1. Scope

This test method covers cut strip test procedures for determining the breaking force and elongation of most nonwoven materials. Instructions are included for wet testing.

This test method describes two procedures Option A and Option B for carrying out nonwoven material tensile tests. These two procedures use two types of specimens which are listed below and three alternative types of testing machines are also listed below. CRE is the instrument of choice.

Types of specimen
   a) Option A – 25 mm strip tensile
   b) Option B – 50 mm strip tensile

Style of tensile testing machine
   a) Constant-rate-of-extension (CRE)
   b) Constant-rate-of-load (CRL)
   c) Constant-rate-of-traverse (CRT)

SI values are regarded as the official standard system of measurement for this standard procedure. If other systems of measurement are used in place of SI units (including inch-pound) their values must be reported independently. Systems of measurement must not be combined in any way, but shall be regarded and reported separately.

NOTE 1 SAFETY

This standard does not claim to address all of the safety concerns, if any, 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. It is expected that the person performing this test has been fully trained in all aspects of this procedure.

2. References

The following referenced documents are useful for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies.
2.1 International standards
a) ISO 139 Textiles — Standard atmospheres for conditioning and testing
b) ISO 2859-1 Sampling procedures for inspection by attributes—Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection
c) ISO 3951-1 Sampling procedures for inspection by variables—Part 1: Specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection for a single quality characteristic and a single AQL

2.2 NWSP
a) NWSP 001.0 Standard Terminology Relating to the Nonwoven Industry, EDANA’s and INDA’s Standard Procedures

3. Terms and Definitions
The following referenced terms are of utility for the application of this document:

3.1 **Breaking force**
The maximum force applied to a material carried to rupture. (Compare breaking point, breaking strength, synonym force-at-break). Materials that are brittle usually rupture at the maximum force. Materials that are ductile usually experience a maximum force before rupturing.

3.2 **Constant-rate-of-extension (CRE) tensile testing machine**
A testing machine in which the rate of increase of specimen length is uniform with time.

3.3 **Constant-rate-of-load (CRL) tensile testing machine**
A testing machine in which the rate of increase of the load being applied to the specimen is uniform with time after the first 3 seconds.

3.4 **Constant-rate-of-traverse (CRT) tensile testing machine**
A testing machine in which the pulling clamp moves at a uniform rate and the load is applied through the other clamp which moves appreciably to actuate a weighing mechanism, so that the rate of increase of load or elongation is dependent upon the extension characteristics of the specimen.

3.5 **Cut strip test**
In nonwovens, a strip test in which the specimen is cut to the specified testing width, i.e. 25 or 50mm wide.
3.6 Elongation
The deformation in the direction of load caused by a tensile force. Elongation is generally expressed as a ratio of the length of the stretched material as a percentage to the length of the unstretched material. Elongation may be determined by the degree of stretch under a specific load or the point where the stretched material breaks.

3.7 Extension
The change in length of a material due to stretching.

3.8 Sample
For testing purposes a product or a portion of a product taken from a production lot. The sample shall be identifiable and traceable back to the origin.

3.9 Specimen
A specific portion of the identified sample upon which a test is performed. Many specimens may be tested from the same sample, using different locations.

3.10 Strip test
In nonwovens, a tensile test in which the full width of the specimen is gripped in the clamps.

3.11 Tensile strength
Is the strength of a material when subjected to either pulling or to compressive stress test. It measures the stress a material can bear without breaking or tearing. High precision electronic test instrument that measures the elongation, tensile strength, tear strength or resistance to compression of materials while pulling or compressing forces are applied to the material.

4. Principle
A test specimen is clamped in a tensile testing machine and a force applied to the specimen until it breaks. Values for the breaking force and elongation of the test specimen are obtained from machine scales, dials, autographic recording charts, or a computer interface.

The strip test method is considered satisfactory for acceptance testing of commercial shipments of most nonwoven materials.

This procedure is applicable for testing nonwoven materials in either a dry conditioned or wet state.

