Doc: TXD 32 (28465) WC
August 2025

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDRADS

Draft For Comments Only

भारतीय मानक मसौदा

ऊष्मा एवं ज्वाला के विरुद्ध संरक्षी परिधान
भाग 2 त्वचा ज्वलन चोट का पूर्वानुमान — अपेक्षाओं का आकलन और परीक्षण के मामले

[आई एस 17881 (Part 2) *का पहेला पुनरीक्षण]*

Draft Indian Standard

Protective Clothing Against Heat and Flame
Part 2: Skin Burn Injury Prediction — Calculation Requirements and Test Cases

[First Revision of IS 17881 (Part 2) *]*

ICS : 13.340.10

Textiles Protective Clothing Sectional Committee, TXD 32	Last date for receipt of comments is 03 September 2025

NATIONAL FOREWORD
(*Formal clauses will be added later*)

This Indian Standard intended to be adopted is identical with ISO 13506-2 : 2024 'Protective clothing against heat and flame Part 2: Skin burn injury prediction — Calculation requirements and test cases' issued by the International Organization for Standardization (ISO).

This standard was originally published in 2022. The present revision has been undertaken to align it with the latest version of ISO 13506-2 : 2024.

This standard has been published in two parts. The other part in this series is:

Part 1 Test Method for Complete Garments — Measurement of Transferred Energy Using an Instrumented Manikin

The text of ISO Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.
b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In the standard intended to be adopted, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 13506-1 Protective clothing against heat and flame — Part 1: Test method for complete garments — Measurement of transferred energy using an instrumented manikin	IS 17881 (Part 1) : 2022 Protective clothing against heat and flame: Part 1 Test method for complete garments — Measurement of transferred energy using an instrumented manikin	Identical

The technical committee has reviewed the provisions of the following International Standard referred in this standard intended to be adopted and has decided that these are acceptable for use in conjunction with this standard:

International Standard	*Title*
ISO 11610	Protective clothing — Vocabulary

In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'.

Extract of ISO 13506-2 : 2024 'Protective clothing against heat and flame Part 1: Test method for complete garments — Measurement of transferred energy using an instrumented manikin'

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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 94, *Personal safety — Personal protective 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 of ISO 13506-2, cancels and replaces the first edition (ISO 13506-2:2017), which has been technically revised.

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.

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, which can be made into a garment or protective clothing ensemble for testing on a manikin fire exposure system.

This document is a companion document to ISO 13506-1. The data gathered by tests according to ISO 13506-1 are used as input for this calculation.
In ISO 13506-1, a stationary, upright, adult-sized manikin (male or female) is dressed in a garment or protective clothing ensemble 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. Thermal energy sensors are fitted to the surface of the manikin. The output from the sensors is used to calculate 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. The information obtained from the calculation of skin burn injury prediction (see Annex B) can be used to assist in evaluating the performance of the garment or protective clothing ensemble under the test conditions. It can also be used as a model-based tool to estimate the extent and nature of potential skin damage resulting from the exposure of the test garment.

Fit of the garment or protective clothing ensemble on the manikin is important. Thus, variations in garment or protective clothing ensemble design and how the manikin is dressed by the operator may influence the test results and skin burn injury prediction. Experience suggests that testing a garment one size larger than the standard can reduce the percentage of predicted body burn by up to 5 %.

ISO 13506-1 uses the calculated skin injury information in the calculation of the thermal manikin performance factor.

The method described in this document as an optional part in the fire fighter standards ISO 11999-3 and EN 469 and as an optional part in the industrial heat and flame protective clothing standard ISO 11612.

The National Fire Protection Association standard NFPA 2112[5] specifies ASTM F1930-18[6], which is a test method similar to the one described in ISO 13506-1 and which contains skin burn injury prediction calculations similar to the one described in this document.

1 Scope

This document provides technical details for calculating predicted burn injury to human skin when its surface is subject to a varying heat flux, such as may occur due to energy transmitted through and by a garment or protective clothing ensemble exposed to flames. A series of test cases are provided against which the burn injury prediction calculation method is verified. It also contains requirements for the in situ calibration of the thermal energy sensor — skin injury prediction system for the range of heat fluxes that occur under garments.

The skin burn injury calculation methods as presented in this test method do not include terms for handling short wavelength radiation that may penetrate the skin. The latter include arc flashes, some types of fire exposures with liquid or solid fuels, and nuclear sources.

