INTERNATIONAL STANDARD

ISO 12127-2

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Clothing for protection against heat and flame — Determination of contact heat transmission through protective clothing or constituent materials —

Part 2:
Test method using contact heat produced by dropping small cylinders

Vêtements de protection contre la chaleur et la flamme — Détermination de la transmission thermique par contact à travers les vêtements de protection ou leurs matériaux constitutifs —

Partie 2: Méthode d'essai utilisant la transmission thermique par contact produite par des petits cylindres compte-gouttes

Reference number
ISO 12127-2:2007(E)

Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 12127-2 was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 13, *Protective clothing*.

ISO 12127 consists of the following parts, under the general title *Clothing for protection against heat and flame — Determination of contact heat transmission through protective clothing or constituent materials*:

— *Part 1: Test method using contact heat produced by heating cylinder*

— *Part 2: Test method using contact heat produced by dropping small cylinders*

Introduction

Protective clothing designed to protect the welders is exposed to high-temperature particles generated from the welding point into the welding environment. These hot particles are small splashes of molten metal, sparks and slag. When the small splashes of molten metal are scattered, they produce heat into the atmosphere, become oxidized and start to change from a molten state into a solidified state.

The diversity of the conditions in which splashes of molten metal and other hot particles may come into contact with materials used for welder's protective clothing makes it difficult to evaluate the hazards that may arise under conditions of use.

The most important protective function is resistance to heat transfer through the layers of clothing from high-temperature metal drops, sparks and solidified hot particles trapped on the fabric in folds or in seamed areas.

The test method described in this part of ISO 12127 allows this heat transfer to be assessed when a hot steel cylinder simulating a small hot particle is allowed to fall on the material. Furthermore, this method can be used to assess charring and hole formation in the material.

This part of ISO 12127 forms a part of a series of standards concerned with clothing designed to protect against heat and fire. This part of ISO 12127 is especially used to assess the consequences for protection of the impact of small hot metal particles on clothing materials.

ISO 12127-1 is a revision of ISO 12127:1996.

Clothing for protection against heat and flame — Determination of contact heat transmission through protective clothing or constituent materials —

Part 2:
Test method using contact heat produced by dropping small cylinders

1 Scope

This part of ISO 12127 specifies a test method designed to evaluate the heat transfer and the behaviour of materials used for protective clothing when such materials are struck by high temperature metal particles, especially when these are trapped in the folds of the garment in working saituations.

The results obtained by this method permit the comparison of the behaviour of different materials which have undergone this test under standardized conditions. They do not permit conclusions to be drawn with respect to contacts with large splashes of molten cast iron or other metal, nor do they allow the behaviour of complete garments under industrial conditions to be predicted.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
maximum temperature
T_{max}
maximum temperature of the calorimeter after contact of the cylinder with the sample

2.2
starting temperature
T_0
temperature of the calorimeter at the starting point of the temperature measurement

2.3
start of the temperature measurement
start the temperature measurement at the exact time when the solenoid is switched on

2.4
temperature difference
ΔT
change in temperature between the maximum temperature reached and the temperature of the calorimeter at the start of temperature measurement ($\Delta T = T_{max} - T_0$)

2.5
cone temperature
T_c
temperature of the cone when removed from the oven

2.6
hole
scorched break in the test specimen caused by charring or melting of the material

NOTE The break is assessed as a hole if threads or construction of the material have been clearly diminished or deteriorated, when viewed with the aid of a magnifying glass, in which case a comparison is made of the new and test samples.

