INTERNATIONAL STANDARD

ISO 15027-1

Second edition
2012-11-01

Immersion suits —

Part 1: Constant wear suits, requirements including safety

Combinaisons de protection thermique en cas d'immersion —

Partie 1: Combinaisons de port permanent, exigences y compris la sécurité

Reference number
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Foreword

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

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 15027-1 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 162, *Protective clothing including hand and arm protection and lifejackets*, in collaboration with Technical Committee ISO/TC 188, *Small craft*, Subcommittee SC 1, *Personal safety equipment*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 15027-1:2002) which has been technically revised. The main technical changes are:

a) addition of “underclothing” under terms and definitions;

b) addition of “cold shock” under terms and definitions;

c) revision of requirements for buddy lines;

d) revision of requirements regarding conspicuity;

e) addition of Clause 6 “Information supplied by the manufacturer”;

f) revision of consumer information label;

g) reordering of subclauses;

h) revision of requirements regarding thermal protection in water.

ISO 15027 consists of the following parts, under the general title *Immersion suits*:

— *Part 1: Constant wear suits, requirements including safety*

— *Part 2: Abandonment suits, requirements including safety*

— *Part 3: Test methods*

Introduction

This part of ISO 15027 has been prepared to meet the needs of persons engaged in certain activities on or near water.

The justification for using a constant wear suit would be to provide protection in the event of accidental immersion, to prolong life and to aid rescue. An individual's estimated thermal protection time when wearing this type of equipment will depend upon the water temperature, weather conditions, clothing, the cold tolerance of the person and the person's behaviour. This part of ISO 15027 specifies the minimum levels of insulation provided by the different ranges of suit in particular water temperatures.

This part of ISO 15027 allows for thermal protection to be provided by a variety of methods and materials, some of which may require action when the suit enters the water (e.g. inflation of chambers by gas from a cylinder). The compliance of a constant wear suit with this part of ISO 15027 does not imply that it is suitable for all circumstances. This part of ISO 15027 cannot make detailed provision for all the special uses to which a constant wear suit may be put, such as special working conditions, i.e. slip resistance or fire resistance or special leisure applications.

This part of ISO 15027 is intended to serve as a minimum performance requirement for manufacturers, purchasers and users of constant wear suits by ensuring that they provide an effective standard of performance in use. Designers should encourage the wearing of this equipment by making it comfortable and functional for continuous wear on or near water.

The primary aims in wearing a constant wear suit are:

a) to reduce the risk of cold shock and to delay the onset of hypothermia;

b) to enable the user to propel himself in the water and extricate himself from the water without it becoming an encumbrance;

c) to make the user sufficiently conspicuous in the water so as to aid his recovery.

The performance of the suit may be altered by a number of factors, including wave action or the wearing of additional equipment. Users, owners and employers should ensure that equipment is correctly maintained according to manufacturer's instructions.

A suit system may comprise one or more pieces provided that in all cases it meets the requirements of this part of ISO 15027 as a complete system.

A constant wear suit may often be worn with a lifejacket as it will provide extra flotation and may help to bring a person to a face-up position.

Immersion suits —

Part 1:
Constant wear suits, requirements including safety

1 Scope

This part of ISO 15027 specifies performance and safety requirements for constant wear immersion suits for work and leisure activities to protect the body of a user against the effects of cold water immersion, such as cold shock and hypothermia.

It is applicable for dry and wet constant wear immersion suits.

Abandonment suits are not covered by this part of ISO 15027. Requirements for abandonment suits are given in ISO 15027-2:2012. Test methods for immersion suits are given in ISO 15027-3:2012.

