TEXTILE FABRICS:
IGNITION AND FLAME SPREAD

0. INTRODUCTION

0.1 This NORDTEST method is principally the same as the test method in ASTM D 1230-83 Standard test method for flammability of apparel textiles. The main differences between this NORDTEST method and the ASTM D 1230-83 method are the following:

1) In the NORDTEST method the ignition time is measured and reported (if it is less than 21 seconds) whilst ASTM D 1230-83 always applies the flame to the specimen for a period of 1 second.

2) In the NORDTEST method the flame spread time is measured by applying the (ignition) flame to the specimen for a period long enough to cause ignition, whilst in the ASTM method the flame spread time can be measured only if ignition has occurred within 1 second.

Other parts of ASTM D 1230, like acceptance testing and placing of fabrics in different flammability classes, are deleted.
The attention of all users of the test is drawn to the following warning:

SAFETY WARNING, IN ORDER THAT SUITABLE PRECAUTIONS MAY BE TAKEN TO SAFEGUARD HEALTH, THE ATTENTION OF ALL CONCERNED WITH FIRE TESTING IS DRAWN TO THE FACT THAT TOXIC OR HARMFUL GASES MAY BE RELEASED DURING COMBUSTION OF TEST SPECIMENS.

1. SCOPE

This NORDTEST method specifies a test procedure for determining the flammability (ignition and flame spread properties) of single- or multicomponent textile fabrics oriented in the 45° angle position.

2. FIELD OF APPLICATION

The method should be used solely to assess the properties of materials or systems in response to heat and flame under controlled conditions. Results may not apply to situations where there is restricted air supply or prolonged exposure to large sources of intense heat as in a conflagration.

Owing to its 45° angle specimen orientation, this NORDTEST method is applicable if the methods using vertical specimen orientation are considered to be too severe or in other ways unsuitable.

3. REFERENCES

ASTM D 1230-83  Standard test method for flammability of apparel textiles

ISO 3175-1979  Determination of dimensional change of dry cleaning in perchlorethylene. Machine method

ISO 4880-1984  Burning behaviour of textiles and textile products – Vocabulary

ISO 6330-1984  Domestic washing and drying procedures for textile testing

ISO 6941-1984  Textile fabrics – Burning behaviour – Measurement
of flame spread properties of vertically oriented fabrics

Textiles. Determination of the flammability of fabrics.

4. DEFINITIONS

The definitions of ISO 4880-1984 (Burning behaviour of textiles and textile products - Vocabulary) are applied.

4.1 Ignition time: The specified length of time for which a material is exposed to an ignition source whether or not ignition occurs (ISO 4880-1984)

4.2 Minimum ignition time: Minimum time of exposure of a material to an ignition source to obtain sustained combustion under specified test conditions (ISO 4880-1984)

4.3 Flame spread time: The time taken by a flame on a burning material to travel a specified distance under specified test conditions (ISO 4880-1984)

4.4 Flammability: Those characteristics of a material that pertain to its relative ease of ignition and relative ability to sustain combustion (ASTM D 1230-83)

4.5 Flame retardant: A substance used to impart improved flame resistance to a material (ISO 4880-1984)

4.6 Flame retarded: Treated with a flame retardant (ISO 4880-1984)

Note: The term "flame retarded" does not apply to textiles that are inherently flame resistant due to the intrinsic properties of the material or the fiber-forming polymer (ASTM D 1230-83).

4.7 Raised fiber surface: In textile fabrics, intentionally lifted fibers or yarns such as pile, napped, tufted, flocked, or similar surfaces (ASTM D 1230-83)
4.8 Surface flash: Rapid spread of flame over the surface of a material without ignition of its basic structure (ISO 4880-1984)

5. SAMPLING AND PRETESTING

5.1 The size of each specimen is 150 mm x 70 mm.

5.2 The number of test specimens depends on the structure of the material to be tested. Preliminary tests are used to select the orientation of specimens, the face of the fabric to be tested, and the part of any pattern to be tested so as to maximize the rate of flame spread. The number of test specimens for preliminary tests can thus vary between 2 (simple structure, both surfaces similar) and 8 (differences in orientation and fabric surface), in patterned fabrics the number of specimens can be considerably higher.