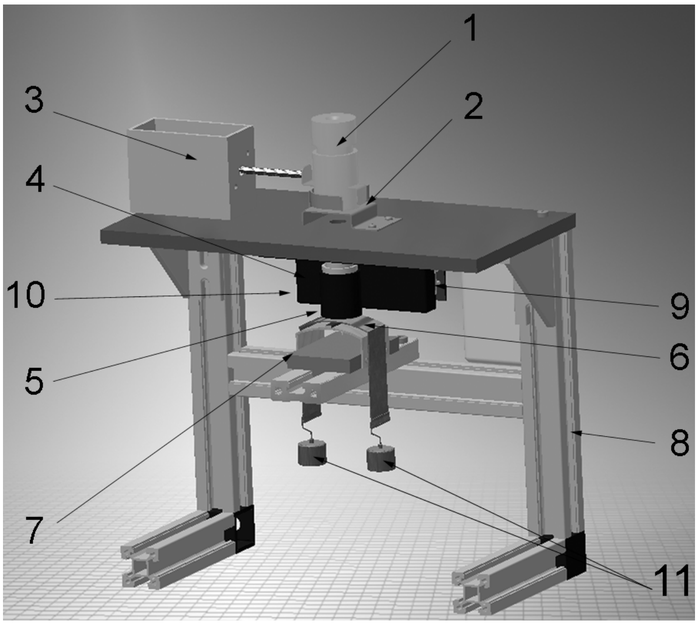
3 Principle

This test method consists of two phases, which are carried out in order.

In the first phase of this method, a hot steel cylinder is allowed to fall on a point on a horizontally oriented test specimen, which is then checked for the formation of a hole. The hole formation is assessed immediately after the sample is gently unfastened from the counterweights, if used. No mechanical stress shall be deliberately applied to the sample before examination.

In the second phase, the maximum temperature difference is measured for the materials that passed the first phase. Changes in appearance of the specimen are recorded. Figure 1 shows the overview of the dropping device.

For details and measurements, ask for technical engineering pictures[1)].



Key

1	steel cone	7	support block for specimen
2	cone holder	8	framework
3	solenoid with rod	9	aluminium block (connect to cooling unit)
4	insulation brick	10	cooling unit
5	drop guide	11	counterweight
6	test specimen		

Figure 1 — Overview of the dropping device

1) Technical engineering pictures are available from Finnish Institute of Occupational Health, Protection and Product Safety, Topeliuksenkatu 41 A, FIN-00320 Helsinki, Finland, Fax +358-30 474 2115.

4 Apparatus and materials

4.1 Heating oven, capable of reaching a temperature of at least 800 °C and with inside measurements adequate for heating the steel cone, e.g. (110 × 140 × 160) mm.

4.2 Steel cylinder, comprising a normal commercial cylindrical roller for roller bearings, with the following dimensions2) :

Material: Steel 58-65 HRC

Diameter: Ø 6,0 mm ± 11 µm

Height: 12 mm ± 11 µm

Mass: 2,6 g ± 20 mg

A new steel cylinder is used for every single drop. The flat circular end of the cylinder shall be in contact with the specimen.

4.3 Steel cone (Figure 2), in which the steel cylinders are heated and from which they are transferred to the test specimen. The cone is machined from heat resistant steel. A thin slot is machined through the cone for a sliding plate, which releases the cylinder to the specimen.

4.4 Cone holder (Figure 3), made from heat resistant steel and which locates the cone in position for releasing the steel cylinder.

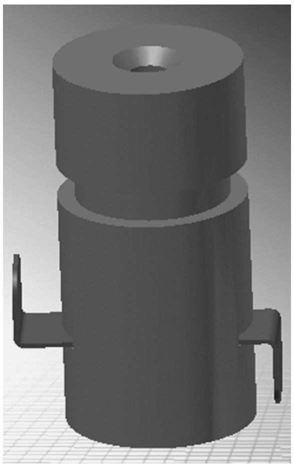


Figure 2 — Steel cone

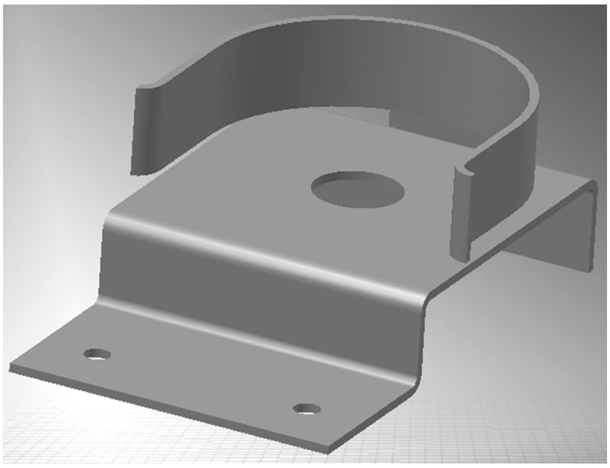


Figure 3 — Cone holder

4.5 Support table (Figure 1), which supports the cone on the metal holder, solenoid and cooling unit. The support table is made of heat resistant and thermo negative material.