2 Normative references

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

CIE 15:2004, *Colorimetry*[1)]

EN 340, *Protective clothing — General requirements*

ISO 105-A02, *Textiles — Tests for colour fastness — Part A02: Grey scale for assessing change in colour*

ISO 105-B04, *Textiles — Tests for colour fastness — Part B04: Colour fastness to artificial weathering: Xenon arc fading lamp test*

ISO 105-E02, *Textiles — Tests for colour fastness — Part E02: Colour fastness to sea water*

ISO 105-X12, *Textiles — Tests for colour fastness — Part X12: Colour fastness to rubbing*

ISO 188, *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

ISO 1421, *Rubber- or plastics-coated fabrics — Determination of tensile strength and elongation at break*

ISO 2411:2000, *Rubber- or plastics-coated fabrics — Determination of coating adhesion*

ISO 3801:1977, *Textiles — Woven fabrics — Determination of mass per unit length and mass per unit area*

ISO 4674-1:2003, *Rubber- or plastics-coated fabrics — Determination of tear resistance — Part 1: Constant rate of tear methods*

ISO 7854:1995, *Rubber- or plastics-coated fabrics — Determination of resistance to damage by flexing*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

ISO 12401, *Small craft — Deck safety harness and safety line — Safety requirements and test methods*

ISO 12402-2, *Personal flotation devices — Part 2: Lifejackets, performance level 275 — Safety requirements*

ISO 12402-3, *Personal flotation devices — Part 3: Lifejackets, performance level 150 — Safety requirements*

1) Available from http://www.cie.co.at/main/publist.html.

ISO 12402-4, *Personal flotation devices — Part 4: Lifejackets, performance level 100 — Safety requirements*

ISO 12402-5, *Personal flotation devices — Part 5: Buoyancy aids (level 50) — Safety requirements*

ISO 12402-6, *Personal flotation devices — Part 6: Special purpose lifejackets and buoyancy aids — Safety requirements and additional test methods*

ISO 12402-7:2006, *Personal flotation devices — Part 7: Materials and components — Safety requirements and test methods*

ISO 12402-8, *Personal flotation devices — Part 8: Accessories — Safety requirements and test methods*

ISO 12402-9:2006, *Personal flotation devices — Part 9: Test methods*

ISO 13934-1, *Textiles — Tensile properties of fabrics — Part 1: Determination of maximum force and elongation at maximum force using the strip method*

ISO 13935-2, *Textiles — Seam tensile properties of fabrics and made-up textile articles — Part 2: Determination of maximum force to seam rupture using the grab method*

ISO 13937-4, *Textiles — Tear properties of fabrics — Part 4: Determination of tear force of tongue-shaped test specimens (Double tear test)*

ISO 15027-3:2012, *Immersion suits — Part 3: Test methods*

Resolution A.658(16)[2] adopted by the IMO[3] Assembly to amend the International Convention for the Safety of Life at Sea (SOLAS), 1974, *Use and fitting of retro-reflective materials on life-saving appliances*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
immersion suit
suit designed to protect the user's body from the cooling effects of unintended immersion in water

Note 1 to entry: Cooling effects include cold shock (3.21) and hypothermia (3.14).

3.2
constant wear suit
immersion suit, designed to be routinely worn for activities on or near water in anticipation of accidental immersion in water, but permitting physical activity to such an extent that actions can be undertaken without undue encumbrance and thus, head, hands and feet need not be covered

3.3
abandonment suit
immersion suit including head, hand and feet protection designed to permit rapid donning in the event of an imminent immersion in water

3.4
dry suit
immersion suit designed to protect the user against the effect of cold water immersion by precluding the entry of water upon immersion

2) Accessible at http://www.imo.org/KnowledgeCentre/HowAndWhereToFindIMOInformation/IndexofIMOResolutions/Pages/Assembly-(A).aspx.

3) IMO is the abbreviation for International Maritime Organization, based in London, UK. IMO issues regulations which are then published as laws by the member states.

