BS ISO 11999-1:2015

BSI Standards Publication

PPE for firefighters — Test methods and requirements for PPE used by firefighters who are at risk of exposure to high levels of heat and/or flame while fighting fires occurring in structures

Part 1: General

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National foreword

This British Standard is the UK implementation of ISO 11999-1:2015.

The UK participation in its preparation was entrusted to Technical Committee PH/14, Firefighters' personal protective equipment.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

ISBN 978 0 580 83305 2

ICS 13.340.10

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 June 2015.

Amendments issued since publication

Date	Text affected

BS ISO 11999-1:2015

INTERNATIONAL STANDARD

ISO 11999-1

First edition
2015-06-01

PPE for firefighters — Test methods and requirements for PPE used by firefighters who are at risk of exposure to high levels of heat and/or flame while fighting fires occurring in structures —

Part 1: General

Équipement de protection personnelle pour pompiers — Méthodes d'essai et exigences pour les équipements de protection personnelle utilisés par les pompiers qui sont à risque d'une exposition à des niveaux élevés de chaleur et/ou de flamme quand la lutte contre les incendies survient dans les structures —

Partie 1: Généralités

Reference number
ISO 11999-1:2015(E)

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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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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 meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 14, *Fire-fighters' personal equipment*.

ISO 11999 consists of the following parts, under the general title *PPE for firefighters — Test methods and requirements for PPE used by firefighters who are at risk of exposure to high levels of heat and/or flame while fighting fires occurring in structures*:

— *Part 1: General*

— *Part 2: Compatibility*

— *Part 3: Clothing*

— *Part 4: Gloves*

The following parts are under preparation:

— *Part 5: Helmets*

— *Part 6: Footwear*

— *Part 7: Face and eye protection*

— *Part 8: Hearing*

— *Part 9: Firehoods*

— *Part 10: Respiratory protection*

NOTE The number of this draft has been changed from ISO/DIS 11613-1 to ISO 11999-1. The Committee agreed a new number for this project was appropriate given the scope of the publication of the ISO 11999 series was to cover ensemble standards. It was further agreed that ISO 11613:1999 would remain current.

Introduction

This International Standard provides minimum design and performance requirements for personal protective equipment (PPE) worn by firefighters to reduce injury and/or the loss of life. Amongst other hazards faced by firefighters is exposure to high thermal loads and to flames.

This International Standard details the design and performance requirements for the various items of PPE covered in all parts and for the compatibility of items of PPE when worn together.

This International Standard specifies, in ISO 11999-2, design and performance requirements for the compatibility of ISO 11999-3, ISO 11999-4, ISO 11999-5, ISO 11999-6, ISO 11999-7, ISO 11999-8, ISO 11999-9, and ISO 11999-10 when all items covered in this International Standard are worn together, thereby creating an ensemble standard. All items have to meet the general requirements for marking and manufacturer's instructions (this part of ISO 11999), as well as the specific marking and manufacturer's instructions of the respective parts of ISO 11999.

Under best practice for health and safety procedures, prior to choosing any PPE, a risk assessment of the workplace is carried out. Where hazards are identified and cannot be removed from a workplace, the items of PPE chosen to protect the personnel need to be fit for their intended use while allowing the personnel to carry out the work required of them. In environments where firefighters may be required to work, not only must the PPE protect the firefighters while enabling them to achieve their objectives at an incident, but it must also safeguard them and allow a safe escape. The PPE chosen must also allow firefighters to carry out their duties without undue stress being caused by the PPE.

Some PPE, particularly PPE to protect against mortal danger, can have failure levels far above the limit of exposures of human beings. On sites where such PPE is being used, it is important to ensure that proper and suitable safety procedures are in place which can identify when personnel should be withdrawn from dangerous or potentially dangerous situations and which can ensure that the relevant medical support is available for firefighters.

Since the decision on which PPE ensemble to use following risk assessment will dictate the parameters for protection of the persons who have to wear it, it is critical that decision-makers have knowledge of the risks against which the PPE is supposed to protect and its limitations. It is recommended that those who make the decision on the choice of PPE for particular workplaces should be competent in their knowledge and understanding of both the workplace hazards and the PPE from which to choose, prior to making these decisions, to ensure that informed decisions are taken.

Further detail on carrying out risk assessment to ascertain the type of PPE required to protect personnel working in specific areas is included in Annex A of this part of ISO 11999.

Hazards in the workplaces of firefighters are varied but can be common from workplace to workplace; therefore, some uses of PPE for firefighters can be multipurpose. Because this International Standard has been developed on a risk assessment approach, a number of different types, levels, or classes are given for certain performance requirements of various parts of a PPE ensemble. Based on their risk assessment, users of this International Standard can make a choice of which levels or classes are required for the particular workplace where their personnel are expected to work. This can include fires in domestic and commercial buildings, fires in industry, including aviation, petrochemical, chemical, pharmaceutical, land-based marine incidents, rescue, etc.

This International Standard includes separate parts for each item of a firefighter's ensemble. As PPE to protect each part of the body can be complex, this International Standard draws from the expertise of other Technical Committees in ISO which specialize in such protection.

The results of the user risk assessment for certain workplaces can require the use of PPE with higher and/or different levels or classes of performance than those in this International Standard. PPE covered in this part of ISO 11999 will not protect from all possible exposures. Nothing in this International Standard is intended to restrict any jurisdiction, purchaser, or manufacturer from exceeding the minimum performance requirements specified in this International Standard.

Another objective in the Business Plan of ISO/TC 94/SC 14 is to provide guidance on the selection, use, care, and maintenance for firefighters' PPE. Such activities are critical to the lifespan and continuing protective ability of any PPE and policies covering these aspects should be implemented as soon as the PPE is introduced into use. ISO/TC 94/SC 14 has developed a Technical Report on this subject, ISO/TR 21808. Firefighters should be trained in the selection, use, care, and maintenance of their PPE. Firefighters should also be trained in the performance and limitation of their PPE.

INTERNATIONAL STANDARD **ISO 11999-1:2015(E)**

PPE for firefighters — Test methods and requirements for PPE used by firefighters who are at risk of exposure to high levels of heat and/or flame while fighting fires occurring in structures —

Part 1: General

1 Scope

This International Standard specifies minimum design and performance requirements for personal protective equipment (PPE) to be used by firefighters, primarily but not solely to protect against exposure to flame and high thermal loads.

To assist with choice based on user risk assessment, types and performance levels for different categories of protection are included.

The scope of this International Standard does not include PPE for use in high-risk fire exposures where, for example, protective clothing with reflective surface according to ISO 15538 might be more appropriate, or for use in long-term firefighting operations in high ambient temperature (for example, bush, wildland, or forest firefighting) where equipment according to ISO 16073 might be more appropriate.

Similarly, this International Standard does not include PPE to protect against chemical and biological hazards, other than against short-term and accidental exposure while engaged in firefighting and associated activities when fighting fires occurring in structures.

This part of ISO 11999 describes the general structure of this International Standard, sets design and performance requirements for PPE, and includes requirements for marking and manufacturer's instructions.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/TR 11610, *Protective clothing — Vocabulary*

ISO 11999-3:2013, *PPE for firefighters — Test methods and requirements for PPE used by firefighters who are at risk of exposure to high levels of heat and/or flame while fighting fires occurring in structures — Part 3: Clothing*

ISO 12947-2, *Textiles — Determination of the abrasion resistance of fabrics by the Martindale method — Part 2: Determination of specimen breakdown*

ISO 13688, *Protective clothing — General requirements*

ISO 17493, *Clothing and equipment for protection against heat — Test method for convective heat resistance using a hot air circulating oven*

EN 469, *Protective clothing for firefighters — Performance requirement clothing for firefighting*

EN 960:2006, *Headforms for use in the testing of protective helmets*

EN 1149-1, *Protective clothing — Electrostatic properties — Part 1. Surface resistivity(test methods and requirements)*

EN 1149-3:2004, *Protective clothing — Electrostatic properties — Part 3.Test methods for measurement of charge decay*

EN 1149-5, *Protective clothing — Electrostatic properties — Part 5. Performance requirements*

NFPA 1971, *Standard on protective ensembles for structural fire fighting and proximity fire fighting*

3 Terms and definitions

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

3.1
accessory
additional part that is approved by the manufacturer and can be attached to an item of PPE but is not necessary to fulfil the requirements of this International Standard

EXAMPLE Cable clips, lamp brackets, etc.

