

AS/NZS 1301.400s:1998

Australian/New Zealand Standard™

Methods of test for pulp and paper

**Method 400s: Tearing resistance
of paper**



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Pulp and Paper Manufacturers Federation of Australia

Additional interests participating in preparation of Standard:

Paper manufacturers
Pulp manufacturers
Research interests
Manufacturers of paper testing instruments
Suppliers of paper testing instruments

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Foreword

This standard was prepared by Joint Technical Committee PK/19, Methods of Test for Pulp and Paper, as a part of AS/NZS 1301, *Methods of test for pulp and paper*.

This edition cancels and replaces (in Australia) AS 1301.400s—1991 and (in New Zealand) NZS/AS 1301.400s:1991, *Method of test for pulp and paper*, Method 400s: *Internal tearing resistance of paper*.

In this revision changes have been made to accommodate developments in tear testers and the title of the standard has been changed to 'Tearing resistance of paper'.

Annexes A, B and C form integral parts of this standard. Annex D is for information only.

Introduction

This standard method, for the tearing resistance of paper and certain classes of paperboard, involves measuring the work done when a test piece of paper is torn through a specified distance. The work is done partly in rupturing the paper along the line of the tear and partly in lifting and bending the paper as it is being torn. The total work done is used, along with the length of the tear and the number of sheets torn together in the test, to calculate a single force which, for the purpose of this standard, is described as the mean force required to continue the tearing of a single sheet of paper. This force is by definition the tearing resistance of the paper and is expressed in millinewtons (mN). This standard provides for the measurement of tearing resistance within the range 0 to 7500 mN.

The tear index, expressed in $\text{mN.m}^2/\text{g}$, of the paper is the tearing resistance divided by the conditioned grammage.

This standard conforms to ISO 1974:1990, except that the ISO standard requires the pendulum friction to be such that 35 complete oscillations of the pendulum occur before the arc of the swing is reduced by 25 mm. Not all modern tear testers, particularly those with pneumatic clamping devices can comply with this requirement in the ISO standard. This standard requires that the number of complete oscillations be at least 15 and within 25% of the number of oscillations measured at the time the pendulum was last calibrated. The pendulum friction requirements for the manually clamped Elmendorf tear testers are unchanged.

Other similar standards are SCAN P 11:96, TAPPI T414om-88 and CPPA D.9 (1993). TAPPI T414om-88 and CPPA D.9 (1993) prescribe a slightly larger test piece but the torn length is the same as in this standard. The TAPPI standard requires the number of sheets torn together to be varied according to the tearing resistance of the sample in order to give a reading near to 40% of full scale using a pendulum similar to the B-pendulum of this standard. Also TAPPI T414om-88 requires the clamp depths to be 15.9 ± 0.1 mm and the test piece dimension in the direction of tear to be 63.00 ± 0.15 mm.

Tearing resistance of paper

1 Scope

This standard prescribes the procedure to be used to determine the tearing resistance of paper and certain classes of paperboard.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of AS/NZS 1301.400s. At the time of publication, the editions indicated were valid. All standards are subject to revisions, and parties to agreements based on AS/NZS 1301.400s are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

AS 1301.P414m—1986, *Conditioning of paper for testing*

AS 1301.P415m—1986, *Standard atmosphere for paper testing*

3 Principle

A test piece of four superimposed sheets, with a specified pre-cut slit, is torn through a fixed distance using a pendulum which applies the tearing force by moving in a plane perpendicular to the initial plane of the test piece. The work done in tearing the test piece is measured by determining the loss in energy of the pendulum due to the tearing of the test piece. The average tearing force (work done divided by the total distance torn) is indicated by a scale on the pendulum or a digital display. The tearing resistance of the paper is determined from the average tearing force and the number of sheets comprising the test piece.

NOTE 1 — By definition, tearing resistance is the mean force required to continue the tearing of a single sheet of paper. The test procedure prescribed in this standard measures the work done in tearing four sheets together through a specified distance. The force required to achieve this is calculated by dividing the work done by the total distance over which the force is applied (i.e. four times the distance torn on each single sheet). Because this standard specifies the number of sheets to be torn, the distance of application of the force is constant and it is possible to calibrate the pendulum scale or transducer directly in units of force (mN).