3.5
wet suit
immersion suit designed to protect the user against the effect of cold water immersion by providing insulation and limiting the entry and exit of water upon immersion

3.6
primary suit closure
closure used in the donning of the suit

3.7
secondary suit closure
additional closure which can be operated by the user to enhance the fit of the suit

3.8
inherent buoyant material
material that provides buoyancy, forming a permanent part of the suit, with a density less than that of water

3.9
exterior fabric
outer fabric of a suit, either in the form of a single or composite fabric

3.10
retro-reflective material
material that reflects light beams back to their point of origin

3.11
sprayhood
cover brought or placed in front of the face of the user in order to reduce or eliminate the splashing of water from waves or the like onto the airways, and thereby promoting the survival of the user in rough water conditions

3.12
buddy line
length of cord which can be tied or otherwise fixed to another person, or to that person's personal flotation device or other objects, so as to keep a user in the vicinity of that person or object with a view to making location and thus rescue easier

3.13
clo value
unit to express the relative thermal insulation values of various clothing assemblies

Note 1 to entry: One clo is equal to 0,155 $Km^2 W^{-1}$.

3.14
hypothermia
condition where body core temperature is below 35 °C

3.15
working environment
environment in which the user of a suit system would engage in normal work

3.16
helicopter transit suit
constant wear suit worn by helicopter occupants

3.17
offshore installation
structure or vessel that is permanently or temporarily sited at sea or away from the shore in a fresh water lake or river and which is not covered by other international regulations

3.18
suit system
combination of a suit and any other products which are used in conjunction with it

3.19
underclothing
clothes worn under the suit system

Note 1 to entry: The underclothing to be worn with the suit system shall be specified by the manufacturer. If not specified by the manufacturer, it shall be according to ISO 15027-3:2012, 3.8.1.3.

3.20
heat strain
increase of body temperature induced by sustained heat stress which cannot be fully compensated by temperature regulation, or activation of thermoeffective activities in response to heat stress which cause sustained changes in the state of other, nonthermal, regulatory systems

3.21
cold shock
short transitory phase lasting about 2 to 3 min upon sudden immersion in cold water and characterized by an uncontrollable hyperventilation accompanied by other cardio-respiratory distress

4 Requirements

4.1 General

4.1.1 The suit system (dry or wet suit) declared to be a constant wear suit shall meet all requirements of this part of ISO 15027. The suit shall not be damaged or fail in its determined function when tested in accordance with ISO 15027-3:2012, Clause 3. The test sequence shall start with the temperature cycling in accordance with ISO 15027-3:2012, 3.9, followed by the rotating shock bin test in accordance with ISO 15027-3:2012, 3.6.

4.1.2 A suit system declared to be a helicopter transit suit shall meet all requirements of this part of ISO 15027.

4.1.3 The manufacturer shall specify the components of the suit system including underclothing and additional items. The constant wear suit may incorporate additional items compliant with ISO 12402-8, none of which shall impair its performance with respect to the requirements of this part of ISO 15027, either by their presence or their use. If a safety harness forms an integral part of the suit designed to comply with this part of ISO 15027, then the complete assembly shall comply both with ISO 12401 and with this part of ISO 15027.

4.1.4 The risk of heat stress and discomfort shall be taken into account in the design and use of the suit system. This should be accompanied in the information supplied by the manufacturer by specific advice or warnings according to Clause 6.

NOTE In general, the higher the protection against cold shock and hypothermia, the higher the possibility of heat strain is. The user of a constant wear suit needs to balance those two effects when choosing a device.

4.1.5 The rotating shock bin test according to ISO 15027-3:2012, 3.6 shall be performed on each sample. There shall be no visible migration of insulation material and no visible wear-and-tear damage after the rotating shock bin test.

4.1.6 Unless the suit system has been designed to be used without a PFD, the suit system shall not prevent the donning of a personal flotation device (PFD) in accordance with ISO 12402-2 or ISO 12402-3 and the manufacturer of the suit system shall specify the type of PFD (inflatable and/or inherent) to be used.

4.1.7 The performance requirements shall be met after cleaning in accordance with ISO 15027-3:2012, 3.7.1.1. The cleaning shall be performed according to the specification of the manufacturer.

4.1.8 The suit system shall be designed in such a way as to minimize the risk of snagging. Test in accordance with ISO 15027-3:2012, 3.10.

4.1.9 The suit system shall not contain or be accompanied by any component likely to injure or impede the user within the context of normal use. Test in accordance with ISO 15027-3:2012, 3.10.

