SIST

SLOVENSKI STANDARD
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Varovalna obleka pred učinki toplote in ognja - 1. del: Preskusna metoda za kompletna oblačila - Merjenje prenesene energije s preskusno lutko, opremljeno z instrumenti (ISO/DIS 13506-1:2014)

Protective clothing against heat and flame - Part 1: Test method for complete garments - Measurement of transferred energy using an instrumented manikin (ISO/DIS 13506-1:2014)

Schutzkleidung gegen Hitze und Flammen - Prüfverfahren für vollständige Bekleidung - Teil 1: Messung der Wärmeübertragung unter Verwendung einer sensorbestückten Prüfpuppe (ISO/DIS 13506-1:2014)

Vêtements de protection contre la chaleur et la flamme - Partie 1: Méthode d'essai pour vêtements complets - Mesurage de l'énergie transférée à l'aide d'un mannequin instrumenté (ISO/DIS 13506-1:2014)

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13.340.10 Varovalna obleka Protective clothing

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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

Titre manque

ICS: 13.340.10

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

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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.

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 13506-1 was prepared by Technical Committee ISO/TC 94, *Personal safety - Protective clothing and equipment*, Subcommittee SC 13, *Protective clothing* and by Technical Committee CEN/TC 162, *Protective clothing including hand and arm protection and lifejackets* in collaboration.

This first edition of ISO 13506-1, along with ISO 13506-2, cancels and replaces the last edition of ISO 13506:2008. The assessment of skin burn injury has been transferred to ISO 13506-2.

ISO 13506 consists of the following parts, under the general title Protective clothing against heat and flame:

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

— *Part 2: Skin burn injury prediction – Calculation requirements and test cases*

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 can be 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 heat transferred through them when exposed to a particular hazard. A variety of test methods are used in these two steps. The test method selected depends on the nature of the potential hazards and the intended end use of the materials. Once suitable materials have been identified they can be made into complete garments or ensembles for testing on a manikin – fire exposure system.

Laboratory bench scale heat transfer tests are used to select suitable materials for a protective clothing ensemble. While these tests are able to allow a ranking of garment or ensemble materials and components, the tests do not allow a complete assessment of a garment or ensemble made of the materials.

Bench scale heat transfer test methods use small amounts of material, up to 150 mm x 150 mm in area, and hold the material initially flat, either in a vertical or horizontal plane. Multiple layers are used where appropriate (e.g. fire-fighting ensembles). In this case, the layer normally worn on the exterior is exposed directly to the energy source, while the layer normally worn on the inside is away from the energy source. With the planar orientation and alignment of materials, shrinkage has little effect on the outcome of the test, unless the shrinkage is so severe as to cause holes to form in the material during the exposure to the energy source. Sagging, however, does directly affect the results, as an air gap can form or grow in size, adding an insulating effect. With the aforementioned test methods it is possible to test seams, zippers, pockets, buttons or other closures, metal and plastic clips or other features that can be included in a complete garment such as heraldry, company logos, etc. However, it is often considered easier to evaluate these aspects together with the overall design features of a garment or ensemble that can affect the performance by testing complete garments or ensembles on a manikin. It is for this purpose that this International Standard was established.

In the test method in this International Standard, a stationary, upright adult sized manikin 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 [1], ISO 6942 [2] and ISO 17492 [3]. 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 will no longer be rising for at least the last 20 seconds of data acquisition. The information obtained can be used to assist in evaluating the performance of the garment or protective clothing ensembles under the test conditions. It can also be used to estimate the extent and nature of skin damage that a person would suffer if wearing the test garment under similar exposure conditions (see ISO 13506-2 [4]).

The manikin is tested in a standing position in initially quiescent air. Controlled air motion for simulating wind effects or body movement is not presently possible. It is possible to move the manikin through a stationary flame but motion of this nature is not within the scope of this International Standard. Variations in the fit of the test garment that can occur when sitting or bending are not evaluated.