3.2
basic plane of the head
plane at the level of the opening of the external auditory meatus and the lower edge of the eye sockets

3.3
basic plane of the headform
plane which corresponds to the basic plane of the human head

3.4
basic shape
outer shape which the helmet would have without comb, brim or any of the fairings or radii associated with these

3.5
brim
ridge protruding outwards from the basic shape of the helmet shell, forming the lower edge of the shell and including its associated fairings and radii

3.6
cellular outsole
cellular outsole having a density of 0,9 g/ml or less with a cell structure visible under 10x magnification

3.7
central vertical axis
construction plane parallel to the basic plane of the headform at a distance from it, which is a function of the size of the headform

3.8
char
formation of a brittle residue when material is exposed to thermal energy

3.9
chinstrap
part of a retention system, including a strap which passes under or on the wearer's chin and which helps to ensure that the helmet is correctly maintained in place

3.10
cleaning cycle
washing/drying cycle or a dry cleaning cycle

3.11
closure system
method of fastening/unfastening the openings in the garment, including combinations of more than one method of achieving a secure closure

3.12
collar lining
part of the collar fabric composite which is next to the skin when the collar is closed in the raised position

3.13
combination of PPE
two or more items of PPE fulfilling the requirements of this International Standard

3.14
comfort system
material in a helmet which serves to improve comfort for the wearer

3.15
component assembly
combination of all materials of a multilayer item presented exactly as in the finished item's construction

Note 1 to entry: This item does not cover reinforced materials.

3.16
cuff
<coat> finished edge of the coat sleeve opening

3.17
cuff
<glove> circular, flared, or otherwise expanded part of the glove that extends beyond the opening of the glove body to cover the wrist area

3.18
cuff
<trousers> finished edge of the trousers' leg opening

3.19
drag rescue device
device incorporated into the upper torso garment that allows the incapacitated wearer to be moved by dragging

Note 1 to entry: It is not a lifting device.

3.20
drip
to run or fall in drops

3.21
dripping
softening with material movement and consequent detachment

3.22
ear covers
part(s) or accessory of the helmet which protect at least the ears of the wearer

3.23
energy absorption system
material and/or system in a helmet which serves to dampen impact energy

3.24
ensemble
combination or assembly of multiple items that are individually compliant with the respective parts of this International Standard that provide protection to the head, upper torso together with arms and hands, the lower torso together with feet, and respiratory protection, and that together fulfil all the requirements of ISO 11999-2

3.25
exterior pocket
pocket located on the exterior of the protective garment

3.26
face shield
form of face and eye protection that can be placed in front of the eyes and which cover a large part of the face, sometimes a part or accessory to a helmet

3.27
facial opening
opening at the front of the fire hood interfacing with the eye and face protectors/breathing apparatus face mask

3.28
fighting fires occurring in structures
activity of rescue, fire suppression, and property conservation in buildings, enclosed structures, vehicles, marine vessels, or similar properties that are involved in a fire or emergency situation

3.29
fire hood
item worn directly in contact with the head to protect exposed parts of the head and neck where the protective coat/helmet/respiratory protective device (RPD) facepiece interface

3.30
firefighter's protective clothing
specialized garments providing protection for the firefighter's torso, neck, arms, and legs, but excluding the head, hands, and feet

3.31
firefighter's protective gloves
specialized gloves for protection for the firefighter's hands and wrists

3.32
fitting device
item on a helmet that enables it to be adjusted to a user's head or neck, with the aim to correctly position it for maximum protection and comfort

Note 1 to entry: These features can be incorporated directly into the helmet, the helmet retention system, or the helmet shock absorption system.

3.33
fitting/interface compatibility
physical compatibility between adjacent PPE items

3.34
fluorescence
process by which radiant flux of certain wavelengths is absorbed and re-radiated non-thermally in other, usually longer wavelengths

3.35
fuel oil
aliphatic hydrocarbon constituent of petroleum

3.36
full face mask
facepiece which covers the eyes, nose, mouth, and chin and provides adequate sealing on the face of the wearer of a respiratory protective device against the ambient atmosphere

3.37
function/performance compatibility
type performance compatibility between two or more PPE items

3.38
garment
single item of clothing which can consist of single or multiple layers

3.39
glove body
part of the glove that extends from the tip of the fingers to 25 mm beyond the wrist crease

3.40
goggles
form of face and eye protection that encloses the orbital area and fits tightly against the face, sometimes a part or accessory to a helmet

3.41
hardware
non-fabric items used in protective clothing, including those made of metal or plastic

EXAMPLE Buttons, zippers, fasteners, and rank markings.

3.42
headform
shape replacing the head which is used for testing

Note 1 to entry: A headform designed to meet EN 960:2006 may be used when testing helmets, face and/or eye protection devices and fire hoods.

3.43
helmet assembly
helmet, together with any optional or mandatory attached protective components such as ear covers, neck protector, face shield, or goggles.

3.44
helmet
headgear intended to ensure protection of the wearer's head (and optionally, the wearer's neck) against hazards which might occur during operations of firefighting in buildings and other structures

Note 1 to entry: This term refers specifically to helmets for structural firefighting.

3.45
helmet shell
component which gives the helmet its general shape and on which could be fixed various helmet accessories

3.46
high-visibility material, trim
retroreflective, fluorescent, or a combination of retroreflective and fluorescent material attached to the outer material for visibility enhancement

3.47
innermost lining
lining on the innermost face of a component assembly of a garment closest to the wearer's skin

Note 1 to entry: Where the innermost lining forms part of a material combination, the material combination shall be regarded as the innermost lining.

3.48
integral additional protective function
part of the helmet, intended by the helmet manufacturer not to be removed by the user, except for maintenance and fitting purposes, and which provide protection to the wearer, other than as provided for by this International Standard

3.49
interface area
area of the body not specifically protected by a protective garment, helmet, face and/or eye protection device, gloves, footwear, or breathing apparatus facepiece or the area such as the neck, wrists, and ankles where items of PPE meet or overlap

EXAMPLE The protective coat/helmet/breathing apparatus, facepiece area, the protective coat/glove area, and the protective trousers/footwear area.

3.50
interface component
item designed to provide limited protection to interface areas

EXAMPLE Fire hood and protective wristlets.

3.51
interior attack
activity of rescue, fire suppression, and property conservation generally performed in the interior or immediate vicinity of the exterior of involved structures, for the purpose of an attack on a fire to directly control or extinguish the fire

3.52
interlining
layer between the outermost layer and the innermost lining in a multilayer garment

3.53
leather
hide or skin tanned to be imputrescible

3.54
longitudinal vertical median plane
vertical plane of symmetry of the headform

3.55
material combination
material produced from a series of separate layers, intimately combined prior to the item's manufacturing stage

EXAMPLE A quilted fabric.

3.56
means of fixing
means by which the ocular of the visor is supported and interfaced with the designated helmet(s)

Note 1 to entry: This means could be an integral part of the helmet, could be fixed permanently or temporarily, or it could be worn separately, but at the same time as the helmet.

3.57
melt
liquefy a material usually by exposure to heat resulting in a non-reversible change to its state

Note 1 to entry: For the purposes of this International Standard, melting is observed as the response to heat as evidenced by flowing or dripping.

3.58
mixed ensemble
ensemble of PPE in which mixed items fulfil heat and flame requirements of Type1 or Type2

3.59
moisture barrier
part of the component assembly of garments which impedes the transfer of liquids

Note 1 to entry: Moisture barriers may not prevent the passage of some chemical (except incidentally), biological, or radiological agents. Appropriate PPE should be provided to protect the wearer in such incidents.

3.60
multilayer clothing assembly
series of garments arranged in the order as worn

Note 1 to entry: It could contain multilayer materials, material combinations, or a series of separate garments in single layers.

3.61
neck protector
integral part or accessory which protects the back of the neck from water and/or other liquids, from hot materials, radiant heat, and flames

Note 1 to entry: In this International Standard, neck protectors are only addressed in association with helmets.

3.62
orbital area
area around and including the eye sockets

3.63
outer material
outermost material of which the protective clothing is made

3.64
performance level
performance gradation of the following four categories of performance measures: a) the flame and thermal properties, b) the strength and physical properties, c) the water and liquid resistance properties, and d) the thermal comfort properties

Note 1 to entry: See Table 1.

Note 2 to entry: The performance level for the flame and thermal performance category determines the item's *type* (3.84). The other three performance categories are reported.

Note 3 to entry: Currently, performance levels are available only for clothing and gloves.

3.65
polymeric materials
high molecular weight organic compounds made by attaching repeated smaller compound units, called monomers, into a long chain-type molecule

EXAMPLE Polyurethane or polyvinylchloride and synthetic fibres such as nylon, polyester, and aramid.

3.66
protective coat
protective garment designed and configured to provide protection to upper torso, neck, and arms, excluding the hands and head

3.67
protective coverall
protective garment designed and configured to provide protection to the torso, neck, arms, and legs, excluding the head, hands, and feet

3.68
protective garment
single item of clothing which can consist of single or multiple layers

EXAMPLE Protective coat, protective trouser, or protective coverall.