4.6 Solenoid with a rod, used to push the sliding plate inside the cone to release the cylinder (Figure 1). The solenoid is located to one side of the support table so that the rod is able to push the sliding plate and release the cylinder from the cone.

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2) Torrington product ZRO. 6 × 12* PO/M6* is an example of a suitable product available commercially (www.torrington.com). This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

4.7 Drop guide (Figure 4), designed to guide the steel cylinder to the horizontally oriented test specimen. Drop guide part 1 (ceramic pipe covered with aluminium pipe) is fixed to the support table. Drop guide part 2 is separate and machined from the aluminium pipe. It is surrounded by glued neoprene cover and has inside ceramic pipe with a tapered throat. Part 2 is lowered on the sample.

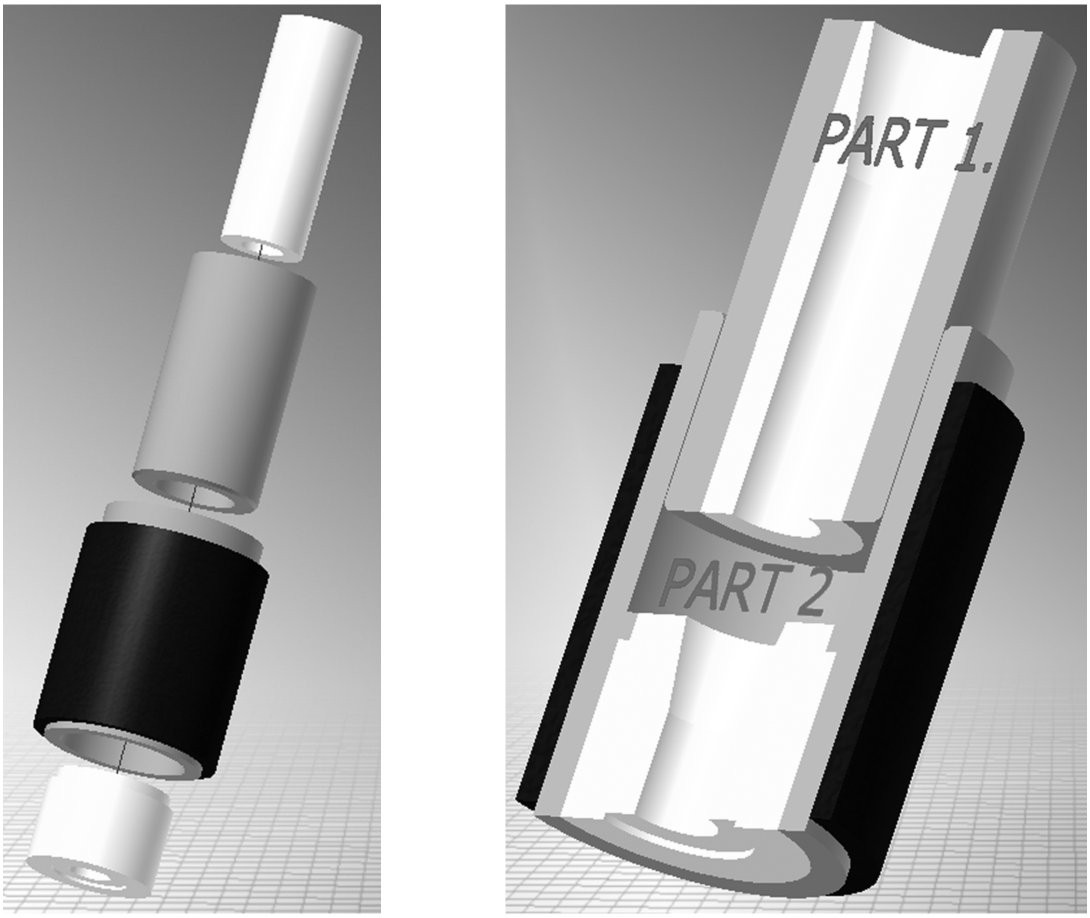


Figure 4 — Parts of drop guide and assembly

4.8 Support block for the specimen and calorimeter (Figure 5), made of a curved aluminium sheet and fitted on a plastic base element. Two blocks are needed:

— one without calorimeter: plain curved aluminium sheet;

— one with the temperature calorimeter: glass-fibre strips are glued on both sides of the calorimeter on the top of the curved aluminium sheet, as shown in Figure 5.

The blocks can be moved forward and backward under the drop guide (see Figure 1).