Comparison of results from tensile testing machines operating on different principles is not recommended. When different types of machines are used for comparison testing, constant time-to-break at 20 ± 3 seconds is the established way of producing data. Even then the data may differ significantly. The constant-rate-of-extension tensile testing machine is preferred for this method.
5. Reagents and Materials

5.1 Distilled water
For wet testing.

5.2 Nonionic wetting agent
For wet testing.

5.3 Container
For wetting out specimens.

6. Apparatus

6.1 Tensile testing machine (CRE, CRL, or CRT)
Must include: force indication, working range, capacity, and elongation indicator and designed for operation at:
   a) Option A, a speed of 300 ± 10 mm/min
   b) Option B, a speed of 100 mm/min

6.2 Clamps and jaw faces
Each jaw face shall be smooth, flat, and with a metallic or other agreed upon surface. The faces shall be parallel and have matching centers with respect to one another in the same clamp and to the corresponding jaw face of the other clamp.

For all strip tests each jaw face shall measure at least 10 mm wider than the specimen being tested and at least 25 mm in the direction of the applied force.

7. Sampling

If provided in the customer specification, take random sample as directed. If no requirements are provided, ISO 2859-1 (Sampling procedures for inspection by attributes) or ISO 3951-1 (Sampling procedures for inspection by variables) can be used. In and of themselves, these are not valid sampling plans by default. An agreement between the purchaser and supplier requires taking into account process stability, producer’s risk, consumer’s risk, acceptable quality level and also the cost needs to be established.

In general, if the test characteristic can be considered normally distributed, the sampling procedures for inspection by variables will require fewer samples. However, small samples may not reflect that normal distribution and the estimated percent defective can therefore be over or under estimated. In this case, as well as for attribute data, the Sampling procedures for inspection by attributes should be used.

In the absence of any sampling size requirement, the following tables can be used. Switching rules are required to maintain the AQL protection.
Attributes (1.0 AQL, General Inspection Level II)

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<th>Number of units in the lot inclusive</th>
<th>Number of units that comprise the lot sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 150</td>
<td>13</td>
</tr>
<tr>
<td>151 to 280</td>
<td>32</td>
</tr>
<tr>
<td>281 to 500</td>
<td>50</td>
</tr>
<tr>
<td>501 to 1200</td>
<td>80</td>
</tr>
</tbody>
</table>

Variables (“s” method, General Inspection Level II)

<table>
<thead>
<tr>
<th>Number of units in the lot inclusive</th>
<th>Number of units that comprise the lot sample</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>16 to 25</td>
<td>4</td>
</tr>
<tr>
<td>26 to 50</td>
<td>6</td>
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<tr>
<td>51 to 90</td>
<td>9</td>
</tr>
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<td>151 to 280</td>
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</tr>
<tr>
<td>281 to 500</td>
<td>25</td>
</tr>
<tr>
<td>501 to 1200</td>
<td>35</td>
</tr>
</tbody>
</table>

NOTE 2 An adequate specification or other agreement between the purchaser and the supplier requires taking into account the variability between rolls of material and between specimens. One must provide a sampling plan with a meaningful producer's risk, consumer's risk, and have an acceptable quality level.

7.1 Laboratory sample
From each roll or portion of material taken from the lot sample, cut at least one laboratory sample the full width of the fabric and 1m in the machine direction.

NOTE 3 Results obtained on small hand samples can only be considered as representative of that sample and cannot be assumed to be representative of the material portion from which the hand sample or swatch was taken.

7.2 Test specimens
From each laboratory sample, test five specimens from the machine direction and five specimens from the cross direction.

8. Conditioning

8.1 Bring samples to moisture equilibrium in the standard atmosphere for testing nonwovens as directed in ISO 139. Equilibrium is considered to have been reached when the increase in mass of the specimen in successive weighings made at intervals of not less than 2 hours does not exceed 0.25% of the mass of the specimen.

NOTE 4 While conditioning for a fixed time cannot be accepted in cases of dispute, it may be sufficient in routine testing to expose the material to the standard atmosphere for testing textiles for a reasonable period of time before the specimens are tested.
8.2 Wet testing
Specimens to be tested in the wet condition shall be immersed in water at room temperature until thoroughly wetted. To thoroughly wet a specimen, it may be necessary to add not more than 0.05% of a nonionic wetting agent to the water. A test of any specimen shall be completed within two minutes after its removal from the water.

9. Preparation of Specimens

9.1 General
a) Cut specimens with their long dimensions parallel either to the machine direction or to the cross direction specimen.
b) Narrow specimens of material which are 50 mm or less wide are tested full width and the size noted on the test report.

NOTE 5 The length of the specimen depends on the type of clamps being used. The specimen should be long enough to extend through the clamps and project at least 10 mm at each end.

9.2 Strip test — Option – A
a) Cut each specimen 25 ± 1mm wide and at least 150 mm long with the long dimension must be parallel to the direction of testing and force application (NOTE 5).