3.69
protective trousers
protective garment designed and configured to provide protection to lower torso and legs excluding the feet

3.70
protective wristlet
interface component that provides limited protection to the protective garment/glove interface area

3.71
reference plane
construction plane parallel to the basic plane of the headform at a distance from it which is a function of the size of the headform

3.72
removable inner liner
winter liner
inner garment designed to be attached to, or to be worn separately, under an outer garment in order to provide thermal insulation in cold environment

3.73
retention system
parts which are responsible for securing the helmet in position on the head, including items which enable adjustment or improved comfort

3.74
retroreflection
reflection of light in which the reflected rays are preferentially returned in the direction close to the opposite of the direction of the incident rays, with this property being maintained over wide variations of the direction of the incident rays

3.75
rubber
vulcanized elastomers

3.76
sagittal plane of the helmet
plane corresponding with the longitudinal vertical median plane of the headform when the helmet is adjusted on it according to the manufacturer's instructions

3.77
seam
permanent junction between two or more pieces of textile material created by sewing, welding, or other methods

3.78
major A seam
outer layer or outer shell seam assembly where rupture could reduce the protection of the garment by exposing the moisture barrier, thermal barrier, undergarment, other clothing, or skin

3.79
major B seam
moisture barrier or thermal barrier seam assemby where rupture could reduce the protection of the garment by exposing the next layer of the garment, undergarment, other clothing, or skin

3.80
minor seam
remaining seam assembly that is not classified as major A or major B seam

3.81
seam sealing material
material applied to a seam to prevent the transfer of liquids through the seam

EXAMPLE Adhesive tape.

3.82
shikoro
standard accessory of a helmet to protect the whole face, ear, and neck parts which are not covered by respirator and helmet from water and/or other liquids, hot materials, radiant heat, and flames, without impediment of vision and installation of respirator

Note 1 to entry: When a shikoro is used with a helmet complying with ISO 11999-2, a fire hood need to be used.

3.83
thermal barrier
component of an element or item that principally provides thermal protection

3.84
type
designation of a protective item in this International Standard based on its level of flame and heat protection

EXAMPLE Type 1 and Type 2.

Note 1 to entry: All items of the same type will have the same level of performance in flame and thermal protection and can be used together to make a Type 1 or Type 2 ensemble.

Note 2 to entry: See 5.2.

3.85
type ensemble
ensemble of PPE in which all single items fulfil heat and flame requirements of the same type

3.86
undergarment
garment which is worn under an outer garment

EXAMPLE Station wear.

3.87
vertical axis of the helmet
axis corresponding with the central vertical axis of the headform when the helmet is adjusted on it according to the manufacturer's instructions

3.88
wristlet
circular, close-fitting part of the glove or coat, usually made of knitted material, that extends beyond the opening of the glove body or coat sleeve

Note 1 to entry: Can be contained within a cuff.

3.89
yoke
area of the fire hood interfacing with the coat

4 Abbreviated terms and subscripts

4.1 Abbreviated terms

CCHR	conductive compressive heat resistance
DRD	drag rescue device
HTI_{12}	heat transmission index (12 °C temperature rise)
HTI_{24}	heat transmission index (24 °C temperature rise)
TTI	thermal threshold index
m	mass
PPE	personal protective equipment
R'	coefficient of retroreflection
$RHTI_{12}$	radiant heat transmission index (12 °C temperature rise)
$RHTI_{24}$	radiant heat transmission index (24 °C temperature rise)
RPD	respiratory protective device
SCBA	self-contained breathing apparatus
tt	conductive heat transfer index
w_w	mass fraction of water absorbed

4.2 Subscripts

12	at 12 °C temperature rise
24	at 24 °C temperature rise
w	water

5 Design and performance requirements for PPE items and ensembles

5.1 Type 1 and Type 2 items of PPE

5.1.1 General

An item of PPE, which is conforming to the requirements of one of ISO 11999-3 to ISO 11999-10, can individually be designated and marked as design and performance requirements for a Type 1 or Type 2 itemsof PPE conforming to the relevant part of this International Standard. Items shall be marked as a Type 1 or Type 2 item determined by the numerical letter code for heat and flame performance requirements. As an example for clothing items according to ISO 11999-3, the numerical letter code A "heat and flame resistance and additional properties" rating, i.e. A1 or A2 shall be used.

Type 1 and Type 2 items of PPE have differing performance characteristics. For example, Type 1 clothing provides a lower thermal resistance. Selection of type should be determined via a risk assessment process that includes consideration of operational practices, environmental conditions, and local building standards.

5.1.2 Combination of Type 1 or Type 2 items of PPE

A combination of two or more items of PPE, of which each item individually is meeting the requirements of the relevant part of this International Standard, shall

a) meet all the relevant fitting/interface compatibility requirements of ISO 11999-2 in case adjacent, and

b) have the same numerical rating for the heat and flame performance category (e.g. both A1 or A2 in the case of clothing and gloves).

NOTE A combination is more than a single item of PPE but is less than an ensemble, i.e. it is not offering protection for the whole firefighter.

5.2 Type 1 and Type 2 ensembles

A combination of items of PPE which individually meets the requirements of the relevant part of this International Standard, and which, as an ensemble, provides protection to the whole body of a firefighter, shall be designated and marked as a "Type 1 Ensemble according to ISO 11999" or "Type 2 Ensemble according to ISO 11999".

An ensemble is classified as Type 1 or Type 2 if every item in the ensemble meets the appropriate requirements for heat and flame performance in each part of this International Standard as described in 5.1.1, i.e. all items meet the Type 1 requirements or all items meet the Type 2 requirements.

For example, the item or items of PPE of a Type 1 or Type 2 ensemble, which are intended to provide protection for the firefighter's upper and lower torso, neck, arms, and/or legs, shall conform to the requirements of ISO 11999-3, and thus consist of

a) either an outer garment which could be, for example, a one-piece protective coverall or a protective coat and a compatible pair of protective trousers, or

b) a series of outer and undergarments compatible to be worn together.

NOTE 1 Requirements for items of PPE according to parts of this International Standard other than ISO 11999-2, ISO 11999-3, and ISO 11999-4 are not yet specified and shall be added in next editions of this part of ISO 11999 as soon as further parts will be published.

NOTE 2 See Annex B.

Table 1 — Performance requirements for Type 1 and Type 2 ensembles

Performance requirements for	Type 1 ensemble	Type 2 ensemble
Compatibility between items of PPE according to ISO 11999-2		
Fitting/interface compatibility	Items of PPE intended to be compatible when worn together shall meet all the relevant fitting/interface compatibility requirements.	
Functional/performance compatibility	Items of PPE intended to be compatible when worn together, and those have a numerical rating for a specific letter code, shall have the same numerical rating for the capital letter code.	
Clothing according to ISO 11999-3 **for protection of upper and lower torso, neck, arms, and legs**		
Letter code A (heat and flame resistance)	The outer garment, or a series of protective garments, which shall always be worn one on top of the other, shall have a letter code A, performance level A1.	The outer garment, or a series of protective garments, which shall always be worn one on top of the other, shall have a letter code A, performance level A2.
Letter code b (strength and physical hazard resistance)	The outer material and seams of the outer garment shall have a letter code b, performance level b_1 or b_2.	
Letter code c (water and liquid penetration resistance)	The outer material and, if present, the moisture barrier and its seams of the outer garment shall have a letter code c, performance level c_1 or c_2.	
Letter code d (thermal comfort)	The outer garment, or a series of protective garments, which shall always be worn one on top of the other, shall have a letter code d, performance level d_1 or d_2.	
Gloves according to ISO 11999-4 **for protection of hands (and possible wrists and lower arms)**		
Letter code G (heat and flame performance)	The gloves shall have a letter code G, performance level G1.	The gloves shall have a letter code A, performance G2.
Letter code b (mechanical performance)	The gloves shall have a letter code b, performance level b_1,b_2, or b_3.	
Letter code c (barrier performance)	The gloves shall have a letter code c, performance level c_1, or c_2.	
Letter code d (ergonomic performance)	The gloves shall have a letter code d, performance level d_1, or d_2.	
Helmets according to ISO 11999-5 **for head protection**		
	Requirements for helmets for Type 1 ensembles are not yet specified.	Requirements for helmets for Type 2 ensembles are not yet specified.
Footwear according to ISO 11999-6 **for protection of feet (and possibly ankles and lower legs)**		
	Requirements for footwear for Type 1 ensembles are not yet specified.	Requirements for footwear for Type 2 ensembles are not yet specified.
Items of PPE according to ISO 11999-7 **for protection of face and eyes**		
	Requirements for face and eye protection for Type 1 ensembles are not yet specified.	Requirements for face and eye protection for Type 2 ensembles are not yet specified.
Items of PPE according to ISO 11999-8 **for hearing protection**		
	Requirements for hearing protection for Type 1 ensembles are not yet specified.	Requirements for hearing protection for Type 2 ensembles are not yet specified.
Fire hoods according to ISO 11999-9 **for head protection**		
	Requirements for fire hoods for Type 1 ensembles are not yet specified.	Requirements for fire hoods for Type 2 ensembles are not yet specified.
Items of PPE according to ISO 11999-10 **for respiratory protective devices**		

NOTE The capital letter code indicating the heat and flame performance for each ensembles item is given in Annex B. All letter codes are listed in Table B.1.

