WI 200308.04

T 807

BALLOT NO. 03 - SARG

DRAFT NO. 02

DATE May 29, 2025

WORKING GROUP
CHAIRMAN Benjamin Frank

SUBJECT
CATEGORY Fiberboard Shipping Container

RELATED
METHODS See "Additional Information"

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 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.

Deleted: Material

Bursting strength of linerboard

(Five-year review of Official Method T 807 om-16)

(Underscores, notes, and strikethroughs show changes from Draft 1)

1. Scope and summary

1.1 This method describes a procedure for measuring the bursting strength of containerboard using a disk shaped diaphragm. This method may also be used to test paperboard. (See also 11.3.)

1.2 A specimen is clamped between two platens with circular openings in their centers. An expansible diaphragm is distended through the lower platen by means of hydraulic pressure until the specimen ruptures. The maximum hydraulic pressure when the specimen ruptures is recorded.

2. Significance

The bursting strength test of containerboard (and paperboard) is a composite measure of certain properties of the sheet structure, principally tensile strength and elongation. In general, bursting strength is dependent on the type, proportion, preparation, and amount of fibers present in the sheet and on their formation, internal sizing, and, to some degree, the surface treatment. While bursting strength is an empirical property, this test, in combination with grammage (basis weight), serves to define some "standard grades" in commerce. The bursting strength relates to sidewall puncture of the finished combined board and has been shown to be important in mixed load LTL types of shipments. See TAPPI T 810 for testing burst on combined board and boxes.

3. Apparatus

3.1 *Bursting tester*[1], consisting of the following:

3.1.1 Means for clamping the test specimen between two annular, plane surfaces having fine concentric tool marks to minimize slippage. The upper clamping platen (clamping ring) has a diameter of approximately 95.3 mm (3.75 in.), with a circular opening 31.50 ± 0.03 mm (1.240 ± 0.001 in.) diameter. The lower edge of the opening (side in contact with the board) has a 0.64-mm (0.025-in.) radius. The lower clamping surface (diaphragm plate) has an opening 31.50 ± 0.03 mm (1.240 ± 0.001 in.) in diameter and an outer diameter greater than or equal to the upper platen. The upper edge of the opening (in contact with the board) has a 0.40-mm (0.016-in.) radius and the lower edge of the opening (in contact with the rubber diaphragm) has a radius of 3.18 mm (0.125 in.) to prevent cutting the rubber when pressure is applied.

3.1.2 The upper clamping ring is connected to the clamping mechanism through a swivel joint to facilitate an even clamping pressure. The openings in the two clamping plates are required to be concentric to within 0.13 mm (0.0051 in.), and their clamping faces must be flat and parallel (see Appendix A.1.1).

3.1.3 A molded (disk-shaped) diaphragm requiring a pressure of at least 160 kPa but not more than 210 kPa (at least 23 psi but not more than 30 psi) to distend it to a height of 9.53 mm (0.375 in.) above the diaphragm plate (see Appendix A.1.2.). Diaphragms that require more pressure to distend may lead to artificially high readings.

3.1.4 Means of forcing liquid into the pressure chamber below the diaphragm at a steady rate of 170 ± 15 mL/min (5.75 ± 0.5 oz/min). This pressure is generated by a motor driven piston, rotary pump, or other suitable method for forcing a hydraulic fluid into the pressure chamber of the apparatus (see Appendix A.1.3).

3.1.5 A pressure gauge of the maximum reading or the lazy hand type. The scale has a radius of 47.6 mm (1.875 in.) with graduations extending over a minimum arc of 270° indicating bursting pressure in kPa (psi), with an accuracy of 0.5% of full scale and must have sufficient capacity so that all readings can be maintained in the middle half of the scale. In its operating position, the gauge should be inclined between horizontal and 30° from the horizontal.

Names of suppliers of testing equipment and materials for this method may be found on the Test Equipment Suppliers list, available as part of the CD or printed set of Standards, or on the TAPPI website general Standards page.

When more than one gauge is mounted on a single apparatus, only the gauge on which the measurement is being made is open to the hydraulic system so as not to reduce the rate of distension of the test specimen.