4.1.10 A dry suit requires a tight fit around neck or face, wrists and ankles. This is tested in the leakage test (see 4.9).

4.2 Basic health and ergonomic requirements

4.2.1 Innocuousness

The suit system shall not adversely affect the health or hygiene of the user. The materials shall not, in the foreseeable conditions of normal use, release substances generally known to be toxic, carcinogenic, mutagenic, allergenic, toxic to reproduction or otherwise harmful.

NOTE 1 More information can be found in ISO 13688.

NOTE 2 Materials should be selected to minimize the environmental impact of the production and disposal of protective clothing (see ISO 13688:—, Annex F).

The examination, in combination with the following requirements in 4.2, shall determine whether the claim that the materials are suitable for use in the protective clothing or protective equipment is justified. Particular attention has to be paid to the presence of plasticizers, unreacted components, heavy metals, impurities and the chemical identity of pigments and dyes.

4.2.2 Design

4.2.2.1 The design of the suit system shall facilitate its correct positioning on the user and shall ensure that it remains in place for the foreseeable period of use, taking into account ambient factors, together with the movements and postures that the wearer could adopt during the course of work or other activity. For this purpose, appropriate means, such as adequate adjustment systems or adequate size ranges shall be provided so as to enable protective clothing to be adapted to the morphology of the user.

4.2.2.2 The design shall ensure that no parts of the body get uncovered by expected movements by the user (e.g. a jacket should not rise above the waist when the arms are raised). When testing according to ISO 15027-3:2012, 3.10 it shall be proven that the suit system can be put on and taken off easily; that arm and knee and bending movements are possible; that unprotected body areas do not appear during movements; that there is an adequate overlap of jacket and trousers; that the manufacturer's information is adequate to explain the correct usage.

4.2.2.3 The design of the suit system shall take into account other additional items to be worn with it. The appropriate level of protection shall be provided at interface areas, for example sleeve to hand protection, trouser to footwear, hood and respirator combinations; there may be other combinations.

4.2.3 Comfort

4.2.3.1 The suit system shall provide users with a level of comfort consistent with the level of protection against hazards for which it is provided, the ambient conditions, the level of the user's activity, and the anticipated duration of use of the protective clothing.

The suit system shall not

— have rough, sharp or hard surfaces that irritate or injure the user;

— be so tight, loose and/or heavy that it restricts normal movement.

4.2.3.2 If applicable, the suit system shall be made of materials with low water-vapour resistance and/or high air permeability and/or shall be sufficiently ventilated to minimize discomfort and thermal stress.

4.2.3.3 The suit system that imposes significant ergonomic burdens such as heat stress, or is inherently uncomfortable because of the need to provide adequate protection, should be accompanied by specific advice or warnings in the information supplied by the manufacturer. Specific advice on the appropriate duration for continuous use of the clothing in the intended application(s) should be given.

4.3 Gas or air inflation

If any part of the suit relies upon air or gas inflation in order to achieve the performance levels set out within this part of ISO 15027 then each part of the assembly — namely: oral inflation tubes, inflation operating head and the gas cylinder — shall meet the relevant requirements of ISO 12402-7.

The inflatable buoyancy chamber material shall meet the relevant requirement of ISO 12402-7:2006, 4.9.

4.4 Buddy lines

A buddy line, if provided, shall be made from synthetic cord or webbing and shall be at least 1 500 mm in length. The line shall have attached securely to the free end a releasable means for attachment to another person or object, such as a loop, a snap hook, or a wooden or plastic toggle. The buddy line, if provided, shall be readily accessible to at least one of the user's hands as confirmed during device testing. The attachment means and line shall be stowed in such a way that they do not create a hazard or affect the normal operation of the immersion suit. If hardware is provided as an attachment means, it shall not have sharp edges. The assembly shall float in fresh water. Hardware on the buddy line shall either not be broken, or if broken, not expose sharp edges after pull testing. Weathering testing is not required when the buddy line is normally stowed inside a pocket.