Table 1 *(continued)*

Performance requirements for	Type 1 ensemble	Type 2 ensemble
	Requirements for respiratory protective devices for Type 1 ensembles are not yet specified.	Requirements for respiratory protective devices for Type 2 ensembles are not yet specified.
NOTE The capital letter code indicating the heat and flame performance for each ensembles item is given in Annex B. All letter codes are listed in Table B.1.		

5.3 Mixed ensemble

An ensemble of PPE, which cannot be classified as either Type 1 or Type 2 because one or more of the parts of the ensemble meets Type 1 requirements and one or more of the parts of the ensemble meets Type 2 requirements, can be used together to provide whole body and respiratory protection to a firefighter.

If all the fitting/interface and compatibility requirements according to ISO 11999-2 are met, such a combination can be designated as an "ISO 11999 Mixed Ensemble" but cannot be designated as an "ISO 11999 Type 1 Ensemble" or an "ISO 11999 Type 2 Ensemble".

6 Marking

6.1 General

Any marking in form of labels shall not adversely affect the performance of any item to which they are attached or present a hazard to the wearer. Labels shall be tested for flammability according to 3.17.2 of ISO 11999-3 only where placed on the exterior of the garment. Labels and closure systems shall be tested to the Type 1 or Type 2 heat and flame requirements according to the type of item they are attached.

Marking of PPE shall be in accordance with the specific requirements for the item in the relevant part this International Standard.

6.2 Label durability and legibility

Labels, when examined at a distance of 300 mm in a well-illuminated area by a person with 20/20 vision or vision corrected to 20/20, shall remain legible after each of the pretreatments specified in 6.2.1 to 6.2.2.

Label durability and legibility shall be followed based on each PPE item's cleaning instructions. Where specified, each PPE items shall be subjected to cleaning according to the manufacturer's care instructions.

6.2.1 Pretreatment by exposure to heat

Pretreatment by oven exposure shall be as specified in ISO 17493 at a temperature of 140 °C +5 °C/−0 °C for 5 min.

6.2.2 Pretreatment by abrasion

Pretreatment by abrasion shall be in accordance with ISO 12947-2, with a 12 kPa pressure and wetted felt abrasive for 200 cycles.

6.3 Compliance marking requirements for an item of PPE

Each item of PPE, for which compliance with this International Standard is claimed, shall have a label permanently and conspicuously attached, upon which the following information is printed in letters at least 1,5 mm high:

a) where practical, the pictogram given in Figure 1;

b) the name, trademark, or other means of identifying or tracing back the manufacturer;

c) the manufacturer's model number and/or user's specified number;

d) the size.

Figure 1 — Pictogram ISO 7000-2418

6.4 Additional marking for clothing

Garments shall be marked with the number of the relevant part of this International Standard, i.e. ISO 11999-3.

Marking of the clothing shall be in accordance with ISO 13688 and the pictogram given in Figure 2.

In the case that the clothing has flame and thermal resistance rating A1, then "ISO 11999-3 Type 1" shall be written underneath the pictogram given in Figure 1.

In the case that the clothing has flame and thermal resistance rating A2, then "ISO 11999-3 Type 2" shall be written underneath the pictogram given in Figure 1.

At the bottom right of the pictogram, the following letter designation shall be used to represent the different performance ratings for garments:

A - Flame and thermal resistance performance

b - Strength and physical hazard resistance performance

c - Water and liquid penetration resistance performance

d - Thermal comfort performance

The performance ratings achieved by the clothing shall be placed next to the letter for each of the performance categories, for example "A2, b_2, c_1, d_3" (see Figure 2).

Figure 2 — Example of marking of a Type 1 clothing item with numerical letter code ratings A1, b_2, c_1, d_2

6.5 Additional marking for gloves

The gloves shall be marked with the number of the relevant part of this International Standard, i.e. ISO 11999-4.

Where practical, the pictogram given in Figure 1 can be used.

In the case that the gloves have flame and thermal category rating A1, then "ISO 11999-4 Type 1" shall be written underneath the pictogram given in Figure 1.

In the case that the gloves have flame and thermal category rating A2, then "ISO 11999-4 Type 2" shall be written underneath the pictogram given in Figure 1.

At the bottom right of the pictogram, the following letter designation shall be used to represent the different performance category levels for gloves:

A - Heat and flame performance category

b - Mechanical performance category

c - Barrier performance category

d - Ergonomic performance category

The performance level achieved by the gloves shall be placed next to the letter for each performance category, for example, A2,b_3,c_2,d_2.

6.6 Additional marking for footwear

The footwear shall be marked with the number of the relevant part of this International Standard, i.e. ISO 11999-5.

Where practical, the pictogram given in Figure 1 with "ISO 11999-5" underneath can be used.

NOTE This Clause is reserved for future text.

6.7 Additional marking for helmets

The helmet shall be marked with the number of the relevant part of this International Standard, i.e. ISO 11999-6.

Where practical, the pictogram given in Figure 1 with "ISO 11999-6" underneath.

NOTE This Clause is reserved for future text.

6.8 Additional marking for face and/or eye protection devices

The face and/or eye protection device shall be marked with the number of the relevant part of this International Standard, i.e. ISO 11999-7.

Where practical, the pictogram given in Figure 1 with “ISO 11999-7” underneath.

NOTE This Clause is reserved for future text.

6.9 Additional marking for hearing protection devices

The hearing protection device shall be marked with the number of the relevant part of this International Standard, i.e. ISO 11999-8.

Where practical, the pictogram given in Figure 1 with “ISO 11999-8” underneath.

NOTE This Clause is reserved for future text.

6.10 Additional marking for fire hoods

The fire hood shall be marked with the number of the relevant part of this International Standard, i.e. ISO 11999-9.

Where practical, the pictogram given in Figure 1 with “ISO 11999-9” underneath.

Labels shall be positioned in the area defined as the yoke of the fire hood.

NOTE This Clause is reserved for future text.

6.11 Additional marking for breathing apparatus

The breathing apparatus shall be marked with the number of the relevant part of this International Standard, i.e. ISO 11999-10.

Where practical, the pictogram given in Figure 1 with “ISO 11999-10” underneath.

NOTE This Clause is reserved for future text.

6.12 Additional marking for compatibility

All items of PPE, which are intended to be worn together in order to form a specific combination of PPE items or a specific mixed ensemble or a specific Type 1 or Type 2 ensemble, and which are intended to be certified together and put together on the market, shall be tested together according to the respective compatibility requirements of ISO 11999-2. An additional marking shall be added to the items’ individual markings, stating for each item that it is “Compatible with _____”.

In the blank, insert, for each of the items, with which items the to-be-marked item of the specific combination, mixed ensemble, or Type 1 or Type 2 ensemble is compatible, namely

a) the name of the manufacturer and/or other means of identifying or tracing back the manufacturer,

b) the manufacture’s model number and/or user’s specified number, and

c) the number of the relevant part of this International Standard, the type and performance levels of item shown to be compatible.

In case of a combination of PPE items or an ensemble where two PPE items and the interface between them do not have the same rating for a specific letter code, additional marking has to be added, which shall provide the user with the information about the performance levels of the interface between these items, determined according to the interface performance tests specified in ISO 11999-2.

The additional marking for compatibility, which is relevant for a specific item of PPE, shall be added onto each specific item of PPE

a) either by the manufacturer of the item, which is individually in accordance with 5.1,

b) by the manufacturing or product supplier, who decides to combine various items of PPE, which are available on the market as individual products, into a combined offering (i.e. a combination of items of PPE or mixed ensemble according to 5.3, or a Type1 or a Type 2 ensemble according to 5.2), or

c) by the user.

EXAMPLE In the case that the waterproof performance rating of the clothing is c_1 and of the gloves is c_2, the user should be informed also by additional marking about the letter code c rating of the interface area.

