is directly in grams-force or in millinewtons (SI unit of force). For pointer and scale instruments, the scale may be in millinewtons or in grams-force for a specified number of plies; i.e., when the specified number of plies are torn together, the scale reading gives the average tearing resistance (force) of a single ply.