If provided, a buddy line of the length provided by the manufacturer shall be tested as indicated for an immersion suit in accordance with ISO 12402-9:2006, 5.5.1.5 and withstand a (750 ± 50) N load for at least 3^{+1}_{0} min without any damage. The force required to separate the buddy line from the suit shall be greater than 750 N and less than 1 500 N. The separation of the buddy line from the immersion suit shall not adversely affect the integrity of the immersion suit. This shall be verified by visual inspection.

The buddy line, if provided, shall be in accordance with ISO 12402-8:2006, 5.4.

4.5 Conspicuity

4.5.1 Colour

4.5.1.1 Where colour is required for search and rescue,

— the colour of the exposed portions (excluding components such as webbing, zips and other fittings) of the suit when deployed in the face-up floating position shall be in the colour range from yellow to red,

— the chromaticity coordinates for non-fluorescent colours shall lie within one of the areas defined in Table 1, and

— the luminance factor shall exceed the corresponding value in Table 1.

The chromaticity coordinates and the luminance factor for fluorescent colours shall comply with Table 2.

The face-up floating position is defined during in-water test according to ISO 15027-3:2012, 3.10.6.

Where colour does not aid search and rescue, other means of detection shall be provided.

4.5.1.2 The colour of the material samples shall be measured with the procedures defined in CIE 15:2004 with polychromatic illumination D65 and 45/0 geometry and 2° standard observer. The specimen shall have a black underlay with reflectance of less than 0,04. The specimens shall be conditioned for at least 24 h at (20 ± 2) °C and (65 ± 5) % relative humidity. If the test is carried out in other conditions, the test shall be conducted within 5 min after withdrawal from the conditioning atmosphere.

4.5.1.3 The colour fastness (dry and wet) of immersion suit material when determined in accordance with ISO 105-A02 shall be resistant to rubbing (wet and dry), when tested in accordance with ISO 105-X12 to at least step 4, and to salt water when tested in accordance with ISO 105-E02 to at least step 4.

Table 1 — Chromaticity coordinates *x* and *y* and luminance factor *β* for yellow, orange and red non-fluorescent colours of suit material

Colour	Chromaticity coordinates		Luminance factor
	x	*y*	*β*
Yellow	0,389 0,320 0,405 0,500	0,610 0,490 0,400 0,500	> 0,35
Orange	0,500 0,405 0,470 0,600	0,500 0,400 0,330 0,400	> 0,25
Red	0,610 0,470 0,525 0,700	0,400 0,330 0,270 0,300	> 0,15

Table 2 — Chromaticity coordinates *x* and *y* and luminance factor *β* for yellow, yellow-orange, orange, orange-red and red fluorescent colours of suit material

Colour	Chromaticity coordinates		Luminance factor
	x	*y*	*β*
Fluorescent yellow	0,380 0,320 0,370 0,440	0,610 0,490 0,440 0,550	> 0,60
Fluorescent yellow-orange	0,440 0,370 0,420 0,505	0,550 0,440 0,390 0,490	> 0,50
Fluorescent orange	0,505 0,420 0,460 0,575	0,490 0,390 0,350 0,425	> 0,40
Fluorescent orange-red	0,575 0,460 0,488 0,630	0,425 0,350 0,320 0,360	> 0,30
Fluorescent red	0,630 0,488 0,525 0,695	0,360 0,320 0,280 0,300	> 0,20

4.5.2 Retro-reflective material

A passive light system of retro-reflective material shall be provided. This shall conform to the specification detailed in IMO Resolution A.658(16), Annex 2. If it is the only light system, then a total area of not less than 400 cm^2 shall be provided. At least 100 cm^2 shall be affixed to the hood, if a hood is provided, and in addition at least 250 cm^2 shall be clear of the water and visible in the suit's normal in-water position as tested in ISO 15027-3:2012, 3.10.6.4.1. At least one piece of 50 cm^2 shall be affixed to the back of the suit.

The performance of the retro-reflective material shall not be degraded by the method used to apply it to the suit. Test in accordance with ISO 15027-3:2012, 3.10.6.4.2.