4.9 Calorimeter for measuring the temperature under the test specimen, comprising a K-type thermocouple (Figure 6) inserted into the copper disc. The dimensions of the copper disc are:

— purity 99,9 %;

— thickness 1,7 mm ± 0,02 mm;

— diameter 8 mm ± 0,02 mm;

— mass 766 mg ± 13 mg.

The calorimeter manufactured in accordance with Figure 6 is mounted to a ceramic ferrule. This assembly is mounted tightly with a thin layer of heat resistant glue[3)] to the hole in the curved aluminium sheet of the support block. (Figure 5).

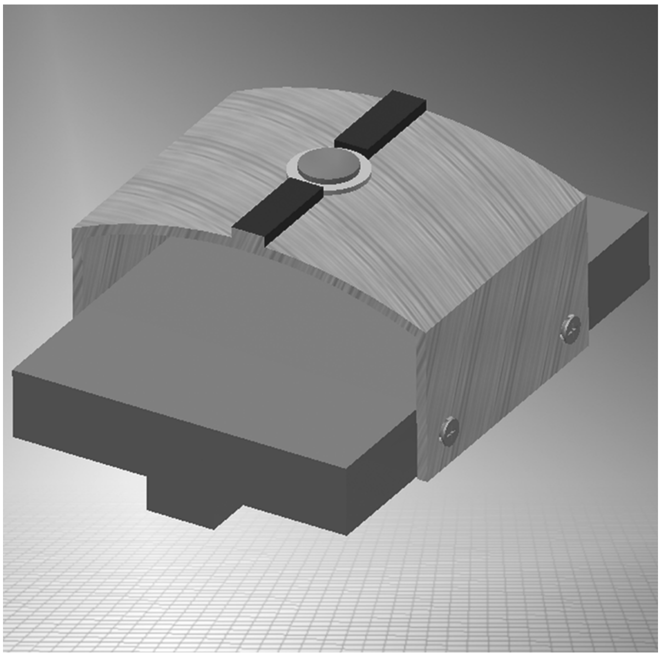


Figure 5 —Support block for the specimen and calorimeter

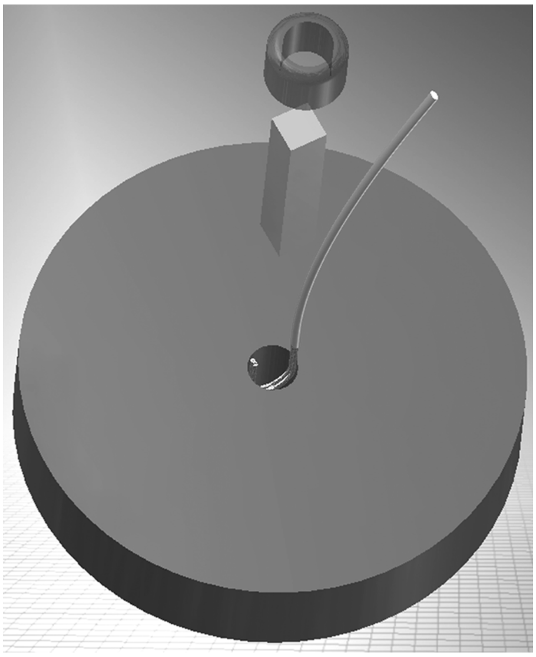
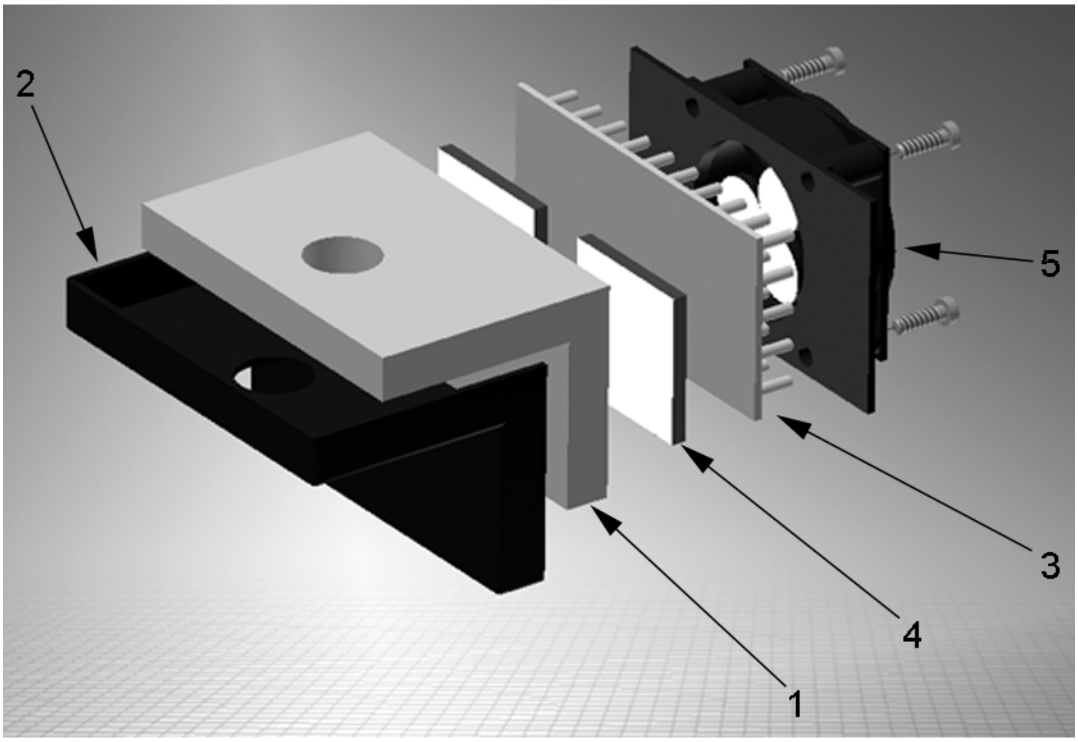