9.3 Strip test — Option – B
a) Cut each specimen 50 ± 0.5mm wide by at least 200 mm long so that the material will fit into testing jaws which are set at 200 mm apart (cutting the specimen 275 mm would aide in placing the specimens into the jaws). The long dimension must be parallel to the direction for which the breaking force is required (NOTE 5).

9.4 When the breaking force of wet fabric
Is required in addition to that of conditioned fabric, cut one set of specimens with each test specimen twice the normal length (Note 5 and clauses 9.2 and 9.3). Number each specimen at both ends and then cut the specimens in half cross-wise, to provide one set for determining the conditioned breaking force, and another set for determining the wet breaking force. This allows for breaks on paired specimens which leads to more direct comparison of conditioned vs. wet breaking force because both specimens of a pair contain the same test material location.

10. Preparation, Calibration, and Verification of Apparatus

10.1 Tensile testing machine
Prepare the testing machine according to the manufacturer's instructions and using the conditions given in 10.1.1 – 10.1.3 (see Annex A).
10.1.1 Set the distance between the clamps
(gage length) according to the option used;
   a) Option A — set at 75 ± 1mm.
   b) Option B — set at 200 ± 1 mm

10.1.2 Select the force range of the testing machine
So that the break will occur between 10 and 90 % of full scale force. Calibrate or verify
the testing machine for this range.

10.1.3 Set the testing machine constant rate of extension
According to the option used:
   a) Option A — set at 300 ± 10 mm/min.
   b) Option B — set at 100 mm/min

10.2 Clamping system
Check the jaw face surfaces for flatness and parallelism.

NOTE 6 Some sources of clamping irregularities are surface contact, metal surface, or jaw coating-cover
surface, condition, and pressure application.

10.3 Verification of the total operating system of the apparatus
   a) Verify the total operating system (loading, extension, clamping, and data
      collecting) by testing specimens of a standard material for breaking force and
      elongation and comparing that data with historical data from that same standard
      material. This verification of the system is recommended on a daily basis before
      use, but at a minimum should be done on a weekly basis. In addition, the total
      operating system should be verified whenever there are changes in the load cells
      or change in grips (clamping system).
   b) Select and prepare the standard material which has breaking force and
      elongation in the range of interest.
   c) Check for adequacy of clamping pressure by mounting a specimen and marking
      the inner jaw face-to-material junctions. Break the specimen and watch for
      movement of either line away from the junction to indicate slippage. If slippage
      occurs, adjust the air pressure of pneumatic clamps or be prepared to tighten
      manual clamps more when testing. If pressures cannot be increased without
      causing jaw breaks, other techniques for eliminating slippage, such as jaw
      cushioning or specimen tabbing will be necessary.
   d) Test the standard material specimens as directed in clause 11.
   e) Calculate the breaking force and elongation, the averages and the standard
      deviations as directed in clause 12.
   f) Compare the data with previous data. If the average is outside the tolerances
      established, recheck the total system to locate the cause for the deviation.
11. Procedure

11.1 Mount the specimen securely in the clamp of the testing machine
Take care that the specimen is centrally located and that the long dimension is as parallel as possible to the direction of force application. Be sure that the tension on the specimen is uniform across the clamped width.

NOTE 7 Carefully mount the specimen so that all the slack in the material is removed, but care should be taken so that pretension is not applied to the specimen.

NOTE 8 Placing of the specimen into the upper and lower jaws of the tensile machine can be a large source of error in performing this method. The elongation measurement is taken from the point where the force curve leaves the zero line. Mounting the specimens carefully and methodically into the jaws can reduce some of the technician error.

11.2 Mark across the specimen at the front inner edge
Of each jaw to check for specimen slippage. When slippage occurs, the mark will move away from the jaw edge and the results of this specimen should be discarded.

11.3 Engage the machine
To run and break the specimen.

11.4 Read the breaking force
And elongation if required, from the mechanism provided for such purpose. Record machine and cross direction results separately.

NOTE 9 For most testing machines, data will be obtained using an interfaced computer.

11.5 If a specimen slips in the jaws or breaks at the edge of or in the jaws
Or if for any reason the result falls markedly below the average for the set of specimens, discard the result and take another specimen. Continue this until the required number of acceptable breaks has been obtained.