An active light system may also be provided. This shall conform to the requirements for emergency lights according to ISO 12402-8. When an active light system is provided, the area covered by the passive light system may be reduced, but a minimum of 300 cm^2 of the passive light system should always be provided. At least 100 cm^2 of this should be affixed to the hood, if a hood is provided, and 150 cm^2 clear of the water and visible in the suit's normal in-water position as tested in ISO 15027-3:2012, 3.10.6.4. At least one piece of 50 cm^2 shall be affixed to the back of the suit.

Alternative systems to provide conspicuity to assist search and rescue operations, such as combinations of active light systems (emergency lights) and passive light systems (retro-reflective material) will be acceptable if they meet the specifications for both emergency lights and retro-reflective material as defined above.

4.6 Foam flotation material

Foam flotation material used to assist the buoyancy performance of the suit system shall comply with ISO 12402-7:2006, 4.8.

4.7 Flammability

When tested in accordance with ISO 15027-3:2012, 3.5, the constant wear suit material shall neither be consumed nor sustain burning nor continue melting 6 s after being removed from the flames.

4.8 Temperature cycling

The suit system shall be resistant to damage caused by changes in ambient temperature.

After temperature cycling and donning in accordance with ISO 15027-3:2012, 3.9, the suit system shall show no visible damage to the external and internal construction components.

Additionally, after temperature cycling and donning, dry suits shall be subjected to the leak test in accordance with ISO 15027-3:2012, 3.7.

4.9 Leakage

The leakage of a dry suit system during jumping shall be measured in accordance with ISO 15027-3:2012, 3.7.1 and the mass of measured water shall not exceed 500 g.

The leakage of a dry suit system during swimming shall be measured in accordance with ISO 15027-3:2012, 3.7.2 and the mass of measured water shall not exceed 200 g.

4.10 Thermal protection in water

The suit system with the underclothing specified by the manufacturer or with standard underclothing according to ISO 15027-3:2012, 3.8.1.3 shall provide the user with thermal protection in a hydrostatical compressed state as defined by its flotation position. The thermal insulation of the dry underclothing shall be no more than 1 Clo, measured with the thermal manikin in air. This part of ISO 15027 recognizes the need for different levels of thermal protection depending upon the water temperature in which the suit will be used. The conditions of thermal protection are shown in Table 3. Testing shall be in accordance with ISO 15027-3:2012, 3.8. None of the six human test subjects' core temperatures shall fall more than 2 °C. Each human test subject's skin temperature shall not be lower than 10 °C for a time period of more than 15 min. If either of these two requirements is not fulfilled, the suit system shall be deemed to have failed.

NOTE See Annex A for more information on thermal protection time.

Table 3 — Test conditions for the different suit performance levels

	Suit performance level[a]			
	A	B	C	D
Period of immersion (h)	6	4	2	2
Water temperature (°C)	2	2	5	10

[a] Tests are performed in calm water. Rough conditions (e.g. wind, waves) will decrease the stated period of immersion.

There are two options for measuring the thermal protection provided that the results are equivalent:

a) using a thermal manikin, in accordance with ISO 15027-3:2012, 3.8.1;

   The validation of the thermal manikin test results shall be accompanied by an exchange of experience between the manikin testing laboratories based on round robin testing, and the correlation of results between the tests with human test subject and manikin.

b) using human test subjects, in accordance with ISO 15027-3:2012, 3.8.2.

4.11 Performance requirements

4.11.1 Walking

A user wearing the suit system correctly donned shall be able to walk easily as tested in accordance with ISO 15027-3:2012, 3.10.3.1.

4.11.2 Climbing

A user wearing the suit system correctly donned shall be able to climb freely as tested in accordance with ISO 15027-3:2012, 3.10.4.1.

4.11.3 Donning

The suit system shall be donned with all primary closures secured and any inflatable chambers inflated, if fitted. The donning shall be tested in accordance with ISO 15027-3:2012, 3.10.2.1 b) without any damage or impairment of the performance of the suit. The donning at (20 ± 2) °C shall be performed within 5 min. When the marking according to 5 c) 1) specifies the suit to be worn with a personal flotation device (PFD), the donning shall be performed with the uninflated PFD.