Figure 6 — Calorimeter, mounting the thermocouple to the copper disc

4.10 Thermo electric cooler (Figure 7), attached to the support table to keep the temperature of the dropping device at constant level. The cooling unit is adjusted to cool the dropping device and calorimeter to (20 ± 1) °C while the cylinder is heated in the oven. Figure 8 shows a block diagram of the thermo electric cooler.

3) Hottinger Baldwin Messtechnik GmbH, type X60 two component adhesive is an example of a suitable product available commercially

(http://www.hbm.de/products/SEURLF/ASP/SFS/SUBCAT.15/CATEGORY.3/PRODID.371/MM.3,33,140/SFE/ProductDataSheet.htm). This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.



Key

1 aluminium angle

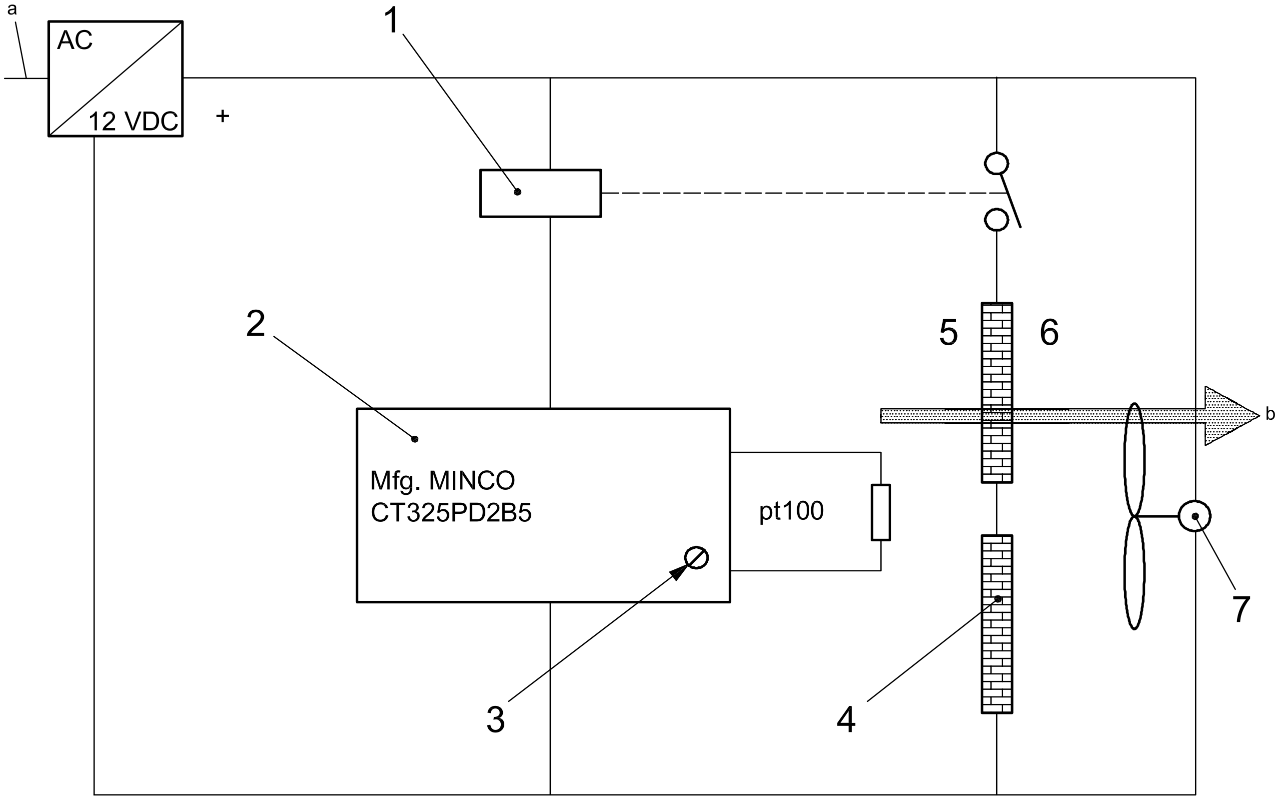
2 insulating layer

3 cooling plate

4 Peltier element

5 fan

Figure 7 — Thermo electric cooler



Key

1 relay
2 ON-OFF controller
3 setpoint
4 Peltier elements
5 cool side
6 warm side
7 fan

a 220 V line.

b Thermal flow direction.

Figure 8 — Block diagram of the thermo electric cooler

4.11 Framework for the specimen support block and support table (see Figure 1), made of a suitable rigid profile (e.g. aluminium).

4.12 Counterweights of (175 ± 5) g on both sides of the test specimen (Figure 1) except for knitted materials, in order to maintain the specimen under tension across the calorimeter. Fastening of the counterweights should cover the full width of the specimen and weight should hang at the centre of the specimen width.

4.13 Temperature reader for measuring the temperature inside the steel cone, comprising a K-type thermocouple[4] and a suitable indicator[5] capable of registering a temperature up to 650 °C and with an accuracy of ± 0,5 % FS shall be used.

4.14 Electronics, comprising suitable electronic devices provided to measure and record the calorimeter temperature to a resolution of 0,1 °C and with an accuracy of ± 0,5 °C.

