The Committee for Conformity Assessment of Accreditation and Certification on Functional and Technical Textiles
Specified requirements protective clothing for workers exposed to heat
Document No. FTTS-FP-106e
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1.Scope：

1.1 This standard specifies test methods and requirements for clothing to protect workers against brief contact with flame, and against at least one type of heat which is claimed. The heat may be in the form of convective heat, radiant heat, or a combination of these heat hazards. It does not cover clothing for use to protect workers against the heat of large molten metal splashes.

1.2 It does not cover firefighters', welders' and metalworkers' clothing.

2.Terminology：

2.1 hole: A break in the test specimen at least 5 mm×5 mm in size caused by melting, glowing or flaming. The hole may be discontinuous.

2.2 afterflame time: The time for which a material continues to flame after the ignition source has been removed.

2.3 afterglow time: The time for which a material continues to afterglow after cessation of flaming or after removal of the ignition source.

2.4 heat transfer index, HTI_{24}: The time in seconds to achieve a temperature rise of (24.0±0.2)℃ when testing by using a copper disc of mass (18.00±0.05) g and a starting temperature of (25±5)℃.

2.5 radiant heat transfer time, t_{24}: The time in seconds to achieve a temperature rise of (24.0±0.2)℃ when testing by using a copper plate of mass 35.9~36.0 g.

3. Requirements：

Protective clothing which is claimed to comply with this standard shall meet 3.1 and 3.2, and at least one other heat transmission performance requirement (3.3 and/or 3.4) at level 1 or above.

3.1 Dimensional change: Each material shall give a dimensional change ≦±3% in both length and width direction.

3.2 Flame spread (code letter A): The assembly shall be tested after the pretreatment and the following requirements shall be satisfied.

3.2.1 No specimen shall give flaming to top or either side edge.

3.2.2 No specimen shall give hole formation.

3.2.3 No specimen shall give flaming or molten debris.

3.2.4 The mean value of afterflame time shall be ≦ 2 s.

3.2.5 The mean value of afterglow time shall be ≦ 2 s.

3.3 Convective heat (code letter B): The assembly which is claimed to offer protection against convective heat shall meet at least level B1 in table 1.

Table 1. Performance levels - Convective heat

Performance levels	Range of HTI_{24} values
B1	3~6
B2	7~12
B3	13~20
B4	21~30
B5	≧31

3.4 Radiant heat (code letter C): The assembly which is claimed to offer protection against radiant heat shall meet at least level C1 in table 2.

Table 2. Performance levels - Radiant heat

Performance levels	t_{24}, s
C1	8~30
C2	31~90
C3	91~150
C4	≧151

4. Test items

(1) Dimensional change

(2) Flame spread

(3) Convective heat

(4) Radiant heat

5.Test method（Summary）：

5.1 Dimensional change

5.1.1Apparatus and materials

(1) Washer of the front loading, horizontal drum type

Diameter of inner drum is (51.5±0.5) cm, depth of inner drum is (33.5±0.5) cm. Three lifting vanes, each (5.0±0.5) cm high, extending the depth of the inner drum and spaced 120° apart. Distance between inner and outer drums is (2.8±0.1) cm. Rotating action for normal is (12.0±0.1) s clockwise, (3.0±0.1) s stop, (12.0±0.1) s anticlockwise, (3.0±0.1) s stop; for gentle is (3.0±0.1) s clockwise, (12.0±0.1) s stop, (3.0±0.1) s anticlockwise, (12.0±0.1) s stop. Rotational frequency during washing is 52 min^{-1}, during

hydroextraction (spin) is (500±20) min^{-1}.Water supply normal is (25±5) L/min。Filling time is less than 2 min when filled to 13 cm, draining time is less than 1 min when drained from 13 cm. Heater capacity is (5.40±0.11) kW.