NOTE 10 The decision to discard a break should be based on observation of the specimen during the test and upon the inherent variability of the material. In the absence of other criteria for rejecting a jaw break, any break occurring within 5 mm of the jaws which results in a value below 50 % of the average of all the other breaks should be discarded. No other break should be discarded unless it is known to be faulty.

11.6 If a material manifests any slippage in the jaws
Or if more than 25 % of the specimens break at a point within 5 mm of the edge of the jaw, one of the modifications listed below may be tried. If any of these modifications are used, state the method of modification in the report.
   a) The jaws may need to have rubber pads applied to each jaw surface.
   b) The surface of the jaws may be serrated or notched to better hold the material.
   c) Carefully check the surface of the jaws for any sharp edges that could be causing these breaks.

NOTE 11 It is difficult to determine the precise reason for certain specimens to break near the edge of the jaws. If such a break is caused by damage to the specimen by the jaws, then the results should be
discarded. If, however, the break is due merely to randomly distributed weak places, it is a legitimate result. In some cases, it may also be caused by a concentration of stress in the area adjacent to the jaws because the jaws prevent the specimen from contracting in width as the force is applied. In such cases, a break near the edge of the jaw is inevitable and should be accepted as a characteristic of the particular material and the test method.

12. Calculation

12.1 Breaking force
For each laboratory sample and testing condition, calculate the average of the breaking force observed for all acceptable specimens, that is, the maximum force exerted on the specimen as read directly from the testing machine.

12.2 Measurement of apparent elongation
Unless some other force is specified, measure the apparent elongation of acceptable specimens at the breaking force. Measure the increase in length from the start of the force-extension curve to a point corresponding with the breaking force, or other specified force. Calculate the apparent elongation as the percentage increase in length based on the gage length.

12.3 For each testing situation
Calculate the average apparent elongation at the breaking force or other specified force, of acceptable specimens.

NOTE 12 The elongation calculated as a percentage of the gage length for the specimen should be referred to as the apparent elongation because the actual length of fabric between the jaws is usually greater than the initial gage length. This difference in length is frequently due to material slippage from between the jaws. Thus, elongation, calculated on the gage length, has an error which is dependent upon the amount of slippage.

13. Report

13.1 State that the specimens were tested
As directed in either Option A or Option B or some combination of the two methods, describe the material or product sampled and the method of sampling used.

NOTE 13 INDA has sponsored studies comparing both options A and B. Studies indicated that if option A was performed using option B’s 50 mm wide material, the result for both options would harmonize, giving the same results, regardless of the other machine settings.

13.2 In addition to the precise test results
In addition to the precise test results, the report shall include the following information:
   a) Reference the test method used
   b) Complete identification of all materials tested and method of sampling
   c) Name and address of testing institution
   d) Make and model of testing equipment
   e) Laboratory testing conditions
   f) Number of specimens tested and note CD and/or MD if significant
   g) For computer processed data, identify the software used and the version
h) Deviation from the standard test procedure, if any
i) When calculated, the standard deviation or the coefficient of variation
j) Whether or not samples were conditioned prior to testing and, if so, for how long
k) Anything unusual noted during the testing
l) Average time required to break, if applicable, for all specimens giving acceptable breaks.
m) Type of tensile testing machine used.
n) Size of jaw faces used
o) Size of the load cell used to perform the test.
p) Average breaking force for specimens giving acceptable breaks for each testing condition.
q) Average percent apparent elongation of the acceptable specimens for each testing condition.
r) Maximum force obtainable in the range used for testing
s) Pretension if used,
t) Types of modification used in the jaws if needed.

14. Precision
The precision for this method is yet to be determined.
ANNEX A

A1. Possible Causes of Low Precision When Strip Tensile Testing

A1.1 Following are some of the causes for low precision
When evaluating test result between and/or within laboratories
A1.1.1 Using different makes and models of tensile machines, i.e. the age and style
of the machine can make a difference
A1.1.2 Using different sized load cells to test similar specimens
A1.1.3 Using different software to calculate the test results
A1.1.4 Using different laboratory conditions
A1.1.5 Using different pre-conditioning times for the test samples

A1.2 Following are some of the technician sources of error
A1.2.1 Failure to recheck the zero after changing the load cell, or other machine
conditions
A1.2.2 Failure to maintain proper and timely calibration on the machines and all
load cells
A1.2.3 Failure to properly train and maintain that training verified through periodic
proficiency testing
# ANNEX B

## Modification Track Sheet

History starting with WSP 2005 or later edition

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