

Protective clothing for firefighters - Physiological impact - Part 2: Determination of physiological heat load caused by protective clothing worn by firefighters (ISO 18640-2:2018)

## EESTI STANDARDI EESSÕNA

## NATIONAL FOREWORD

See Eesti standard EVS-EN ISO 18640-2:2018 sisaldab Euroopa standardi EN ISO 18640-2:2018 ingliskeelset teksti.	This Estonian standard EVS-EN ISO 18640-2:2018 consists of the English text of the European standard EN ISO 18640-2:2018.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
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English Version

Protective clothing for firefighters - Physiological impact -  
Part 2: Determination of physiological heat load caused by  
protective clothing worn by firefighters (ISO 18640-  
2:2018)

Vêtements de protection pour sapeurs-pompiers -  
Impact physiologique - Partie 2: Détermination de la  
déperdition de chaleur provoquée par les vêtements de  
protection portés par les sapeurs-pompiers (ISO  
18640-2:2018)

Schutzkleidung für die Feuerwehr - Physiologische  
Wärmebelastung - Teil 2: Bestimmung der  
physiologischen Wärmebelastung ausgelöst durch von  
Feuerwehrleuten getragene Schutzkleidung (ISO  
18640-2:2018)

This European Standard was approved by CEN on 2 January 2018.

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EUROPÄISCHES KOMITEE FÜR NORMUNG

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## European foreword

This document (EN ISO 18640-2:2018) has been prepared by Technical Committee ISO/TC 94 "Personal safety - Personal protective equipment" in collaboration with Technical Committee CEN/TC 162 "Protective clothing including hand and arm protection and lifejackets" the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2018, and conflicting national standards shall be withdrawn at the latest by November 2018.

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

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## Endorsement notice

The text of ISO 18640-2:2018 has been approved by CEN as EN ISO 18640-2:2018 without any modification.

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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](http://www.iso.org/directives)).

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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](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 14, *Firefighters' personal equipment*.

A list of all parts in the ISO 18640 series can be found on the ISO website.

## Introduction

Protective clothing for (structural) firefighting may have a serious physiological impact<sup>1),2)</sup> on the wearer and a serious effect on the acute physical condition of the wearer during activities with increased metabolic heat production<sup>[3][4]</sup>. Protective clothing impedes heat exchange by sweat evaporation and therefore maintenance of a constant core body temperature and thermal homeostasis is disturbed. This could increase the risk of heat strain and subsequently impact on the length and time that the firefighter is able to work safely. If this is identified in a risk assessment, it is important that (thermal) physiological parameters are obtained to ensure the suitability of the protective clothing chosen under the expected conditions of use. The assessment of the physiological impact of the protective clothing provides important information about the effect on individuals undertaking different tasks in various environmental conditions. In ISO 18640-1, relevant physical parameters of protective clothing are measured with a Sweating torso. Standard Sweating torso measurements provide physical parameters about combined and complex heat and moisture transfer (ISO 18640-1). By coupling the sweating torso to a mathematical model for thermo-physiological responses, the thermo-physiological impact of protective clothing is estimated and the maximum exposure time for defined environmental conditions and a defined activity protocol are predicted by Thermal Human Simulator (THS) measurements.

The purpose of this document is to consider aspects of protective clothing performance that cannot be determined by tests described in other standards. The aim of this document is to quantify the thermo-physiological impact of protective garments for (structural) firefighting under relevant exposures. This document provides the background for the specification of a minimum level of performance requirements during defined firefighting scenarios for the assessed firefighters' protective clothing by calculation of the maximum allowable work duration in order to avoid heat stroke.

NOTE The method allows to characterizing the thermo-physiological impact for different levels of complexity. This includes the characterisation of the single PPE ensembles (standard procedure) as well as the characterisation of protective clothing ensembles including under wear and protective clothing, including air layers or including design features of protective clothing ensembles (e.g. pockets, reflective strips) as optional procedures<sup>3)</sup>.

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1) Nunneley (1989) reported a significant physiological burden due to the protective clothing upon the wearer, both in the form of increased metabolic rate and reduced heat dissipation.

2) Taylor (2012) showed that the relative influence of the clothing on oxygen cost was at least three times that of the breathing apparatus.

3) This listing of standard and optional procedures is a first proposal for prioritization. The expressiveness of the different levels of complexity for the characterisation of the thermo-physiological impact needs to be further investigated. Results will be presented at the next ballot.

# Protective clothing for firefighters — Physiological impact —

## Part 2:

# Determination of physiological heat load caused by protective clothing worn by firefighters

## 1 Scope

This document specifies a method for evaluating the thermo-physiological impact of protective fabric ensembles and potentially protective clothing ensembles in a simulated activity under defined relevant conditions for firefighters.

This document is intended to be used to assess the thermo-physiological impact of protective fabric ensembles and potentially protective clothing ensembles but not the risk for heat stress due to actual fire conditions. The results of this test method can be used as elements of characterisation and comparison of thermo-physiological impact of various types of protective fabric ensembles and potentially protective clothing ensembles.

Default measurements are undertaken on fabric samples representing the garment or protective clothing combination. Optionally and in addition to the standard test method, the same testing protocol can be applied to characterise protective clothing ensembles including underwear, air layers and certain design features<sup>4)</sup>. In addition measurements on readymade garments are optionally possible.

NOTE The presently used evaluation methods are only validated for structural firefighting garments.

## 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 11092, *Textiles — Physiological effects — Measurement of thermal and water-vapour resistance under steady-state conditions (sweating guarded-hotplate test)*

ISO 18640-1, *Protective clothing for firefighters-physiological impact — Part 1: Measurement of coupled heat and mass transfer with the sweating torso*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18640-1 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 <http://www.electropedia.org/>

4) A study conducted at Empa (Swiss Federal Laboratories for Materials Science and Technology, Switzerland) showed good correlation between results of standard torso tests (without both underwear and air layers on fabrics) to tests on fabrics with underwear, tests on fabrics with underwear and air layers and test on readymade garments (with underwear and with or without air layers) of the same material composition. Due to the different thermal insulation of the systems direct comparison of the results is not possible.