(2) Dryer of the rotary tumble type

Controlled exhaust temperature is maximum 80℃. Drum volume is 80 L to 120 L. Drum diameter is minimum 55 cm. Drum reversal. Lifting vanes shall be at least three in number, regularly spaced within the drum. Each 4 cm to 8 cm high. Heating input is maximum 3.5 kW. Cool-down period is minimum 5 min.

(3) IEC Reference Detergent (with optical brightener)。

(4) Ballast: The pieces shall be square and measure (30±3) cm×(30±3) cm, and shall consist of two thicknesses of 100% knitted polyester fabric, overlocked together on all four sides.

(5) Rule marked in mm.

5.1.2 Test specimens and condition: Cut three specimens for each material used in the assembly, each measuring at least 500 mm×500 mm. For materials less than 500 mm×500 mm, full material may be used. Condition each specimen for at least 24 h in an atmosphere of (20±2)℃ and (65±5)% R.H.

5.1.3 Procedure

(1) Lay the specimen flat on the smooth and flat surface without stretching. Make at least three pairs of marks on it in both length and width directions. Ensure that the distance between marks of each pair is at least 350 mm. No mark is less than 50 mm from the edges of the specimen and that the measuring points are regularly spaced across the specimen.

(2) Wash and dry the specimens according to the procedure specified in 5.2.2.

(3) After drying, condition each specimen for at least 24 h in an atmosphere of (20±2)℃ and (65±5)% R.H. Measure the specimens.

5.1.4 Report: Calculate the mean changes in dimensions in both length and width directions. State whether the dimension has decreased (shrinkage) by means of a minus sign (−) or increased (extension) by means of a plus sign (+). Express the average dimensional changes to the nearest 0.5%.

$$DC = \frac{L' - L}{L} \times 100$$

DC = Percentage change in dimensions (%)

L= Original (mm)

L' = Final (mm)

5.2 Flame spread

5.2.1 Apparatus and materials

(1) Washer of the front loading, horizontal drum type: As specified in 5.1.1(1)

(2) Dryer of the rotary tumble type: As specified in 5.1.1(2)

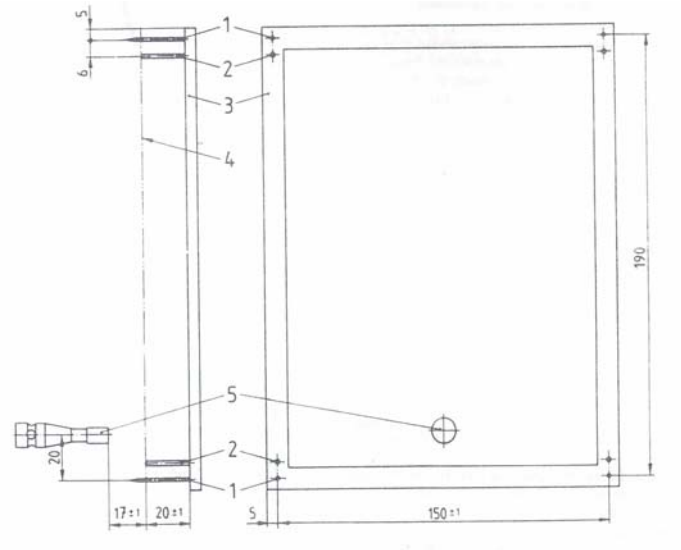
(3) Reference Detergent: As specified in 5.1.1(3)

(4) Ballast: As specified in 5.1.1(4)

(5) Mounting frame (see figure 1)

(6) Gas burner (see figure 2-5)