3.1.5.1 Calibrate the gauges before initial use and frequently enough to ensure their specified accuracy (weekly or monthly as needed, or before using if they have been idle for a month or more). Calibrate the gauges while inclined at the same angle as used during a test. During calibration, apply the pressure so that the rate of travel of the needle is similar to that when actually testing the board. If a gauge is accidentally subjected to a pressure beyond its capacity, recalibrate it before it is again used (see Appendix A.1.4).

3.1.6 As an alternative to 3.1.5, a pressure transducer with equivalent accuracy and suitable signal processing circuitry to display the maximum bursting pressure may be used provided it gives comparable results.

4. Sampling and test specimens

From each test unit obtained in accordance with TAPPI T 400 "Sampling and Accepting a Single Lot of Paper, Paperboard, Containerboard, or Related Product," select 10 or more specimens, each with areas at least 100 × 100 mm (4 × 4 in.), preferably larger.

5. Conditioning

Precondition and condition the specimens prior to testing, and make the tests in the conditioning and testing atmosphere, as specified in TAPPI T 402 "Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets, and Related Products."

6. Procedure

6.1 Clamp specimen uniformly so that no slippage is visible during or after test. On units with automatic clamping devices, a minimum clamping pressure of 690 kPa (100 psi) is recommended. For linerboard with bursting strength above 2000 kPa (290 psi) a minimum clamping pressure of 1000 kPa (145 psi) is recommended to assure meeting the no-slip condition. Note that clamping pressure = gauge pressure × (area of piston/area of clamp). See Appendix B for an example of this calculation.

NOTE 1: Using excessive clamping pressures may lead to lower burst results mostly due to damage at the clamping site. If the recommended clamping pressure is insufficient to prevent slipping, perform additional testing to identify the lowest clamping pressure required to restrain the sample.

6.2 Apply the bursting pressure at the specified rate until the specimen ruptures. Record the maximum pressure registered by the gauge. **Make an equal number of tests on each side of the sheet.** This is very important because there is usually a significant difference between sides.

6.3 Make tests only in areas away from creases, imperfections, or visible damage. Position the specimen so that the clamped area is completely covered by the platens and the specimen extends beyond the clamped area. After each test, gently return the indicator needle of the gauge or digital readout to zero.

7. Report

7.1 Report as test result, in kilopascals (pounds per square inch), to the nearest gauge division.

NOTE 2: In some countries, other classical unit systems are in use (Kg/cm^2, bar, etc.). One may report values in these other systems in addition to the forms above if it would be particularly useful to the report recipient.

7.2 For each test unit report:

7.2.1 Average of 10 test determinations, five from each side (if desired average from each side can be reported).

7.2.2 Maximum and minimum values and/or,

7.2.3 Standard deviation,

7.2.4 Number of test determinations made.

8. Safety precautions

8.1 Safety issues include the use of box cutters and paper cutters used to prepare samples. It is recommended that cut proof gloves be used any time a box cutter is being manipulated.

8.2 The burst tester upper platen comes down to secure the specimen creating a potential nip (pinch) point. Care should be taken on unguarded older units. Ensure that newer units always have properly functioning guards.

8.3 The internal pressurizing fluid may be released with significant force if a diaphragm or rupture disc fails. Goggles are recommended when using an unshielded machine to protect the eyes from such hydraulic fluid discharges.

9. Precision

9.1 Repeatability (within a laboratory) = 9%

Reproducibility (between laboratories) = 13%

Repeatability and reproducibility are estimates of the maximum difference (at 95% confidence) that should be expected when comparing test results for materials similar to those described below under similar test conditions. These estimates may not be valid for different materials and testing conditions.

9.2 The estimates of repeatability and reproducibility are based on results from the Containerboard Interlaboratory Program conducted by CTS. The testing was conducted in 2010 using the om-08 version of the method. Testing was conducted on 3 linerboard weights: 35lbs. (171 g/m^2), 42lb (205 g/m^2), and 69 lb (337 g/m^2). Laboratories made 10 determinations on 5 specimens for each test result. The estimates in the chart below are based on 16 results per laboratory for 42 lb linerboard and 8 results per laboratory for 35 lb and 69 lb linerboard.

Linerboard weight	*Average*	*Repeatability r and %r*		*Reproducibility R and %R*		*Test results included*	*Labs included*
35 lb	92	8.2	9.0%	11.4	12.4%	8	48
42 lb	107	8.8	8.2%	14.4	13.5%	16	48
69 lb.	163	16.4	10.1%	20.9	12.8%	8	48

Results listed in pounds per square inch

10. Keywords

Linerboards, Burst strength

11. Additional Information

11.1 Effective date of issue: To be assigned.

11.2 Revisions in recent versions

11.2.1 Changes in the 2016 version include an emphasis on the importance of preconditioning in section 5, clarification of the materials that fall under this test method (in scope and elsewhere), and minor language corrections.