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4) For example, thermocouple TESTO K-type 0602.5792 is suitable (www.testo.com).

5) For example, indicator TESTO 925 is suitable (www.testo.com).

5 Specimens

The test specimens shall have minimum dimensions (180 × 25) mm and shall be taken from points more than 20 mm from the edge of the piece of material, in an area free from defects. Hem both edges of the specimen so as to enable the specimen to be fastened to the clamps of the counterweights. Knitted specimens are measured without tension of the counterweights. Consider the required size of the knitted specimen because no counterweights are used.

When warp/weft cannot be determined, samples shall be taken in two perpendicular directions.

For phase 1, cut at least 4 specimens, 2 in weft and 2 in warp direction.

For phase 2, cut at least 6 specimens, 3 in weft and 3 in warp direction.

6 Procedure

WARNING — Protective gloves and shoes shall be worn when handling hot objects. Heat durable tongs are needed to move the hot cone.

6.1 Conditioning

Condition the test specimen at least for 24 h at a temperature of (20 ± 2) °C and (65 ± 5) % relative humidity and test within 3 minutes of removal from this environment.

6.2 Preliminary procedure

a) For the heating oven: check the adjustment of the thermocouple inside the steel cone at room temperature. The thermocouple shall fit inside the cone to lie approximately 1 cm from the bottom hole of the cone. Adjust the oven temperature to keep the temperature inside the cone at (600 ± 5) °C throughout the testing. Measure the cone temperature inside the heated oven.

b) For the cooling unit: switch on the cooling unit at least one hour before the first steel cylinder is heated to keep the sensor temperature at (20 ± 1) °C. Put the support block with sensor and the drop guide to testing position.

6.3 Testing

6.3.1 Test conditions

The measurements shall be carried out in an atmosphere with a temperature of (20 ± 5) °C and relative humidity between 15 % and 80 %.