7 Manufacturer's instructions to be supplied with each item of PPE

7.1 Contents

The manufacturer's information shall be in accordance with each part of this International Standard.

The manufacturer shall provide user information including, but not limited to, data showing conformity of the item to the relevant part of this International Standard, any additional data required by this International Standard, the results of any optional tests undertaken, warnings, information, and instructions with each PPE.

The manufacturer shall provide at least the following instructions and information with each PPE:

a) safety considerations;

b) limitations of use;

c) all information contained on the marking, explanations of the various marking details, and recommendations for further additional marking, which can eventually be added by the supplier or user of a combination of items of PPE or of an ensemble;

d) preparation for use;

e) sizing;

f) recommended storage practices;

g) inspection frequency and details;

h) donning and doffing procedures;

i) maintenance and cleaning;

j) retirement and disposal;

k) known shelf life limitations;

l) information about the use of integrated devices.

7.2 Additional information for ISO 11999-3 clothing

7.2.1 Optional clothing test using an instrumented manikin

Information explaining the performance categories A, b, c, and d specified in ISO 11999-3 shall be given.

In case that the optional test according to 3.21.8 in ISO 11999-3 has been performed for a clothing item or an assembly of clothing items, the results of the test shall be provided with at least the following details:

a) name and address of the laboratory in which the test was carried out;

b) total number and description of arrangement of the burners used to create the flash fire exposure;

c) description of any holes or cuts that was necessary to be made in the clothing or ensemble to accommodate cable connections or other necessary parts of the test manikin;

d) statement of the nominal exposure heat flux density level, the duration of the exposure and the duration of the data acquisition time, and whether the burn injury predictions has ceased to increase prior to the end of the data acquisition time;

e) predicted total area (%) of manikin injured based on area of manikin covered by the test specimen:

   1) predicted covered area of second-degree burn injury (%);

   2) predicted covered area of third-degree burn injury (%);

   3) predicted total covered area of burn injury [sum of second-degree and third-degree burn injuries (%) and associated variation statistic, such as the standard deviation];

f) diagram of the manikin showing location and burn injury levels as predicted second-degree and third-degree burn injury areas;

g) table of individual heat flux sensor results.

7.2.2 Optional drag rescue devices (DRD)

Information concerning optional DRD shall be as specified in 4.21.7 of ISO 11999-3:2013.

7.3 Additional information for ISO 11999-4 gloves

Information explaining the performance categories A, b, c, and d specified in ISO 11999-3 shall be given.

At the bottom right of the pictogram, the following alphanumeric code shall be used to represent the different performance levels achieved by the gloves:

A - Heat and flame performance category

b - Mechanical performance category

c - Barrier performance category

d - Ergonomic performance category

The performance level achieved by the gloves shall be placed next to the letter for each performance category, for example, A2, b_3, c_2, d_2.

7.4 Additional information for ISO 11999-5 helmet

NOTE This Clause is reserved for future text.

7.5 Additional information for ISO 11999-6 footwear

NOTE This Clause is reserved for future text.

7.6 Additional information for ISO 11999-7 face and eye protection

NOTE This Clause is reserved for future text.

7.7 Additional information for ISO 11999-8 hearing protection devices

NOTE This Clause is reserved for future text.

7.8 Additional information for ISO 11999-9 fire hoods

NOTE This Clause is reserved for future text.

7.9 Additional information for ISO 11999-10 respiratory protection

NOTE This Clause is reserved for future text.

7.10 Additional information for whole ensembles

NOTE This Clause is reserved for future text.

7.11 Additional information about compatibility

In addition to information given by the additional marking for compatibility according to 6.12, which, according to 7.1, shall be contained as well in the manufacturer's instructions, the manufacturer's instructions shall give the following additional information.

In case of a combination of PPE items or an ensemble where two PPE items and the interface between them do not have the same rating for a specific letter code, the manufacturer's instructions shall also indicate additional effects and risks which can occur due to the fact of different ratings of two PPE items and the interface between them.

In the case that the waterproof performance rating of the clothing is c_1 and of the gloves is c_2, the user shall be informed also by additional marking about the letter code c rating of the interface area. Furthermore, the manufacturer's instruction shall also inform the user, in the case that the water proof performance rating of the clothing is c_1 and of the gloves is c_2, there is a risk of water possibly wicking from the higher water proof area to the lower water proof area.

7.12 Availability

The manufacturer shall attach the manufacturer's instructions, or packaging containing this information, to the relevant item of PPE in such a manner that it is not possible to use the item of PPE without being aware of the availability of the information.

The manufacturer's instructions, or packaging containing this information, shall be attached to the item of PPE so that a deliberate action is necessary to remove it. The manufacturer shall provide notice that the information is to be removed only by the end user.

8 Information available upon request from the supplier of a combination of items of PPE or of an ensemble

In addition to manufacturer's instructions according to Clause 7 for each item of PPE, which is individually meeting the requirements of 5.1.1, the following information shall be available upon request from the supplier of a combination of items according to 5.1.2, or a mixed ensemble according to 5.3, or a Type 1 or Type 2 ensemble according to 5.2:

For all items of PPE, which according to the suppliers' instructions can possibly be worn together, it shall be indicated, with which other items of PPE they have been tested together according to the respective compatibility requirements of ISO 11999-2. It shall be stated for each item that it is "Compatible with _____".

In the blank insert, for each of the items with which it is compatible, the following information:

a) the name of the manufacturer and/or other means of identifying or tracing back the manufacturer;

b) the manufacturer's model number and/or user's specified number;

c) the number of the relevant part of this International Standard, the type, performance levels of item shown to be compatible.

Annex A
(informative)

Information on risk assessment

A.1 General

Personal protective equipment (PPE) is only one part of an effective system of firefighter safety. Well-trained, closely supervised, and properly staffed fire departments are equally essential elements of minimizing the operational risk.

The performance levels in this part of ISO 11999 are taken from EN 469 and NFPA 1971, and represent two similar yet different approaches for structural firefighting protective clothing. These documents reflect the fire experience and the firefighters' death and injury history of the respective world communities that developed these documents. Both provide for protection of the firefighter, but take into account that different fire ground factors and different firefighting operations can exist in various parts of the world.

Regardless of location, the primary goals of firefighting and rescue work are to control an emergency as quickly as possible and at the same time take steps to minimize eventual damage and loss of persons and materials. In order of priority, the objectives of a firefighter reaching an incident are to

— save lives and to prevent or minimize injury,

— prevent or minimize damage to property, and

— prevent or minimize damage to the environment.

The role of firefighters' personal protective equipment is not only to protect the firefighter but also to enable the firefighter to achieve these objectives.

However, in emergency situations where the firefighter is unable to achieve these objectives, the PPE shall also provide sufficient protection to enable the firefighter to escape without receiving unacceptable injury. The class of PPE and the protection it offers shall be selected on the basis of a risk assessment specific to PPE use for identifying hazards, evaluating those hazards, and selecting specific performance requirements which eliminate or reduce these hazards.

A.2 General approach for conducting a risk assessment

The three major steps of the risk assessment process are as follows.

1) **Risk identification:** For every aspect of the operation of the fire department or brigade, list potential problems and hazards. The following are examples of sources of information that can be useful in this process:

— a list of the risks to which members are or can be exposed;

— records of previous accidents, illnesses, and injuries, both locally and nationally;

— facility and apparatus surveys, inspections, etc.

2) **Risk evaluation:** Evaluate each item listed in the risk identification process using the following questions.

— What is the level or potential severity of the occurrence?

— What is the potential frequency or likelihood of the occurrence?

— What are the potential consequences of the occurrence?

This will help set priorities in developing specifications for PPE performance. Some sources of information which can be useful are

— safety audits and inspection reports,

— prior accident, illness, and injury statistics,

— application of national data to local circumstances, and

— professional judgement in evaluating risks unique to the jurisdiction.

3) **Risk control:** Once the risks are identified and evaluated, a control for each should be implemented and documented. In the case of PPE, this should include determining the appropriateness of specific tests and requirements for eliminating or reducing risk. Normally, the two primary methods of controlling risk, in order of preference, are as follows.

— Wherever possible, totally eliminate and/or avoid the risk or activity that presents the risk.

— Where it is not possible to or practical to avoid or eliminate the risk, steps should be taken to control it (such as developing appropriate PPE specifications).

Specification of appropriate PPE shall be part of any overall safety program which includes Standard Operating Procedures, training, and inspections. As with any program, it is important to evaluate whether the plan is working. Periodic evaluations should be made, and if the program elements are not working satisfactorily, then modifications to the program should be made. If the methods are changed, a new risk assessment should be performed.

Paragraph A5 provides a format for specifically identifying and evaluating firefighter risks.