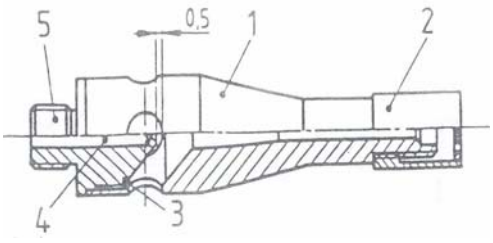
Dimensions in mm



1. Pin
2. Spacer stub
3. Specimen holder
4. Specimen
5. Burner

Figure 1. Mounting frame

Dimensions in mm



1. Burner tube 2. Flame stabilizer
3. Notch 4.Choke tube
5. Gas jet

Figure 2. Gas burner

Dimensions in mm

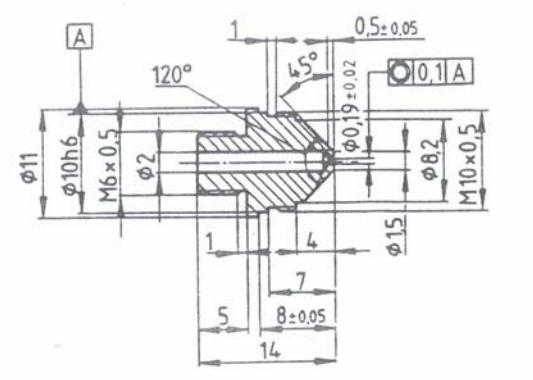
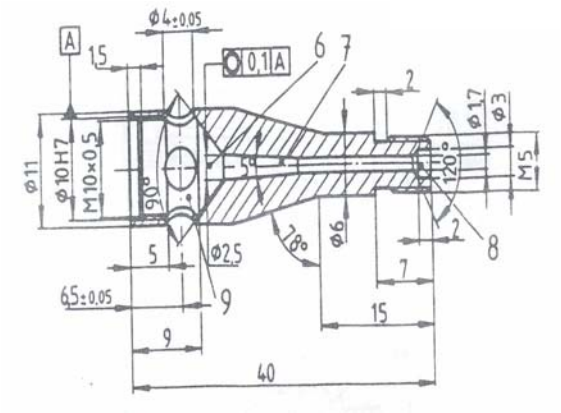


Figure 3. Gas jet

Dimensions in mm



6. Gas mixing zone 7.Diffusion zone
8. Outlet 9.Air chamber

Figure 5. Burner tube

Dimensions in mm

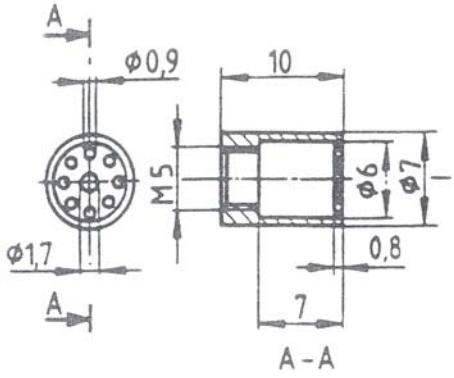
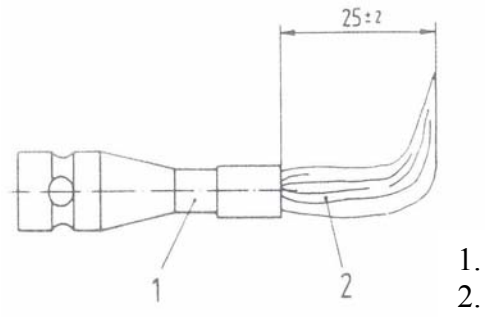


Figure 4. Flame stabilizer

Dimensions in mm



1. Burner
2. Flame

Figure 6. Horizontal reach

5.2.2 Pretreatment: The test specimens shall be washed five times in a front loading washer using 1g/L IEC reference detergent and finally dried in accordance with the procedures of ISO 6330. Washing shall be carried out by procedure 2A(at(60±3)℃) and drying by procedure E(tumble drying) unless otherwise specified in the care labeling. Materials which are labeled as dry cleanable only shall be dry cleaned five times in accordance with ISO 3175. If it has no care label, separate samples shall be tested after five cycles of washing and five cycles of dry cleaning.

5.2.3 Test specimens and condition: Cut each assembly after the pretreatment a set of six test specimens (200±1) mm×(160±1) mm, three with the longer dimension in the length direction of the material and three with the longer dimension in the width direction. Each test specimen shall arrange in the order as used. An extra test specimen is required for the setting up procedure. Condition each specimen for at least 24 h in an atmosphere of (20±2)℃ and

(65±5)% R.H.

