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Protective clothing against heat and flame —

Part 1: Test method for complete garments — Measurement of transferred energy using an instrumented manikin

Habillement de protection contre la chaleur et les flammes —

Partie 1: Méthode d'essai pour vêtements complets — Mesurage de l'énergie transférée à l'aide d'un mannequin instrumenté

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Contents

Page

Foreword ..... **v**
Introduction ..... **vi**
1 Scope **1**
2 Normative references **1**
3 Terms and definitions **2**
4 Overview **4**
4.1 General 4
4.2 Heat flux - energy balance on the sensor 4
4.3 Assumptions to achieve the required heat flux 5
5 Apparatus **6**
5.1 Instrumented manikin 6
5.2 Posture of the manikin 9
5.3 Manikin sensors 10
5.3.1 Principle 10
5.3.2 Number of manikin sensors 11
5.3.3 Manikin sensor-measuring capability 12
5.3.4 Manikin sensor specification 12
5.3.5 Manikin sensor positioning 14
5.3.6 Manikin heat flux validation 14
5.4 Data acquisition system 16
5.5 Computer software program 16
5.5.1 General 16
5.5.2 Incident heat flux 17
5.5.3 Exposure heat flux 17
5.5.4 Thermal manikin protection factor (TMPF) 17
5.5.5 Transferred energy 18
5.6 Flame exposure chamber 19
5.6.1 General 19
5.6.2 Chamber size 19
5.6.3 Chamber air flow 19
5.6.4 Chamber isolation 19
5.6.5 Chamber air exhaust system 19
5.6.6 Chamber safety devices 19
5.7 Fuel and delivery system 20
5.7.1 General 20
5.7.2 Fuel 20
5.7.3 Fuel delivery and shut-off system 20
5.7.4 Burner system 20
5.8 Image recording equipment 21
5.9 Safety checklist 21
5.10 Laboratory capability demonstration 22
6 Sampling and test specimens **22**
6.1 General 22
6.2 Number of test specimens 22
6.3 Size of test specimen 22
6.4 Specimen preparation 23
6.4.1 Conditioning 23
6.4.2 Optional laundering 23
6.5 Standard reference garment design 23
7 Pre-requisites for products implementing this test method **24**
8 Procedure **25**
8.1 Preparation of test apparatus 25

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8.1.1 General ... 25
8.1.2 Manikin sensor check ... 25
8.1.3 Flame exposure chamber purging ... 26
8.1.4 Confirming safe operation conditions and lighting of pilot flames ... 26
8.1.5 Gas line charging ... 26
8.1.6 Confirmation of nude and garment exposure conditions ... 26
8.2 Specimen testing procedure ... 27
8.2.1 General ... 27
8.2.2 Dressing the manikin ... 27
8.2.3 Recording the specimen identification, test conditions and test observations ... 28
8.2.4 Starting the image recording system ... 28
8.2.5 Setting time for heat transfer data acquisition ... 29
8.2.6 Exposure of the test specimen ... 29
8.2.7 Recording of specimen response remarks ... 29
8.2.8 Calculation of surface incident heat flux and transferred energy ... 29
8.2.9 Still images ... 29
8.3 Preparing for the next test exposure ... 29

9 Test report ... 30
9.1 General ... 30
9.2 Specimen identification ... 30
9.3 Exposure conditions ... 30
9.4 Results for each specimen ... 31
9.4.1 General ... 31
9.4.2 Heat flux data of each manikin sensor ... 31
9.4.3 Thermal manikin protection factor ... 31
9.4.4 Transferred energy ... 31
9.4.5 Other information that may be reported ... 32
9.5 Observations ... 32

Annex A (informative) **Considerations for conducting tests and using test results ... 33**

Annex B (informative) **Interlaboratory test data analysis ... 34**

Annex C (normative) **Calibration and validation procedure ... 36**

Annex D (informative) **Burner stand alignment for flame engulfment ... 39**

Annex E (informative) **Elements of a computer software program ... 42**

Bibliography ... 44

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 13, *Protective clothing*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 162, *Protective clothing including hand and arm protection and lifejackets,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 13506-1:2017), which has been technically revised.

The main changes are as follows:

— revision of definitions (see Clause 3);

— heat flux, requirements and its definition (see Clauses 4 and 5);

— female manikin (see Clause 5 and rest of document);

— manikin sensor calibration (see Clause 5);

— heat flux symmetry (see Clause 5);

— thermal manikin protection factor (TMPF) (see Clause 5);

— transferred energy and its calculation (see Clause 5);

— interlaboratory test data analysis results (see Annex B);

— calibration and validation procedure (see Annex C).