A.3 Recommended factors for identifying and evaluating firefighter risks

In using this part of ISO 11999 for purchasing appropriate firefighting clothing, some of the factors that should be considered in a risk assessment include the following.

— **Level of firefighter training and experience**: Well trained and experienced firefighters are more likely to recognize fire ground hazards and appropriately respond in ways to minimize their potential for injury. The quality, amount, and frequency of training will also have an impact on the firefighters potential for injury. Firefighters should be specifically trained in the use of the selected PPE.

— **Level of fitness and health of the firefighter**: Firefighters who are in good health and physical shape are more likely to respond safely and be less subject to stress-related injuries on the fire ground than firefighters having poor health and physical conditioning.

— **Function of the firefighter at the incident scene**: Firefighters who make aggressive interior attacks at structural fires can be at more risk from burn injury than firefighters who assume defensive positions outside of burning structures. Some organizations can segregate firefighter responsibilities at the fire scene and subsequently require different levels of protection. Other organizations can require each firefighter to be equipped to perform any function at the fire scene, recognizing the possibility that any individual can be required to respond under emergency conditions. In all cases, the specific activities of firefighters in responding to fires or other emergencies shall be accounted for in determining risk of injury. Examples can include equipping firefighters with PPE that is designed for aggressive interior attack as compared to functions where firefighters activities are primarily defensive.

— **Environmental conditions at the incident scene**: Hot and humid conditions as well as cold conditions can affect firefighter protection at the response scene. In addition, the physical

environment in which the response is conducted and its impact on firefighters performing assigned duties shall be accounted for. For example, firefighters using hoses can become wet. Water inside clothing systems has both positive and negative impacts on its performance.

— **Specific hazards to be faced at the incident scene**: Thermal as well as physical and other hazards should be considered in evaluating response risks. The type, level, and duration of heat exposure as well as the physical environment in which it is contained will have a significant effect on the potential risks faced by firefighters. Other hazards such as potential for flame contact, low visibility, fire ground chemicals, and rough physical surfaces are known to create additional risks for injury at the fire scene.

— **Known limitations of the protective clothing and other PPE**: While protective clothing is designed to prevent or minimize injury, the specific limitations of protective clothing in providing protection under all situations shall be recognized. Clothing performance can be limited based on certain design features or material performance characteristics. In addition, these characteristics can be diminished as the clothing is worn. Protective clothing shall be properly maintained to ensure continued performance. Methods for integrating other PPE such as helmets, gloves, boots, and self-contained breathing apparatus shall be done in a manner that provides complete protection to the wearer.

— **Type and application of command system at the incident scene**: The amount of discipline and coordination of firefighters at the accident/response scene can have an impact on the risk for injury. Firefighters who have well-defined responsibilities and are closely supervised are less likely to be injured as compared to firefighters which act more independently and in a less coordinated fashion.

Consideration should also be given to the buildup of heat stress by prolonged use of the PPE in firefighting and associated activities. Heat stress and other stress-related conditions are some of the more frequent causes of firefighter fatalities and injuries. Heat stress is affected by a number of factors, including those described above.

A.4 Other considerations

No matter where in the world firefighting operations take place, firefighters are exposed to a number of conditions. These conditions include exposure to heat and products of combustion from the interior of structures or other areas where there can be a rapid increase in fire volume. Firefighters who are confronted with these conditions will face the same exposure regardless of type of building construction and general firefighting strategy. No structural firefighting protective equipment can give prolonged protection from such hostile conditions. Certain injury, and quite possibly death, will occur if firefighters do not quickly extricate themselves from these severe exposures.

The community disposition towards fire protection plays a key role in the planned deployment of firefighting operations. Fire departments and brigades over the world develop strategy and operating procedures that reflect the nature of the fire hazard in their community and the available resources dictate their level of intervention. Where fire protection is a key objective of the community and is reflected in community planning and through their regulations, building codes, and use of built-in and monitored automatic detection and suppression systems these communities should not experience many severe fires. Where fires do occur, interior operations will probably be conducted in the incipient fire stage where danger to interior firefighting operations is low. Well- managed, highly trained, closely supervised, and properly staffed fire departments and brigades will perform effectively to minimize the economic loss to the community and provide risk management to enhance operational safety.

Building construction can be a very important factor affecting interior firefighting operations. Where buildings are of compartmentalized fire-resistive construction, fires can be expected to be confined by the building design to the areas of origin or within a building “compartment”. In such situations, fire might be allowed to burn itself out while confined to the area or room of origin without direct firefighting intervention, or less aggressive firefighting operations might be used, resulting in firefighters being exposed to a less hostile thermal environment.

In communities where water supplies for firefighting are weak, or where buildings are relatively small and well spaced, or where the fire department or brigade is not well organized, extensively trained, properly staffed, supervised, or does not have adequate resources for interior firefighting operations, exterior firefighting operations can work effectively for that community provided the fire department or brigade is not required or expected to perform interior search and rescue functions. Such exterior operations do not require as high a level of protective equipment as interior operations do.

Other communities do not have extensive fire-resistive construction and many buildings are built of combustible materials. In many situations, such buildings are built closely together and uncontrolled fire can extend from building to building. Many fire departments or brigades are also expected to extend interior search and rescue operations into all uninvolved areas of the fire building to locate and remove any endangered occupants. Where the fire department or brigade is expected to perform interior search and rescue operations, and is expected to minimize the economic loss to the community by confining the fire to the smallest area possible, firefighters will be exposed to hostile thermal environments while performing their tasks. Such operations call for an aggressive interior attack to achieve the objectives in as little time as possible. Protective clothing for firefighters performing such operations should afford optimum protection.

In many fire departments and fire brigades, specific personnel will be assigned to interior firefighting operations, while others will be assigned to tasks that do not bring the firefighters into interior operating positions being affected by the fire. Such fire departments or brigades might choose to provide the "interior attack team" with a higher level of protective clothing than personnel assigned to other duties. Other fire departments and brigades might require that all firefighters be able and available to perform "interior attack team" operations at any incident or at any time during an incident. In these situations, perhaps all firefighters need to be regularly equipped with the higher level of protective clothing.

In all cases, the community must be clear in what is expected of their fire department or brigade in terms of its mission and objectives to be met. The fire department or brigade shall properly define for the community and for itself what levels of organization, supervision, training, staffing, and resources are necessary to effectively and safely perform the operations to achieve the objectives. Part of this process will identify the hazards of the various operations and what the appropriate protective clothing and equipment should be.

A perception can exist that modern firefighting protective clothing allows firefighters to "overextend" themselves, thus getting themselves into more dangerous situations than they would if they were not wearing such "sophisticated" equipment or advanced protective clothing which does not allow them to "feel the heat" and better judge their environment. Firefighters who "overextend" themselves are probably not operating under close supervision or in an incident command system that controls the position, function, and safety of all operating teams. Nonetheless, protective clothing can allow firefighters, operating safely within the incident command system, to be able to perform more effectively. Regardless of the level of protection afforded by any clothing, anything except bare skin can allow firefighters to "overextend" further enforcing the position that all operations shall be managed by the incident command system and that firefighters only operate under direct supervision within that system.

The ability to judge heat buildup can differ depending on what the firefighter is wearing. It is actually a training issue for the firefighter to become familiar as to how a particular ensemble transmits heat. What can be felt in one garment can be entirely different in another garment. There is not a single "measure of heat building up" that can be applied to all garments. Moreover, it is not practical to rely on exposed human body parts to indicate heat exposure as second-degree burns occur at relatively low temperatures (about 55 °C) after short exposure.

Another perception that can exist is that the thermal insulation of the protective clothing can cause more injuries, due to heat stress, than lighter weight (but less protective) garments. Incorrect conclusions have been drawn about reported stress-related injuries and deaths. Some positions state that these injuries are the consequences of wearing protective clothing. Heat stress cannot be addressed only by the garment but must be approached from several factors that equally affect it. The total factors affecting stress and heat stress shall be evaluated including firefighters' age, physical condition, individual metabolism, as well as how firefighters are managed and if their physical conditions are monitored and cared for during

incident operations. Although it is true that lighter garments will most likely help to reduce the stress to the wearer, lighter garments that provide the minimum protection specified by this International Standard should be selected. The entire spectrum of heat stress and stress-related problems shall be fully addressed by the fire department or brigade. Practices for ventilating firefighters (by opening clothing), replacement of fluid, and other rehabilitation measures should be considered in the reduction of heat stress.

With any selection of protective equipment, fire departments and fire brigades shall carefully review their needs and determine what will be an appropriate level of protection. Purchase specifications should reflect these needs and should specifically require compliance with the applicable International Standards. This International Standard should not be construed as setting levels of protection for all firefighting situations and conditions to which firefighters can be exposed.