For final testing six additional specimens (one specimen for estimation of the approximate ignition time) are cut in the same way (direction, surface, pattern) as the specimens showing the most rapid flame spread in the preliminary trials. (For classification and control purposes 10 specimens are cut, see Clause 6.4.5).

Specimens from multi-layered materials should include all the layers held in the same relative position they occupy in the sample. Preferably the outer surface is tested, if it is known, otherwise both surfaces.

In some cases (see Clause 6.4.9) it may be necessary to have an additional series of five specimens in the final testing.

5.3 In pretests, the flame impingement time of 20 second is used. After selecting the specimens for final testing, one specimen is used to measure the approximate ignition time. This is done manually using an extra timer (the flame impingement time being adjusted to 20 second).
6. METHOD OF TEST

6.1 Principle

A defined ignition flame from a specified burner is applied for a defined period of time to the surface near the lower end of textile specimens which are oriented in 45° angle position. The flame spread time is the time in seconds for a flame to proceed up the fabric a distance of 127 mm. Other properties relating to flame spread may also be observed, measured and recorded.

The time of exposure in seconds to cause ignition leading to the severance of stop cord is also measured.

6.2 Apparatus

6.2.1 Flammability tester as shown in Fig. 1 or an equivalent electrically operated tester equipped with an automatic electric timer, as described in the Annex of ASTM D 1230-83. In addition to 1 second flame impingement (ASTM D 1230-83) it should also be possible to use longer impingement times (up to 20 seconds).

Testers are normally supplied with specimen holders.

6.2.2 Brushing device as shown in Fig. 2 and described in the Annex of ASTM D 1230-83.

6.2.3 Laboratory drying oven

6.2.4 Desiccator, 250 mm diameter

6.2.5 Calcium chloride, anhydrous

6.2.6 Butane, CP

6.2.7 Cotton sewing thread No 50 (about 12 tex) (or a thin, e.g. 32 tex, synthetic thread especially for measuring the surface flash).

6.3 Preparation of test samples

6.3.1 Prior to the testing flame retarded fabrics shall be drycleaned or
washed two times, according to the care instructions.

The fabrics are drycleaned according to ISO 3175-1979 or a corresponding commercial method. The fabrics are washed according to ISO 6330-1984, using temperature recommended in the care label, followed by tumble drying, if no other method is recommended.

6.3.2 The specimens are clamped individually in the specimen holder of the flammability tester so that the bottom edge of the specimen coincides exactly with the lower edge of the top frame.

6.3.3 Each specimen having a raised fiber surface is brushed before being mounted in a specimen holder. The movable carriage holding the specimen is drawn forward whilst the stationary brush is touching the face of the specimen from above. In case the pile is unidirectional, the brushing is carried out counterdirectionally.

6.3.4 The mounted specimens are dried in a horizontal position in an oven for 30 min at 105 ± 2 °C, removed from the oven, and placed over anhydrous calcium chloride or equivalent in a desiccator until cool, but not less than 15 min.

6.4 Procedure

6.4.1 The test is carried out in an atmosphere having a temperature between 10 °C and 30 °C and a relative humidity between 20% and 65%.

6.4.2 The burner and the sample holder are adjusted so that the flame is applied to the vertical center of the specimen, 19 mm from the bottom of the specimen and with the burner face 8 mm from the face of the specimen.

6.4.3 The control valve of the fuel supply is opened and the air driven from the fuel line. The gas is ignited and the flame is adjusted to a length of 16 mm measured from its tip to the opening in the gas nozzle.

6.4.4 A mounted specimen is removed from the desiccator and placed in the chamber of the apparatus. The specimen shall be exposed to the flame within 45 s of the time it was removed from the desiccator. The stop
The flame is applied to the specimen for a time period which preliminary testing has indicated will be approximately the same as the minimum ignition time. If ignition occurs, the flame spread time is recorded. For the next specimen, the flame impingement time is reduced by 1 second and if ignition occurs the flame spread time is recorded. Then the flame impingement time is reduced again by 1 second step by step until a non-ignition is recorded. Then the lowest flame impingement time causing ignition is used for the remaining specimens until at least five test results are available to calculate the flame spread time.