5.2.4 Procedure

(1) If testing is not carried out immediately after conditioning, place the conditioned test specimens in a sealed container. Begin testing each specimen within 2 min of removing it from either the conditioning atmosphere or the sealed container.

(2) Place the extra test specimen on the specimen holder and each layer shall be arranged in the order as used. Fit the specimen holder to the mounting frame. Move the burner into the horizontal standby position and adjust the horizontal reach of the flame (propane gas) to (25±2) mm(see figure 6). Move the burner from the standby position to the horizontal operating position. Confirm that the flame impinges on the test specimen in the correct location.

(3) Position a test specimen on the specimen holder and each layer shall be arranged in the order as used. Fit the specimen holder to the mounting frame. Move the burner from the standby position to the horizontal operating position. Apply the igniting flame for 10 s to the surface. Repeat on the remaining test specimens.

5.2.5 Report: Record whether flaming to top or either side edge; whether a hole formation; whether the occurrence flaming or molten debris; the mean value of afterflame time; the mean value of afterglow time.

5.3 Convective heat

5.3.1 Apparatus and materials

(1) Gas burner: A Meker burner with a perforated top area of (38±2) mm diameter and a jet suitable for propane gas shall be used.

(2) Copper disc calorimeter: Copper disc has a diameter of (40±1) mm, thickness (1.6±0.1) mm, and a weight of (18.00±0.05) g. Be located in a mounting block which shall be non combustible, heat insulating board(see figure 7). A copper-constantan thermocouple is used.

(3) Calorimeter location plate: The plate shall weigh (264±13) g (see figure 8).

(4) Specimen support frame: The specimen support frame consists of a piece of copper (see figure 9).

(5) Support stand (see figure 10).

Dimensions in mm

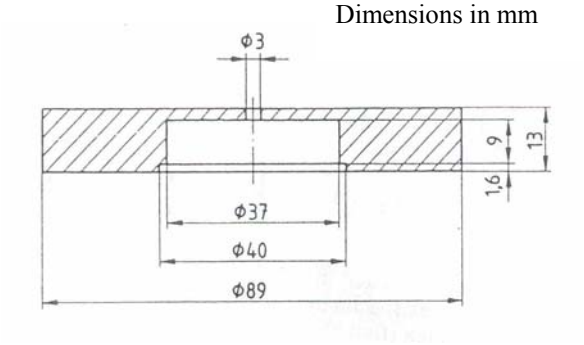


Figure 7. Calorimeter mounting block

Dimensions in mm

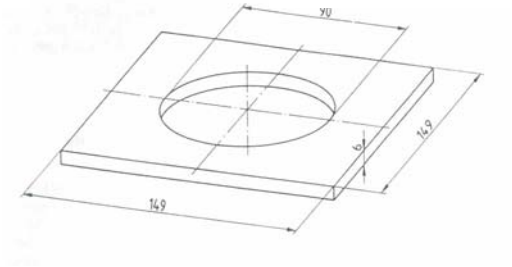


Figure 8. Calorimeter location plate

Dimensions in mm

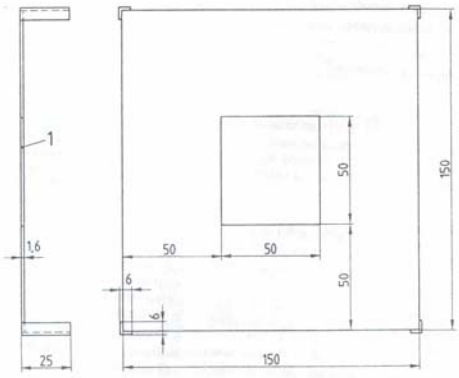
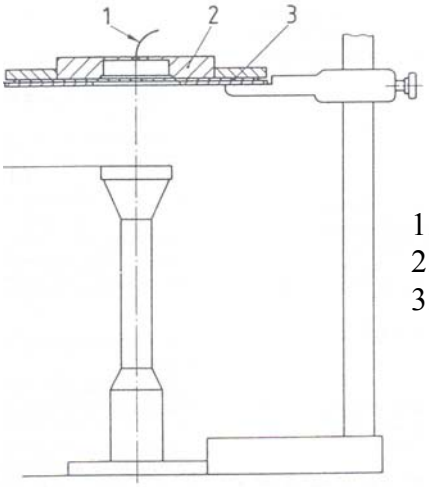