A list of all parts in the ISO 13506 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

The purpose of heat and flame-resistant protective clothing is to shield the wearer from hazards that can cause skin burn injury. The clothing is made from one or more materials. The evaluation of materials for potential use in this type of clothing generally involves two steps. First, the materials are tested to gauge their ability to limit flame spread. They are then tested to determine the rate of transferred energy through them when exposed to a particular hazard. A variety of bench scale test methods are used in these two steps. Bench scale test methods permit testing fabrics, seams, zippers, pockets, badges, buttons or other closures, metal and plastic clips or other features that can be included in a complete garment. Once suitable materials are identified, they are made into complete garments or ensembles. The overall design and performance of the garment can be assessed on a manikin-fire exposure system. This test method is not designed to measure material properties directly, but to evaluate the interaction of material behaviour and garment design.

In this test method, a stationary, upright adult-sized manikin (male or female) is dressed in a complete garment and exposed to a laboratory simulation of a fire with controlled heat flux, duration and flame distribution. The average incident heat flux to the exterior of the garment is 84 kW/m^2, a value similar to those used in ISO 9151, ISO 6942 and ISO 17492. The protection offered by the test specimens is evaluated through quantitative measurements and observations. Heat flux sensors fitted to the surface of the manikin are used to measure the heat flux variation with time and location on the manikin and to determine the total energy absorbed over the data-gathering period. The data gathering period is selected to ensure that the total energy transferred has been completed. These measurements are suitable for use in predicting skin burn injury (see ISO 13506-2).

The fire simulations are dynamic. The heat flux resulting from the exposure is neither constant nor uniform over the surface of the manikin/garment. Under these conditions, the results are expected to have more variability than carefully controlled bench scale tests (interlaboratory results are found in Annex B).

Fit of the garment on the manikin is important. Variations in garment design and how the manikin is dressed by the operator can influence the test results. A test garment or specimen size is selected by the laboratory from the size range provided by the manufacturer to properly fit the laboratory's manikin. Variations in the fit of the test garment that can occur when sitting, bending or moving are not evaluated.

Most manikins do not have sensors on the hands and feet, but it is possible to assess some aspects of hand protection depending upon the specific design of the hands. All manikins contain heat flux sensors in the head. The reason for this is that many outer garments include an integral hood, but not gloves or footwear. Tests for gloves and footwear are covered by other ISO documents for specific end uses.

The method described in this document as an optional part in the fire fighter standards ISO 11999-3, EN 469[11] and as an optional part in the industrial heat and flame protective clothing standard ISO 11612. The National Fire Protection Association (NFPA) specifies a test method similar to the one described in this document as part of a certification process for garments (see NFPA 2112[13]).

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Protective clothing against heat and flame —

Part 1:
Test method for complete garments — Measurement of transferred energy using an instrumented manikin

1 Scope

This document specifies the overall requirements, equipment and calculation methods to provide results that can be used for evaluating the performance of complete garments or protective clothing ensembles exposed to short duration flame engulfment.

This test method establishes a rating system to characterize the thermal protection provided by single-layer and multi-layer garments made of flame resistant materials. The rating is based on the measurement of heat transfer to a full-size manikin exposed to convective and radiant energy in a laboratory simulation of a fire with controlled heat flux, duration and flame distribution. The heat transfer data is summed over a prescribed time to give the total transferred energy. Transferred energy and thermal manikin protection factor (TMPF) assessment methods provide a means to quantify product performance.

The exposure heat flux is limited to a nominal level of 84 kW/m^2 and durations of 3 s to 20 s dependant on the risk assessment and expectations from the thermal insulating capability of the garment.

The results obtained apply only to the particular garments or ensembles, as tested, and for the specified conditions of each test, particularly with respect to the heat flux, duration and flame distribution.

This test method covers visual evaluation, observation, inspection and documentation on the overall behaviour of the test specimen(s) before, during and after the exposure. The effects of body position and movement are not addressed in this test method.

The heat flux measurements can also be used to calculate the predicted skin burn injury resulting from the exposure (see ISO 13506-2).

This test method does not simulate high radiant exposures such as those found in arc flash exposures, some types of fire exposures where liquid or solid fuels are involved, nor exposure to nuclear explosions.

NOTE This test method is complex and requires a high degree of technical expertise in both the test setup and operation. Even minor deviations from the instructions in this test method can lead to significantly different test results.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3801, *Textiles — Woven fabrics — Determination of mass per unit length and mass per unit area*

ISO 11610, *Protective clothing — Vocabulary*

ISO 13506-2:2024, *Protective clothing against heat and flame — Part 2: Skin burn injury prediction — Calculation requirements and test cases*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

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