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 11610, Protective clothing — Vocabulary
- ISO 13506-1, Protective clothing against heat and flame — Part 1: Test method for complete garments — Measurement of transferred energy using an instrumented manikin

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13506-1 and ISO 11610 and the following apply.
ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- — ISO Online browsing platform: available at https://www.iso.org/obp
- — IEC Electropedia: available at https://www.electropedia.org/

3.1
burn injury
damage which occurs at various depths within human tissue due to elevated temperatures resulting from heat transfer to the surface.

Note 1 to entry: Burn injury in human tissue occurs when the tissue is heated and kept at an elevated temperature (>44 °C) for a critical period of time. In this document, it is assumed that skin has three layers: the epidermis, which is the tough outer layer, the dermis, which is the layer below the epidermis, and the subcutaneous tissue (adipose), which is the fatty layer of tissue deeper than the dermis. In this document, it is assumed that the thicknesses of the layers are the same everywhere on the human body. Variations in thickness that occur with age, location and sex are not included. The severity of damage, referred to as predicted first-, second-, or third-degree (or partial thickness or full thickness) burn injury, depends upon the magnitude of the elevated temperature above 44 °C and the time during which it remains at or above 44 °C.

3.1.1
first-degree burn injury
first-degree burn
burn damage in which only the superficial part of the epidermis has been injured

Note 1 to entry: The skin turns red, but does not blister or actually burn through. First-degree burn injury is reversible. In this document, the time for a predicted first-degree burn injury to occur is indicated when the value of $\Omega = 0{,}53$ [see Formula (3)] at a skin depth of 75 µm, i.e. at the epidermis/dermis interface.

3.1.1.1
first-degree burn injury area
first-degree burn area
sum of the areas represented by heat flux sensors for which only a calculated first-degree burn injury (3.1.1) is predicted to occur

3.1.2
second-degree burn injury
second-degree burn
partial thickness burn
burn damage in which the epidermis and a varying extent of the dermis are burned, but the entire thickness of the dermis is not usually destroyed and the subcutaneous layer is not injured

Note 1 to entry: Second-degree burn injury is more serious than first-degree burn injury, resulting in complete necrosis (living cell death) of the epidermis layer, usually accompanied with a blister,

but is reversible especially if the affected area is small. In this document, the time for a predicted second-degree burn injury to occur is indicated when the value of $\Omega = 1{,}0$ [see Formula (3)] at a skin depth of 75 µm, i.e. at the epidermis/dermis interface.

3.1.2.1
second-degree burn injury area
second-degree burn area
sum of the areas represented by heat flux sensors for which a calculated second-degree burn injury is the most severe injury predicted to occur

3.1.3
third-degree burn injury
third-degree burn
full thickness burn

burn damage which extends through the dermis, into or beyond the subcutaneous tissue

Note 1 to entry: Third-degree burn injury is not reversible. In this document, the time for a predicted third-degree burn injury to occur is indicated when the value of $\Omega = 1{,}0$ [see Formula (3)] at a skin depth of 1 200 µm, i.e. at the dermis/subcutaneous interface.

3.1.3.1
third-degree burn injury area
third-degree burn area
sum of the areas represented by the heat flux sensors for which a calculated third-degree burn injury (3.1.3) is predicted to occur

3.1.4
total burn injury area
total burn area
sum of the areas represented by the heat flux sensors for which at least a second-degree burn injury is predicted to occur

3.2
omega value
Ω
skin injury parameter, the value of the damage integral [see Formula (3)], which indicates predicted burn injury (3.1) at specific skin depths and temperature regimes

3.3
time to pain
time taken for the pain receptors to reach 43,2 °C

Note 1 to entry: In this document, the pain receptors are located 195 µm below the surface of the skin.

FORMAT FOR SENDING COMMENTS ON BIS DOCUMENTS

(Please use A4 size sheet of paper only and type within fields indicated. Comments on each clause/sub clause/table/fig etc. be started on a fresh box. Information in column 3 should include reasons for the comments and suggestions for modified working of the clauses when the existing text is found not acceptable. Adherence to this format facilitates Secretariat's work)

Please e-mail your comments to txd@bis.gov.in

NAME OF THE COMMENTATOR/ORGANIZATION:

DOCUMENT NO: TXD 32 (28465) WC

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Item, Clause Sub-Clause No. Commented upon (Use Separate Box afresh)	**Comments**	**Specific Proposal (Draft clause to be add/amended)**	**Remarks**	**Technical References and justification on which (2), (3), (4) are based**
(1)	**(2)**	**(3)**	**(4)**	**(5)**