11.2.2 Changes in the 2011 version include an updating of the precision statement, clarification of the allowance of other hydraulic fluids beyond glycerin, and an addition of section A2 regarding the use of foils to check the instrument.

11.2.2.1 The estimates of repeatability and reproducibility presented above differ from those published in previous revisions of the method (repeatability 6.4% and reproducibility 10.6%). The revised estimates are based on more recent testing in the same interlaboratory program. The increase of the precision estimates reflects larger variation within the more recent data.

11.2.3 Changes in the 2008 version include the addition of Appendix B and the safety precautions, plus some additional revisions to improve the scope and summary in order to explain how this method differs from other burst strength methods. Also, corrections to conversions and minor editorial were incorporated.

11.3 This method uses a different instrument as TAPPI T 403, “Bursting Strength for Paper”, and the same instrument as TAPPI T 810, “Bursting Strength of Corrugated Board”. The two instruments have different requirements for the diaphragm used and the opening of the plate through which pressure is applied. As a result, they produce different results even on the same material. Because corrugated board is constructed from multiple containerboard components, industry convention relies on the same test method and instrument to test both the finished product and its constituents, independent of the weight of those constituents.

11.3.1 Prior versions of this method recognized the challenge of using the heavy diaphragm of the instrument in this method on particularly light weight containerboard, and suggested that basis weights for this method should be at least 98 g/m2 (20#/MSF) with a minimum burst of 350kPa (51 psi). However, many in the industry use this method even for liners of lighter weight given the desire to maintain the direct relationship between values measured on the combined board and its components.

Appendix A.

A.1 *Calibration of apparatus for the original instrument design using Bourdon gauges and a demountable clamping tripod* (*1*, *2*)

NOTE 2: Some newer instruments may require slight modifications to the following procedures.

A.1.1 *Platens.* The condition of the platens may be checked as follows: Place a sheet of filter paper over the lower platen and a sheet of pencil carbon paper face down on the filter paper. Hold the upper platen so that it does not rotate while the clamping pressure is applied. When the clamp is raised and the paper is removed, a print of the platen contact will be found on the paper. Rotate the clamp through 90° and repeat the operation. If the platens are in good condition, a uniform print of the entire platen surface will be obtained.

A.1.1.1 Frequently, it will be found that the lower platen has been strained so that only the central portion will print. If this occurs, replace the lower platen. If the print is heavy on one side, the platens are not parallel. This may be remedied by loosening the Allen setscrew in the center of the yoke assembly, which contacts the cylinder, rotating the cylinder in the proper direction and relocking the setscrew. In some cases, it may be necessary to loosen the cylinder nut so that the cylinder can be rotated.

A.1.1.2 Check the lateral alignment of the platens when clamped together to make certain that the holes in the two platens are concentric. If the holes are not concentric, add shims between the cylinder and the yoke assembly or reduce the seat to move the chamber with respect to the frame.

A.1.2 *Diaphragms.* When diaphragms on instruments using the disk-shaped diaphragms are to be changed, make sure that the control lever has been thrown into reverse and has returned automatically to neutral. Turn down the clamping wheel tightly to enable an easier removal of the diaphragm nut with the special spanner wrench. When the diaphragm ring has been completely unscrewed, raise the clamp and remove the demountable tripod. The ring nut and lower platen may then be removed easily. Before inserting a new diaphragm, fill the chamber with air-free hydraulic fluid to the top of the saucer-like depression so that it is even with the clamping ridges. Keep these ridges clean and dry to minimize capillary leakage past them, and if any hydraulic fluid is spilled, wash the ridges with alcohol and wipe them dry. Carefully place the new diaphragm on the surface of the fluid with the flat side down and the reinforced side up. To minimize the inclusion of air, place the diaphragm into place with a rolling motion starting from the rear of the surface of the liquid and rolling it forward. Place the lower platen on the diaphragm so that the small hole in the platen fits over the pin at the rear of the cup, replace the diaphragm ring, and screw it down tightly, preferably after replacing and clamping down the upper platen. The diaphragm should be level with, but not above the top of the diaphragm plate.