Some other standards permit or require other than four sheets to be torn simultaneously. Tear testers designed to meet such standards are not usually calibrated to give a direct reading of force and in such cases the reading has to be multiplied by a factor (calculated from the number of sheets actually torn simultaneously and from the scale units used) to give tearing resistance in mN. Results obtained by tearing other than four sheets simultaneously may be different because the work done increases disproportionately with increasing number of sheets^[1].

4 Apparatus

4.1 An approved tear tester, consisting of a frame, mounted on a rigid base, carrying a pendulum which is free to swing about a horizontal axis on bearings of very low frictional resistance. The test piece is held by two clamps, one of which is attached to the frame and the other to the pendulum. The clamping surfaces are at least 25 mm wide and 15 ± 1 mm deep. Traditionally, the work done in tearing a test piece is determined from the change in maximum potential energy, i.e. the difference in the maximum potential energy of the pendulum after a free pendulum swing, and the maximum potential energy after a test piece is torn. In some tear testers the work done is determined from the change in kinetic energy

of the pendulum near the low point of its swing, i.e. near the point where the kinetic energy is a maximum^[2]. The kinetic energy of the pendulum can be determined by measuring the tangential velocity at a known radius. The kinetic energy tear testers comply with this method as long as it can be shown that they satisfy the design and accuracy requirements given below. Additional information on the kinetic energy tear tester is given in annex C.

For all tear testers, at the starting position (before the paper is torn) the pendulum is displaced from its equilibrium position and held by a suitable device. The distance between the clamps is then 2.8 ± 0.3 mm and the clamping surfaces lie in a vertical plane which is perpendicular to the plane of oscillation of the pendulum. The upper edges of the clamping surfaces are in a horizontal line, lying at a distance 104 ± 1 mm from the axis of the pendulum, and the plane containing this line and the pendulum axis makes an angle of $27.5 \pm 0.5^\circ$ with the vertical. For all tear testers a knife is mounted on the frame so that, when a test piece is clamped in the tear tester with the pendulum in its starting position, operation of the knife produces a cut in the test piece. The cut should be such that the length of test piece to be torn is 43.0 ± 0.5 mm and the end of the cut is 4.0 ± 0.5 mm from the edge of the clamps.

NOTE 2 — Some tear testers make two parallel initial cuts in the test piece and make a double tear. Such tear testers do not conform to this standard which requires a tear tester which makes a single tear.

The tear tester is provided with a means of indicating the work done during the test, preferably as a direct reading of tearing resistance in mN. In some tear testers it is achieved by a transducer/digital display system. In others it is achieved by means of a pointer assembly which consists of a sleeve, to which a pointer is attached, mounted coaxially on the pendulum. The position of the pointer relative to the pendulum can be read from a circumferential scale carried on the pendulum. The frictional resistance of this sleeve shall be kept within the range 40 to 80 mN (see paragraph A3, annex A). The pointer engages an adjustable base plate pointer stop, and the scale, pointer and stop are so arranged that the scale reading is a measure of the average force required to tear the test piece. The base plate pointer stop provides a means for setting the scale reading to zero when no work is done in tearing. This adjustment provides an approximate compensation for pendulum and pointer friction at other points on the scale.

Interchangeable pendulums, or a pendulum with interchangeable weights, are provided to allow for the measurement of a wide range of tearing resistance. Each pendulum or pendulum weight combination is associated with a scale or calibration constant which preferably gives a direct reading on the scale or on the display in mN. The most common pendulums are known as A-pendulum which is used for papers with tearing resistance up to 1500 mN, B-pendulum which is used for papers with a tearing resistance of 600 to 3000 mN, and C-pendulum which is used for papers with a tearing resistance of 2000 to 7500 mN.

NOTES

3 — In some tear testers the C-pendulum consists of a B-pendulum with a weight added and in such tear testers the reading on a direct reading scale has to be multiplied by two, or some other action has to be taken, to ensure that the reading takes this into account.

4 — In some tear testers of the type described it is possible for a test piece to foul the pendulum during the test^[1]. Such tear testers are not acceptable for testing in accordance with this standard.