If ignition does not occur using the approximate minimum ignition time ascertained in preliminary testing, the flame impingement time is increased by 1 second step by step until ignition occurs and the flame spread time can be recorded. Then the lowest flame impingement time causing ignition is used for the remaining specimens until there are at least five test results to calculate the mean flame spread time.

The maximum flame impingement time used is 20 seconds. When this impingement time is used and no specimen or only some specimens are ignited, the number of non-ignition is recorded and the maximum burnt or damaged length measured. In this case, the mean flame spread time can be calculated if there are at least three test results.

The lowest flame impingement time causing ignition is regarded as the minimum ignition time.

For special purposes, as for classification and control purposes, a specified flame impingement time (as agreed) can be used. In that case the number of specimens for final testing should be 10. The number of specimens that failed to ignite or to burn until the stop cord is recorded. The mean flame spread time can be calculated if there are at least three test results.

The raised-surface fabrics are tested analogically to other fabrics,
the flame spread time being recorded irrespective of which part of the material (surface or basic structure) is flaming.

In addition, for raised-surface fabrics, the number of the specimen is recorded in which the base ignited, charred or melted. Also the number of the specimen is recorded in which the flame passed the stop cord without severing it. In order to measure the flame spread time of surface flash, a thin synthetic stop cord may be useful.

6.4.7 The maximum burnt or damaged length is recorded in case the flame does not reach the stop cord.

6.4.8 One may also record whether any flaming debris falls below the burning specimen and continues to flame.

6.4.9 If any result in a set of five specimens exceeds the minimum result by 50%, another similar set of five specimens is tested. The time of flame spread shall then be the average time for the ten specimens, or for as many of them that burnt.

6.5 Expression of results

6.5.1 Flame spread time: Time, in seconds, from the start of the application of the ignition flame to the severance of the stop cord at the distance of 127 mm from the point of flame impingement.

6.5.2 Mean flame spread time: Mean of times, in seconds, of flame spread, preferably calculated on at least five test results.

6.5.3 Mean ignition time: The arithmetical mean of the times of exposure, in seconds, to cause ignition leading to the severance of the stop cord, preferably calculated on at least five test results.

6.5.4 Minimum ignition time: Minimum time of exposure, in seconds, to cause ignition leading to the severance of the stop cord.

6.5.5 Burnt or damaged length: The maximum length, in millimeters, of the burnt or damaged area. This parameter is measured, if ignition occurs but the specimen does not burn to the stop cord, and no flame spread time can be recorded.
6.5.6 Mean burnt or damaged length: The mean of maximum burnt or damaged lengths, in millimeters, preferably calculated on at least three test results.

6.6 Accuracy

Not stated.

6.7 Test report

The test report shall include the following:

a) Name and address of the testing laboratory
b) Identification number of the test report
c) Name and address of the organization or the person who ordered the test
d) Purpose of the test
e) Method of sampling and other circumstances
f) Name or other identification marks of the tested object
g) Description of the tested object (e.g. mass/m², fabric structure, fiber content, finishing treatment (if any))
h) Date of supply of the tested/object
i) Date of the test
j) Ambient temperature and relative humidity
k) Type of washing or drycleaning, if any
l) A tabulation of the following facts
   1) flame impingement time
   2) flame spread time
   3) burnt or damaged length
m) Mean flame spread time
n) Mean ignition time and minimum ignition time
o) The number of specimens that failed to ignite or to burn until the stop cord (when a specified flame impingement time is used)
p) For raised-surface fabrics, additional information about the number of the specimen of fabric in which the base ignited, charred, or melted and the number of the specimen in which the flame passed the stop cord without severing it
q) Surface flash spread time (if possible)
r) Date and signature.
Fig. 1. Flammability tester.

Fig. 2. Brushing device.
Example for tabulation of test results

Table 1. Test results

<table>
<thead>
<tr>
<th>Test number</th>
<th>Flame impingement time, s</th>
<th>Flame spread time, s</th>
<th>Burnt or damaged length, mm</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>20 (4) *)</td>
<td>12</td>
<td>totally</td>
<td>*) approximate ignition time</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>11</td>
<td>-</td>
<td>non-ignition</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>10</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>-</td>
<td>scorch mark</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>12</td>
<td>totally</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>9</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>10</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

mean flame spread time 11 s
mean ignition time 3 s
minimum ignition time 3 s