A.1.2.1 The stiffness of a diaphragm can change with time as the diaphragm ages and is exposed to pressure from the hydraulic fluid. Diaphragm distention should be verified periodically (per 3.1.3) and/or a regular replacement program for the equipment diaphragms should be implemented.

A.1.3 *Hydraulic system.* The complete absence of air in the tester is very important, because any flow of hydraulic fluid through the gauge lines must be minimized. For example, it has been observed that if two carefully calibrated gauges are connected to the tester and the pressure is applied simultaneously, there may be significant difference between the two readings. This difference may be caused by the presence of air in one of the gauges lines, so that as the pressure is increased and the air is compressed, a greater flow of hydraulic fluid results. Because of the resulting greater attendant frictional resistance to pressure transfer, there will be a lower reading in that gauge. Air should be purged from the machine after every diaphragm change or if the machine is unused for over a month.

A.1.3.1 Glycerin is the most common hydraulic fluid used in this type of equipment, though other oils may be appropriate for some instrument designs. Care should be taken to ensure that they hydraulic fluid does not interact with other system components, particularly the diaphragm.

A.1.3.2 Air is best removed from the system by pumping clean, air-free hydraulic fluid through it. The hydraulic fluid may be freed of air by placing it in a sturdy vessel and applying suction. Air bubbles will be seen to form, and when the vapor pressure of hydraulic fluid has been reached, the hydraulic fluid will commence to foam. At this point, the hydraulic fluid may be considered free of air and ready for use.

A.1.3.3 To remove the air from the tester, remove the gauges and tip it forward. While in this position, open the gauges valves and engage the piston with the motor running. The hydraulic fluid and any air present in the manifold line will then be expelled. As soon as the hydraulic fluid stops flowing, shut the gauge valves tightly and tip the tester back to its horizontal position. If there are no gauge valves, seal the gauge line carefully with a tight plug before tipping it back, taking care that no air is trapped. Remove the diaphragm and add hydraulic fluid through the opening while retracting the piston, taking care that no air is introduced. (Hydraulic fluid may also be replaced without removing the diaphragm by use of a special hydraulic fluid gun available from the manufacturer of the tester.) The diaphragm is then temporarily replaced and the tester tipped on end so that the piston is in the vertical position. The plug at the top-most part of the hydraulic fluid chamber is then removed and the piston again run forward to expel hydraulic fluid and any air which may have been trapped in the piston and cylinder assembly. The plug is then replaced, the tester set down, the diaphragm removed, and the chamber again filled with hydraulic fluid while retracting the piston. If care has been taken, all air should then be out of the tester.

A.1.4 *Pressure Validation* The pressure indicating device shall be calibrated by means of a dead-weight tester of the piston type. For an instrument error of less than 3%, the pressure indicating device shall be calibrated in such a manner that known pressures are applied dynamically at approximately the same rate as in testing of linerboard.

Maximum reading pressure devices are subject to dynamic errors as well as ordinary static calibration errors. (See TAPPI T403.) Before calibration, verify that the entire hydraulic system of the tester is full of liquid and is completely free of entrapped air as indicated above.

A.1.4.1 *Bourdon-type Gauges ("Lazy Hand")*. A Bourdon-type gage must be calibrated while inclined at the same angle at which it is to be used. Preferably, the calibration is to be carried out with the gage in its normal position. If necessary, remove the air in the Bourdon tube of the gauge and replace it by hydraulic fluid as follows: Insert two tubes of Pyrex or metal through a rubber stopper into the neck of a small vacuum vessel one-third filled with hydraulic fluid. Have one tube extend almost to the bottom, and the other extend to just below the stopper. Connect the latter to a vacuum pump and with vacuum tubing connect the other to the Bourdon tube. Turn on the vacuum pump and tip the vessel just enough to uncover the tube connected to the gauge to ensure a minimum of back pressure while drawing air from the gauge. Continue the evacuation for several minutes after the hydraulic fluid in the vessel appears to boil. Tip the vessel until the end of the tube leading to the gauge is completely immersed in the hydraulic fluid and slowly admit air into the vessel. This will force hydraulic fluid into the Bourdon tube. If the air has been completely removed from the tube, a minimum of hydraulic fluid will be pulled out of it upon re-evacuating the system.