The fire simulations are dynamic. As such, the exposure is more representative of an actual industrial accident fire than the exposures used in bench scale tests. 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. In addition, the garment is not constrained to be a flat surface, but is allowed to have a natural drape on the manikin. The effect these variables have on a garment can be seen in several ways: ignition and burning of the garment and heraldry, sagging or shrinkage in all directions, after flaming, whole generation, smoke generation and structural failure of seams. Many of these failures rarely appear in the bench scale testing of the materials because they are a result of garment design variables, interaction between material properties and design variables, construction techniques and localized exposure conditions that are more severe.

Fit of the garment on the manikin is important. Thus variations in garment design and how the manikin is dressed by the operator may influence the test results. A standard garment is specified to minimize the effect of this variable. Experience suggests that testing a garment one size larger than the standard will reduce the total energy transferred and percentage body burn by about 5 %.

This International Standard is not designed to measure material properties directly, but to evaluate the interaction of material behaviour and garment design. One can compare relative material behaviour by making a series of test garments out of different materials using a common pattern. The performance of the complete garments will not necessarily be ranked in the same order as might be obtained when the materials are tested using ISO 9151 [1], for example. Correlations between small scale tests and results from single-layer garments have been examined [5].

The hands and feet of the manikin do not contain sensors, but it is possible to assess some aspects of hand protection depending upon the specific design of the hands. The head, however, does contain heat flux sensors. 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 protection offered by the test specimens is evaluated through quantitative measurements and observations. Heat flux sensors fitted to the manikin are used to measure the energy transferred to the manikin surface during the data-gathering period. This information can be reported directly (this part of the standard) or used to calculate the nature and extent of the damage that would occur to human skin from the exposure (ISO13506-2 [4]).

Documents listed in the Bibliography [6,7] give details of manikin and sensor construction, data acquisition, computer software requirements, flame exposure chamber and fuel and delivery system. They also suggest numerical techniques that can be used to carry out the calculations required.

The European Committee for Standardization (CEN) specifies the test method described in this International Standard as an optional part of EN 469 [8]. This test method is also specified in ISO 11612 [9] as an optional test.

The National Fire Protection Association (NFPA) specifies a test method similar to the one described in this International Standard as part of a certification process for garments (see Bibliography [10]).

Protective clothing against heat and flame — Part 1: Test method for complete garments - Measurement of transferred energy using an instrumented manikin

1 Scope

This International Standard provides the general principles of a test method for evaluating the performance of complete garments or protective clothing ensembles in a fire or other short duration fire exposure. This test method characterizes the thermal protection provided by garments, based on the measurement of heat transfer to a full-size manikin exposed to 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. The heat transfer measurements can also be used to calculate the predicted skin burn injury resulting from the exposure (see ISO 13506-2). In addition, observations are recorded on the overall behaviour of the test specimen during and after the exposure.

This test method serves for the purpose of evaluation of a garment or ensemble for a particular application or specification. 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. For the purposes of this test method, the incident heat flux is limited to a nominal level of 84 kW/m^2 and limited to exposure durations of less than 12 s.

This International Standard shall be used to measure and describe the behaviour of complete garments or protective clothing ensembles in response to convective and radiant energy under controlled laboratory conditions. 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.

This test method does not apply to the evaluation of protection for the hands or the feet if they do not contain sensors. For the interfaces of ensembles tested, the test method is limited to visual inspection. The effects of body position and movement are not addressed in this test method.

Considerations for the use of this test method are provided in Annex A. Inter-laboratory data for the test method are provided in Annex B.

NOTE 1 This test method provides information on material behaviour and a measurement of garment performance on a stationary upright manikin. The relative size of the garment and the manikin and the fit of the garment on the shape of the manikin have an important influence on the performance.

NOTE 2 This test method is complex and requires a high degree of technical expertise in both the test setup and operation.

NOTE 3 Deviations from the instructions in this test method can lead to significantly different test results. Technical knowledge concerning fabric behaviour and the theory of heat transfer and testing practices is needed in order to evaluate which deviations are significant with respect to the instructions given in this test method. Standardization of the test method reduces, but does not eliminate, the need for such technical knowledge.