6.3.2 Measuring the maximum temperature without sample

Perform testing procedures specified in 6.3.5, except c) and j), and check that the temperature difference, $\Delta T = T_{max} - T_0$, without sample is $230\,^{+40}_{-0}$ °C.

If the required maximum temperature rise is not achieved, verify that:

— the cone temperature is measured correctly inside the oven and the cone;

— the position of the support block and the calorimeter are directly under the dropping area;

— the temperature measurement has started within ten seconds after removing the cone from the oven;

— the temperature starts to rise in the specified time;

— the sensor is attached according to this part of ISO 12127.

6.3.3 Phase 1: Hole formation test

Use the support block without calorimeter. The cooling unit is not needed for this phase. Proceed according to 6.3.5 a) to c), e), f) and i) to k). Repeat the test procedure until the four samples have been tested. The material is determined to fail the test if hole formation (see 2.6) is noted in any of the test specimens, in which case the phase 2 test is not needed.

6.3.4 Phase 2: Temperature difference test

Use the support block with calorimeter and cooling unit. Proceed according to 6.3.5 a) to k) for all six specimens, cut in two perpendicular directions.

6.3.5 Testing procedure

a) Heat the cone to the temperature of (600 ± 5) °C. Confirm that the cone is closed by the sliding plate.

b) Place a new cold steel cylinder inside the cone. The cone is placed back in the oven such that the thermocouple again goes inside the cone 1 cm from the bottom hole of the cone. Heat the steel cylinder for (30 ± 5) min.

c) Position the test specimen on the support block using the counterweights, except for knitted specimens, for which no counterweights are used.

d) Check that the sensor temperature is (20 ± 1) °C.

e) Take the cone out of the oven when cylinder has been heated for (30 ± 5) min, place it on the cone holder above the drop guides and specimen.

f) Within ten seconds of removing the cone from the oven, switch on the solenoid to move the sliding plate inside the cone and release the cylinder onto the specimen through the drop guides.

g) Start the temperature measurement. If a computer is used, connect it into the solenoid so that switching on the solenoid automatically starts the temperature measurement. Observe whether the temperature starts to rise rapidly. Record at least the starting temperature, T_0, the maximum temperature, T_{max}, and temperature of the cone, T_c. Calculate the temperature difference, $\Delta T = T_{max} - T_0$.

h) Reject the test if there is a clear deviation in ΔT from the mean value of ΔT for all other tests of the material.

i) Remove the cone from the cone holder as soon as the steel cylinder is released from the cone. Put a new steel cylinder inside the cone and place the cone back in the oven for a heating period of (30 ± 5) min. Avoid cooling the cone.

j) Lift up the drop guide part 2 (see Figure 4) after the temperature has started to decrease. Check the adherence of the steel cylinder to the fabric and let the cylinder fall, e.g. into small cup. Pull the support block back. Remove the specimen and immediately examine for the formation of a hole, adherence and any changes in the fabric generally.

k) If necessary, clean from the surface of the sensor and the drop guide any residual cinder layer using a small brush. Adjust the support block with sensor and drop guide part 2 back to their test position and let them cool down.

l) Record the test report for each test specimen, hole formation, temperature difference (ΔT), mean value and standard deviation of the six specimens and temperature of the cone.

7 Precision

The results of precision of an interlaboratory test are given for information in Annex A.

8 Report

The test report shall include the following particulars:

a) reference to this part of ISO 12127;

b) identification of the test sample and, if required, the sampling procedure;

c) the results obtained on each test specimen, hole formation, the temperature difference (ΔT), the mean value and standard deviation, and the temperature of the cone;

d) observations of any other noteworthy phenomena (smoke, flames, etc.);

e) date of testing;

f) any deviation from this part of ISO 12127.

Annex A
(informative)

Precision

In an interlaboratory test using three materials with six repetitive measurements in five laboratories, the precision (coefficient of variation) of the temperature difference, ΔT, was found as specified in Table A.1.

Table A.1 — Results of precision of interlaboratory test

Fibres of the materials	Construction/Mass g/m^2	Mean value of ΔT °C	Deviation of mean value	Repetability %	Reproducibility %
CO FR	Satin/320	59	4,29	2,00	4,59
Conex/Viscose FR	Satin/310	72	3,45	1,98	3,80
PPAN/CO FR	Twill/325	79	4,27	1,65	4,26

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