A.1.4.1.1 Some gauges are available with a bleeder mounted inside the Bourdon tube, which may be used to bleed off the air instead of removing it by the vacuum procedure described.

A.1.4.2 *Transducer/Digital Read Out Systems* Pressure values for a system using a transducer can be calibrated using the same device, or following manufacturer's recommendations. For transducers with a cavity or well at the sensing location, assure that the cavity is filled with hydraulic fluid before mounting it on the instrument to avoid entrapping an air bubble at the sensor. Entrapped air will lead to a lower reading.

A.2 Check foils, typically made of aluminum, come from controlled batches of material with specified thicknesses that have been tested on certified machines. Such devices are a useful means of checking the overall function of an instrument, but since the behavior of foil under stress is different from paper, they should not be used as calibration standards. They are typically packaged in groups of 10 with the certified reference value printed on the package or with accompanying certificates of analysis. Burst values should fall within the tolerance of these foils in various ranges. It is important to note that commercial/consumer aluminum foil, plastic films, and other similar materials are typically not produced in such a way as to produce consistent or reliable results batch-to-batch, are not certified to a reference machine, and should not be used for this purpose.

Appendix B.

B.1 *Calculation of the pressure setting for the clamp heads to give a minimum of 690 kPa (100 psi)*

B.1.1 *Area of the upper platen*. To calculate the area of the upper platen clamping surface, see 3.1.1 for dimensions of the platen and the hole. It is critical to subtract the area of the hole from the total area.

B.1.2 *Area of the pressure head*. To calculate the area of the pressure head, take the diameter of the platen from the specifications if they are available. Otherwise, measure the outside diameter of the bell in which the upper platen is mounted. Deduct the thickness of the bell's wall, approximately 0.636 cm (0.25 inch). Calculate the area

Deleted: A.1.3 *Hydraulic system.* The complete absence of air in the tester is very important, because any flow of hydraulic fluid through the gauge lines must be minimized. For example, it has been observed that if two carefully calibrated gauges are connected to the tester and the pressure is applied simultaneously, there may be significant difference between the two readings. This difference may be caused by the presence of air in one of the gauges lines, so that as the pressure is increased and the air is compressed, a greater flow of hydraulic fluid results. Because of the resulting greater attendant frictional resistance to pressure transfer, there will be a lower reading in that gauges.¶
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A.1.4 *Gauges.* Before tests are made, verify that the entire hydraulic system of the tester, including the inner tubing of each gauge (Bourdon tube) is full of liquid and is completely free of entrapped air. Air should be purged from the machine after every diaphragm change or if the machine is unused for over a month. If necessary, remove the air in the Bourdon tube of a gauge and replace it by hydraulic fluid as follows: Insert two tubes of Pyrex or metal through a rubber stopper into the neck of a small vacuum vessel one-third filled with hydraulic fluid. Have one tube extend almost to the bottom, and the other extend to just below the stopper. Connect the latter to a vacuum pump and with vacuum tubing connect the other to the Bourdon tube. Turn on the vacuum pump and tip the vessel just enough to uncover the tube connected to the ...

using the formula πr^2. Then measure the center hole in the platen, calculate its area and deduct this area from the platen area. This is the area of the clamping surface.

B.1.3 *Formula*. To determine the regulator setting, divide the clamping pressure 690 kPa (100 psi) by the area of the pressure head and multiply this by the area of the upper platen. This value is the setting for the pressure regulator that controls the pressure to the head.

B.1.4 *Calculation*:

$$x = (690 / y) \times z$$

where

x = the regulator setting

y = area of pressure head

z = area of the upper platen

Example:

If the diameter of the pressure head is 17.462 cm (6.875 inches):

$$x = (690 \text{ kPa} / 239.483 \text{ cm}^2) \times 63.484 \text{ cm}^2$$

$$x = 182.9 \text{ kPa } (26.5 \text{ psi})$$

Literature cited

1. Institute of Paper Chemistry, "A Method for Determining the Bursting Strength of Paperboard and Paperboard Products," *Fibre Containers,* February 1948.
2. McKee, R. C., Root, C. H., and Ayre, L. R., "Instrumental and Operational Variables Influencing Bursting Strength Results," *Fibre Containers,* May, June, July 1948.

Your comments and suggestions on this procedure are earnestly requested and should be sent to the TAPPI Standards Department.

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