2 Normative references

The following referenced documents are indispensable for the application 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 9162, *Petroleum products – Fuel (class F) – Liquefied petroleum gases – Specifications*

EN 13402-3, *Size designation of clothes - Part 3: Body measurements and intervals*

3 Terms and definitions

For the purposes of this document, the terms and definitions in ISO/TR 11610 and the following apply.

3.1
Absorbed energy
Energy absorbed by the manikin sensors mounted in the surface of the manikin when exposed to the incident energy.

3.2
Absorbed heat flux
Heat flux absorbed by the manikin sensors mounted in the surface of the manikin when exposed to the incident heat flux

3.3
Complete garments
Any single garment or combination of garments designed to protect the torso, arms and legs of the wearer

Note to entry: Both a single garment and a combination of garments can include protection for the head of the wearer by means of a hood (integral or separate) or balaclava. A combination of garments can include undergarments and outer garments.

3.4
Fire
A rapid oxidation process, which is a chemical reaction of fuel and oxygen resulting in the evolution of light, heat and combustion products in varying intensities.

Note to entry: The fuel can be a dust, a gas or vapours of an ignitable liquid. The fire will last as long as there is a combustible fuel-air mixture.

3.5
Flame distribution
Spatial distribution of incident flames from the test facility burners which provides a controlled heat flux over the manikin surface

3.6
Garment ease
Difference between body (manikin) dimensions and garment dimensions

3.7
Heat flux
The thermal intensity indicated by the amount of energy transmitted per unit area and per unit time to the surface; kW/m2

3.8
Heat flux sensor
Device capable of directly measuring the heat flux to the manikin's surface under test conditions, or of providing data that can be used to calculate the heat flux.

Note to entry: In either case, the created data needs to be in a form that can be processed by a computer program to assess the total energy transferred over the recording period and/or the potential skin burn injury according to ISO 13506-2.

3.9
Incident energy
Energy to which a test item or nude manikin is exposed

3.10
Incident heat flux
Heat flux to which a test item or nude manikin is exposed

Note to entry: the incident heat flux is determined from the characteristics of the manikin sensors and their measured output during a nude manikin exposure

3.11
Instrumented manikin
Model representing an adult-sized human which is fitted with manikin sensors on the surface for use in testing

3.12
Manikin sensor
Heat flux sensor fulfilling the requirements of this standard (see 3.8 and 5.2)

3.13
Maximum Heat Flux
Highest value of absorbed heat flux recorded by a manikin sensor during a test

3.14
Energy transmission factor
Ratio of the total energy transferred to the surface of the manikin dressed in the test specimen to that without the test specimen in place (nude), for the energy calculation period.

3.15
Protective clothing ensemble
Any combination of complete protective garments

Note to entry: even though energy transferred to the hands and feet is not measured, gloves and footwear can be included in the ensemble. This will allow a more realistic representation of interfaces and make possible a visual inspection of gloves and footwear during and after the test.

3.16
Thermal protection
Overall protective performance of a garment or protective clothing ensemble relative to how it limits the transfer of energy to the manikin surface over the defined calculation period.

Note to entry: In fire testing of clothing, thermal protection of a garment or ensemble can be quantified by the measured manikin sensor response which indicates how well the garment or protective clothing ensemble limits heat transfer to the manikin surface. In addition to the measured sensor response, the physical response and degradation of the garment or ensemble are observable phenomena which are associated with the manikin sensor calculation and are useful in understanding garment or protective clothing ensemble thermal protection.

3.17
Total transferred energy
The sum of the transferred energy of all manikin sensors

Note to entry: each manikin sensor has an associated area. It is assumed that the measured energy transferred for each manikin sensor is uniform over this associated area. Some manikins have a sensor layout that has the same area associated with each manikin sensor, others do not.

3.18
Transferred energy
Energy transferred through the test item and absorbed by a manikin sensor over the defined calculation period