A.5 Recommended approach

A.5.1 Introduction

During firefighting operations and other activities undertaken by firefighters, many different hazards can be encountered. Where possible, the level of risk that each hazard presents to the firefighter should be eliminated or reduced to an acceptable level. The guidance given in this document indicates how to carry out a risk assessment by acknowledging the hazards that can be present, the likelihood of the firefighter becoming exposed to them and the possible consequences of such exposure.

These guidelines have been produced to assist employers in making the decision on choosing the correct type of PPE for firefighters for whom they are responsible.

A.5.2 Basis of this guideline

A definition of "risk" is "the probability that the harm or damage from a particular hazard is realized". Risk reflects both the probability and consequences of the harm.

In Table A.2 in A.5.5, categories of many of the hazards likely to be encountered by firefighters in the execution of their duties are listed. It is very unlikely that all hazards listed will be encountered during one incident, nor is the list of hazards definitive. Hazards can be deleted or added to by any organization carrying out a particular risk assessment, subject to local conditions and requirements.

By considering the various activities to which a firefighter can be exposed and by applying the risk assessment formula in this model line by line, i.e. for each hazard that might be encountered, the more serious risks will be identified by their higher numbers. This will highlight where decisions shall be taken to ensure adequate and correct levels of protection for firefighters.

Table A.3, included in A.5.9, lists the body portions for which the risk most applies. This analysis will indicate where certain types of protection are needed more or less on the body. This table has been populated with the paragraphs indicating the performance required by this standard.

A.5.3 Risk assessment formula

$$R = L \times S \qquad \text{(A.1)}$$

where

R is the risk;

L is the likelihood of the firefighter being exposed to the hazard;

S is the severity/consequences to the firefighter if exposed to the hazard.

PPE should be chosen based on protecting the firefighters against the identified risks.

NOTE Values for L and S are listed in Table A.1.

A.5.4 Values of L and S

Table A.1 — Values of L and S

Value	Likelihood	Severity/Consequence	
0	Never	Nil	
1	Exceptional	LOW	e.g. Minor injury: small cuts, superficial burns, etc.
2	Occasional	MODERATE	e.g. Major injury: broken bones, serious burns, etc.
3	Very likely	HIGH	e.g. Life threatening
4	Always	EXTREME	Death
NOTE "0" should only be allowed where there is absolutely no chance of the hazard being encountered.			

A.5.5 Risk assessment guidelines

Table A.2 — Hazard L × S = R

Hazard origin and type	Likelihood of firefighter being exposed to hazard	Severity consequences to the firefighter if exposed to hazard	Risk (Total of L × S)	Control measures
1) Thermal hazards				
a.)Convective heat				
b)Radiant heat				
c) Conductive heat				
d) Flame				
e) Molten metal/drops				
f) Burning embers				
g) Flashover				
2) Electrical hazards				
a) Electric arc				
b) Static electricity				
c) Electrical current, high voltage				
d) Low voltage				
3) Environmental hazards				
a) Ambient cold				
b) Ambient hot				
c) Cold surfaces				
d) Air velocity — mechanical				
e) Air velocity — wind				
f) Rain				
g) Splashes				
h) Work in water				
i) Falling in water				

Table A.2 *(continued)*

Hazard origin and type	Likelihood of firefighter being exposed to hazard	Severity consequences to the firefighter if exposed to hazard	Risk (Total of L × S)	Control measures
4) Mechanical hazards				
a) Penetration				
b) Cut				
c) Abrasion				
d) Falling objects				
e) Impact				
f) Falling/slipping				
5) Non-visibility hazards				
a) Not being seen				
6) Biological/chemical hazards				
a) Liquid				
b) Contamination by body fluids				
c) Gas				
d) Smoke				
e) Radioactivity				
7) Other hazards				
a) Physiological/heat stress				

A.5.6 Other factors to be considered

The training, tactics, and operational procedures of each organization will have an impact on any risk assessment and will probably dictate how each hazard is regarded and indicate the figures to be applied to L and S.

Even if not identified as a potential serious risk under 7 a) of Table A.2, the physiological aspects of wearing PPE should also be considered when carrying out the risk assessment as these can have a serious impact on the health and safety of the firefighter.

Decide whether the risk assessment is carried out for the actual incident or from when the firefighter leaves the station until he/she returns, e.g. environmental issues may not be a serious hazard while tackling the incident but can be, if a firefighter must stand by in bad weather conditions while waiting to tackle the incident.

Consider whether the risk assessment is carried out on the basis of the firefighter having no protection or having existing levels of protection, e.g. under normal conditions, firefighters wearing full clothing compliant with this International Standard will be well protected in fire situations.

Even with different risks being identified by the risk assessment, the decision might be taken to protect against the risk of highest severity. For example, protection in accordance with ISO 11999 might be required for indoor firefighting.

The introduction of national databases for recording incidents of firefighters being exposed to hazards would be a valuable source of information when assessing the likelihood of events occurring.

A.5.7 Electrostatic hazards

Firefighters need to be aware of the hazards of static electricity. This is because under certain conditions, less than 1 millijoule (mJ) of energy, much less than the static that builds up in the human body can ignite

hydrocarbon vapour/air mixtures, and other explosive gases. Also, nuisance static can cause clothing to be uncomfortable to wear.

Energy stored in the body poses a much greater hazard than static clothing because the body is made almost entirely of water and electrolytes and can store up to 40 mJ of energy.

Garments and fabrics used for protective clothing for firefighters often have antistatic fibres built into the fabric to reduce static hazards. There are two basic types of antistatic fibre. Conductive fibres and inductive or non-conductive fibres.

The fabrics containing conductive fibre can be tested according to EN 1149-1, to measure the surface resistivity of the fabric. The performance has to be evaluated according to EN 1149-5.

Fabrics containing inductive fibre or non-conductive antistatic fibre cannot be tested according to EN 1149-1. They shall be tested according to method 2 of EN 1149-3:2004 and the performance evaluated according to EN 1149-5.

Although fabrics and garments containing antistatic fibres can substantially reduce static electricity generated by fabric to fabric friction, and can also reduce the contribution of clothing to the static charge build up in the body, they do not eliminate body charges.

For this reason, proper grounding procedures, such as discharging static from the body by wearing a wristlet connected to a ground source, and the use of conductive footwear are necessary in an explosive atmosphere to reduce spark potential. For further and more detailed tailed information, see EN 1149-5.

A.5.8 Electric arc hazards

Electric arc hazards normally generate a much higher level of energy than flash fires, but for a much shorter duration of time.

The relevant series of ASTM standards consists of the following:

— ASTM F1958/F1958M, which is a test method for determining ignitability of clothing by electric arc exposure, using a mannequin;

— ASTM F1959/F1959M, which is a test for determining Arc Thermal Performance Value (ATPV) of Textile Materials for clothing by electric arc exposure method using instrumented sensor panels;

— ASTM F2178, which is a test method for determining the arc rating and standard specifications for eye and face protective devices;

— ASTM F2621, which is a test method for determining response characteristic and design integrity of arc rated finished products in an electric arc exposure;

— ASTM F1506, which gives performance specifications for flame resistant textile materials for wearing apparel for use by electrical workers exposed to momentary electric arc and related thermal hazards.

The relevant series of IEC standards consists of the following:

— IEC 61482-1-1, which contains a test method (Method A) for determining Arc Thermal Performance Value (ATPV), equivalent to ASTM F1959/F1959M, and a second test method (Method B) for the evaluation of the clothing response and design integrity, in a way equivalent to ASTM F2621;

— IEC 61482-1-2, which is a test method for determining the arc protection class of materials and clothing by using a constrained and directed arc (box test);

— IEC 61482-2, which covers performance requirements.

The test method standards IEC 61482-1-1 and IEC 61482-1-2 have been adopted by CENELEC in identical form as EN 61482-1-1 and EN 61482-1-2. IEC 61482-2 has not yet been adopted by CENELEC.

There exists interest and work is going on for developing IEC, ISO, and EN standards for PPE items other than clothing.

There exists several ways of carrying out the needed hazard and risk assessment. Most commonly, one bases the hazard and risk assessment on the IEEE 1584 Guide or on NFPA 70E and uses the ATPV as the criterion for the selection of appropriate protective clothing. The 2011 edition of the ISSA "Guideline for the selection of personal protective clothing when exposed to the thermal effects of an electric arc" indicates also an additional hazard and risk assessment method based on the use of the box-test class rating of protective clothing obtained by IEC 61482-1-2.

Because of the nature of higher energy level of arc hazards than flash-fire hazards, although only for relatively short durations of time, in many workplace situations a multilayer garment is needed for achieving the needed protection, or alternatively several garments one worn on top of the other, both made from heat and flame resistant materials will be required.