Figure 9. Specimen support frame

Dimensions in mm



1. Thermocouple
2. Calorimeter block
3. Specimen

Figure 10. Support stand

5.3.2 Test specimens and condition: A minimum of three specimens 140 mmx140 mm shall be cut for assembly. Each test specimen shall arrange in the order as used. Condition each specimen for at least 24 h in an atmosphere of (20±2)℃ and (65±2)% R.H.

5.3.3 Procedure

(1) If testing is not carried out immediately after conditioning, place the conditioned test specimens in a sealed container. Begin testing each specimen within 3 min of removing it from either the conditioning atmosphere or the sealed container.

(2) Light the gas burner and wait until the flame (propane gas) is stable. Adjust the heat flux density. Allow the burner to remain in position

without specimen for about 10 s, Determine the rate of rise of temperature in linear region. The heat flux density is calculated from the following equation:

$$Q = \frac{M \times Cp \times R}{A} \quad (kW/m^2)$$

opper disc (kg)

Cp is the specific heat of the copper (0.385 kJ/kg℃)

R is the rate of rise of temperature in linear region (℃/s)

A is the disc area (m^2)

Adjust the gas flow rate until the heat flux density is (80±4) kW/m^2. Repeat until three consecutive values are obtained which fall within the required limits.

(3) Place the specimen face downwards on the specimen support frame. Allow the test to continue until a temperature rise of (24.0±0.2)℃ is observed.

5.3.4 Report: Measure the time in seconds for a temperature rise (24.0±0.2)℃, calculate the mean as the HTI_{24}.

5.4 Radiant heat

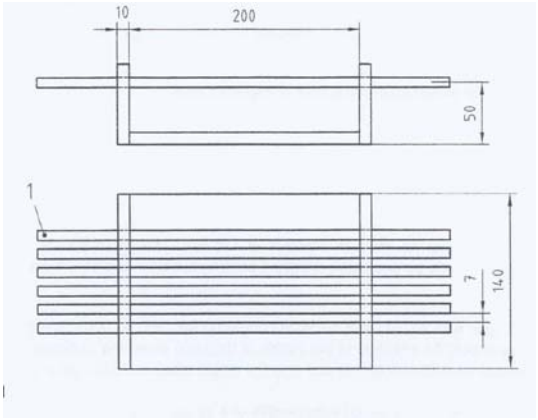
5.4.1 Apparatus and materials

(1) Source of radiation: Consist of six SiC heating rods, with diameter (7.9± 0.1) mm and electrical resistance (3.60±0.36)Ω at 1070℃ (see figure 11)。

(2) Calorimeter: The copper sheet shall be 50.0 mm×50.3 mm, 1.6 mm thick and have a mass of 35.9~36.0 g. This copper plate is bent in the longer direction into an arc with a radius of 130 mm, a chord of 50 mm. The calorimeter is located in a mounting block which is non-combustible and heat insulation board (see figure 12). A copper constantan thermocouple is used.