A.5.9 Hazards associated with body parts

Table A.3 refers to subclause numbers for clothing and gloves of the previous draft, as the new parts of this International Standard for these PPE items were not yet available with full details, when ISO/TC 94/SC 14 drafted this part of ISO 11999. Table A.3 shall be amended as soon as further parts of this International Standard will be available.

Table A.3 — Hazards and parts of the body to be protected

Hazard origin and type	Upper and lower torso, and arms and legs	Hands	Feet	Head	Head	Head	Head	Interface
	Clothing	Gloves	Footwear	Helmet	Face and eye	Ears	Respiration	Fire hood
1) Thermal hazards Type 1/Type 2								
a) Convective heat	3.17.5	7.2						
b) Radiant heat	3.17.6	7.3						
c) Conductive heat	3.17.9	7.5						
d) Flame	3.17.2 3.17.3	7.1						
e) Molten metal/ drops	N/A	N/A						
f) Burning embers	3.9 3.12	4.2 4.5						
g) Flashover	3.17.7	7.4						
2) Electrical hazards								
a) Electric arc	N/A	N/A						
b) Static electricity	N/A	N/A						
c) Electrical current, high voltage	N/A	N/A						
d) Low voltage	N/A	N/A						
3) Environmental hazards								
a) Ambient cold	N/A	N/A						
b) Ambient hot	N/A	N/A						

Table A.3 *(continued)*

Hazard origin and type	Upper and lower torso, and arms and legs	Hands	Feet	Head	Head	Head	Head	Interface
	Clothing	Gloves	Footwear	Helmet	Face and eye	Ears	Respiration	Fire hood
c) Cold surfaces	N/A	N/A						
d) Air velocity — mechanical	N/A	N/A						
e) Air velocity — wind	N/A	N/A						
f) Rain	3.19.8	9.1						
g) Splashes	3.19.2 3.19.3	9.1						
h) Work in water	N/A	N/A						
i) Falling in water	N/A	N/A						
4) Mechanical hazards								
a) Penetration	3.18	8.4						
b) Cut	3.18	8.2						
c) Abrasion	3.18	8.1						
d) Falling objects	N/A	N/A						
e) Impact	N/A	N/A						
f) Falling/ slipping	N/A	N/A						
5) Non-visibility hazards								
a) Not being seen	3.13 3.21.3 3.21.4	N/A						
6) Biological/chemical hazards								
a) Liquid	3.19.5 3.19.6 3.19.7	9.2 9.3 9.5						
b) Contamination by body fluids	3.19.7	9.5						
c) Gas	N/A	N/A						
d) Smoke	N/A	N/A						
e) Radioactivity	N/A	N/A						
7) Other hazards								
a) Physiological/ heat stress	3.20	N/A						

Annex B
(normative)

Testing and classification of performance for items of PPE, for combinations of items of PPE, and for ensembles

In the case that several items of PPE have been tested together according to the respective compatibility tests and meet the relevant compatibility requirements, then the manufacturer of an ensemble or product offering, consisting of the tested items of PPE, or the manufacturer or product supplier, who decides to combine the tested items of PPE, which are available on the market as individual products, into a combined product offering, shall, according to 6.12, provide a declaration stating for each PPE item that it is "Compatible with _____".

In the blank, the number or code, which has been specified by the manufacturer or product supplier or user for each PPE item for which compatibility has been demonstrated, shall be inserted. Also the types, levels, or classes of each PPE item shown to be compatible shall be indicated.

From the point of view of the user, the process for achieving compatibility testing and classification can be described as follows.

— Identification of protection needs: The user specifies the performance levels, types, and classes of each PPE item according to the application where the PPE ensemble is intended to be used. Then, the user identifies an appropriate combination of PPE items.

— Compatibility testing: In the case that the compatibility of the items of PPE of a combination, which the user has identified and intends to select, has not yet been proven by the manufacturer or product supplier, further compatibility testing shall be carried out and it shall be certified that all the relevant requirements of 11999-2 are met.

NOTE The party who gives the test is the one who is entrusted with the testing by the user.

— Performance coding of PPE items: Table B.1 indicates the performance coding system for various PPE items, which is used in this International Standard, i.e. the mainstream performance criteria heat and flame, indicated by big letters index in the grey-shaded boxes, which is used for defining the Type of a PPE item, and the various other performance criteria, such as mechanical, liquid proof, and thermal comfort performance, indicated by lower letters.

Table B.1 — Letter codes for the type defining heat and flame performance requirements and for other performance requirement categories

Ensemble items	Requirements	Type 1	Type 2
Clothing	Heat and flame	A1	A2
	Strength and physical hazard	b_1, b_2	
		b_1, b_2	
	Water and liquid penetration	c_1, c_2	
	Thermal comfort	d_1, d_2	
Gloves	Heat and flame	G1	G2
	Mechanical	b_1, b_2, b_3	
	Barrier	c_1, c_2	
	Ergonomic	d_1, d_2	

Table B.1 *(continued)*

Ensemble items	Requirements	Type 1	Type 2
Helmets	Heat and flame	H1	H2
	Others	y_1, y_2, y_3	
Footwear	Heat and flame	FW1	FW2
	Others	z_1, z_2, z_3	
Face and eye protection	Heat and flame	FE1	FE2
	Others	n_1, n_2	
Hearing protection	Heat and flame	HP1	HP2
	Others	m_1, m_2, m_3	
Fire hoods	Heat and flame	FH1	FH2
	Others	o_1, o_2	
Respiratory protection	Heat and flame	R1	R2
	Others	f_1, f_2, f_3, f_4	

Three examples on how to indicate the performance of compatible combinations of PPE items and of ensembles are shown below.

EXAMPLE 1 Letter coding for a combination of Type 1 or Type 2 items of PPE, according to 5.1.2.

If the risk assessment identifies the level of heat and flame Type 2 for all combined items, and mechanical performance level b_2, water penetration level c_1, and thermal comfort level d_3 for clothing items, and if, for example, a compatibility verification for say three PPE items, clothing, fire hood, and helmet, has to be conducted, all PPE items have to be tested and passed according to the individual PPE-relevant parts of this International Standard, the compatibility between these PPE items have to be demonstrated by passing the tests according ISO 11999-2 and marked according to this part of ISO 11999.

EXAMPLE 2 Compatibility marking for a combination of Type 2 items of PPE:

ISO 11999, A2 $b_2c_1d_2$/H2 y_1/ FH2o_2

The indication that the items are compatible with the main performance requirements of Type 2, is shown by the capital letters and their indices 2. For the other requirements indicated by the lower case letters, the PPE item configuration depends on the risk assessment of the local/national application.

EXAMPLE 3 Letter coding for a Type1 or Type 2 ensemble, according to 5.2.

If in case the risk assessment identifies the level of heat and flame Type 1, a compatibility verification for application Type 1 for all PPE items tested according to the relevant parts of this International Standard, the interface compatibility shall be tested according to ISO 11999-2 compatibility and marked according to this part of ISO 11999.

EXAMPLE 4 Compatibility marking for Type 1 ensemble:

ISO 11999 Type1 Ensemble, A1 $b_1c_2d_2$/G1$b_3c_1d_2$/H1 y_1/FW1 z_3/FE1 n_2/HP1 m_3/FH1 o_1/R1 f_4

The indication that the items are compatible with the main performance requirements suitable for application Type 1 is shown by the capital letters and their indices 1. For the other requirements indicated by the lower case letters, the item configuration depends on the risk assessment of the local/national application.

EXAMPLE 5 Letter coding for a "ISO 11999 Mixed Ensemble", according to 5.3.

If the risk assessment identifies that not all items of the ensemble need to have the same numerical letter code ratings, i.e. do not need to fulfil all the performance compatibility requirements which are required for a Type 1 or Type 2 ensemble, a performance compatibility verification has to be conducted only for those items of PPE and according to those compatibility tests identified a necessary by the risk assessment. However, all PPE items have to be according to the relevant parts of this International Standard and the interface compatibility between all parts shall be tested and met according to ISO 11999-2 and marked according to ISO 11999-1.

EXAMPLE 6 Compatibility marking for ISO 11999 mixed ensemble:

ISO 11999 Mixed Ensemble, A1 $b_1c_2d_1$/G2 $b_1c_2d_1$/H1 y_1/FW2 z_3/FE1 n_2/HP1 m_3/FH2/R1 f_4

The indication that the items are compatible with the main performance requirements suitable for application Type 1 or Type 2 is shown by the capital letters and their indices 1 or 2. For the other requirements indicated by the lower case letters, the item configuration depends on the risk assessment of the local/national application.

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ICS 13.340.10
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