(3) Specimen holder (see figure 13)

Dimensions in mm



1. SiC rod

Figure 11. Source of radiation

Dimensions in mm

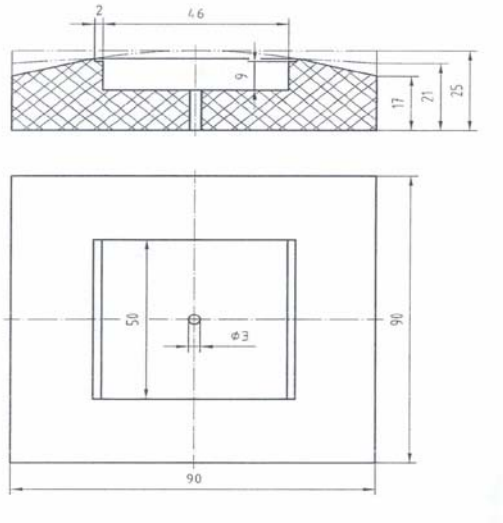
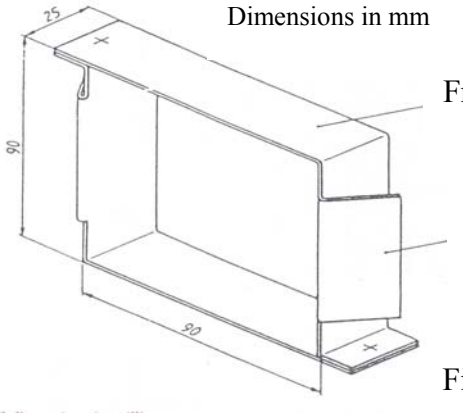


Figure 12. Calorimeter mounting block

Dimensions in mm



Frame

Bent flap

Figure 13. Specimen holder

5.4.2 Test specimens and condition: A minimum of three specimens 230 mm×80 mm shall be cut for assembly. Each test specimen shall arrange in the order as used. Condition each specimen for at least 24 h in an atmosphere of (20±2)℃ and (65±2)% R.H.

5.4.3 Procedure

(1) Begin testing each specimen within 3 min of removing it from the conditioning atmosphere.

(2) Light the source of radiation and wait until to be stable. Adjust the heat flux density. The calorimeter without test specimen is fixed in its position in the opening of the vertical plate of the test frame. After the measuring device has been switched on, the movable screen is

withdrawn and again returned to its position when a temperature rise of about 30℃ has been reached. Determine the rate of rise of temperature in linear region. The heat flux density is calculated from the following equation:

$$Q = \frac{M \times Cp \times R}{A \times \alpha}$$

Q is heat flux density (kW/㎡)

M is the mass of the copper plate (kg)

Cp is the specific heat of copper (0.385 kJ/kg℃)

R is the rate of rise of temperature in linear region (℃/s)

A is the area of the copper plate (㎡)

α is the absorption coefficient of the painted surface of the calorimeter (greater than 0.9)

Before the start of every measurement the temperature of the calorimeter should be within ±2℃ of ambient temperature. Adjust the distance between the radiant source and the calorimeter until the heat flux density is (20.0±0.4) kW/m^2.

(3) The test specimen is fastened to specimen holder and held in contact with the face of the calorimeter, applying a force of 2 N. The calorimeter with test specimen is fixed in its position in the opening of the vertical plate of the test frame. The distance is same as 5.4.3(2). After the measuring device has been switched on, the movable screen is withdrawn, the starting point of the irradiation is recorded, and again returned to its position when a temperature rise of about 30℃ has been reached. The measurement may be stopped earlier if the specimen is obviously destroyed by the radiation.

5.4.4 Report: Measure the time in seconds for a temperature rise (24.0±0.2)℃, calculate the mean as the t_{24}.

6.Reference standard：

6.1 EN 531：1995 + A1：1998 Protective clothing for workers exposed to heat

6.2 ISO 3175：1995 Textiles – Determination of stability to machine dry-cleaning

6.3 ISO 6330：1984 Textiles – Domestic washing and drying procedures for textile testing

6.4 ISO 6942：2002 Protective clothing - Protection against heat and fire – Method of test: Evaluation of materials and material assemblies when exposed to a source of radiant heat

6.5 EN 367：1992 Protective clothing - Protection against heat and fire – Method of determining heat transmission on exposure to flame

6.6 EN 532：1994 Protective clothing – Protection against heat and flame – Method of test for limited flame spread