4.11.4 Dexterity and mobility

The suit system, when correctly donned and adjusted, shall not hinder the user's mobility, to be tested in accordance with ISO 15027-3:2012, 3.10.5.

4.11.5 Hand protection

When hand protection is part of the system, a person wearing a suit system correctly donned shall be able to remove the hand protection from storage and don the hand protection when tested in accordance with ISO 15027-3:2012, 3.10.6.2.2.

4.11.6 Jumping

A user wearing a suit system correctly donned shall be able to jump vertically feet first into water from a height of $(4{,}5^{+\,0{,}5}_{\;0})$ m without any operational damage to the suit system or injury to the user, when tested in accordance with ISO 15027-3:2012, 3.10.6.1. The leakage of a dry suit system during the jump shall be measured in accordance with ISO 15027-3:2012, 3.7.1. The mass of measured water shall not exceed 500 g and shall be used

as threshold value for the thermal test in accordance with ISO 15027-3:2012, 3.8. The user shall be able to secure any secondary suit closures (if fitted) within 2 min of entering the water. This shall be tested in accordance with ISO 15027-3:2012, 3.10.6.2.1. The suit shall not be damaged or dislodged in any way by the jump.

A user wearing the suit system shall not be injured by any part of the suit system as a result of the jump.

4.11.7 Boarding a platform

A user wearing a suit system correctly donned, with both primary and secondary (if fitted) closure systems secured, shall be able to swim and to board a platform. Test in accordance with ISO 15027-3:2012, 3.10.6.6.

4.11.8 Flotation and righting

4.11.8.1 Floating position

A user wearing a suit system correctly donned, with both the primary and secondary closure systems activated (if fitted), shall be able to adopt a face-up position in water in not more than 5 s and to remain in that position without any movement from the user when testing in accordance with ISO 15027-3:2012, 3.10.6.3. Where the constant wear suit system is claimed to provide flotation, the freeboard shall meet the requirements specified in the relevant part of ISO 12402 as applicable to the performance level of the suit system as specified by the manufacturer when tested in accordance with ISO 12402-9.

4.11.8.2 Avoiding entrapment

The buoyancy of a helicopter-transit-suit system and the underclothing shall be measured in accordance with ISO 15027-3:2012, 3.10.7.2 and be no more than 150 N to be achieved within 15 s of submersion with the suit fully vented.

NOTE This requirement is to prevent the entrapment of the user in the helicopter in an emergency.

4.11.9 Field of vision

The combination of a suit system and personal flotation device, if donned and adjusted, shall not prevent the user from having an acceptable field of vision, as tested in ISO 15027-3:2012, 3.10.6.5. With the heads of the seated or standing human test subjects in a fixed position when wearing an immersion suit correctly donned and adjusted, the lateral and the vertical field of vision shall be at least 120° when tested in accordance with ISO 15027-3:2012, 3.10.6.5. Accessories in accordance with ISO 12402-8 shall not prevent the user from having an acceptable field of vision.

4.11.10 Helicopter escape

During the escape procedure, no part of the suit shall cause a significant hindrance when tested in accordance with ISO 15027-3:2012, 3.10.7.1.

4.12 Requirements on materials, fabrics and components

4.12.1 Fuel resistance

Samples of material, fabrics and components of a constant wear suit shall withstand the tests in accordance with ISO 15027-3:2012, 3.4 after having been submitted to the temperature cycling in accordance with ISO 15027-3:2012, 3.9.

After the fuel resistance test, the tensile seam strength shall be at least 150 N in accordance with ISO 13935-2.

4.12.2 Resistance to illumination

Suit materials shall be tested for their resistance to illumination in accordance with ISO 105-B04. Illumination shall have a numerical rating of 5-6 with 1/2 unit tolerance. Materials which are screened by some form of cover when in normal use shall not undergo illumination testing.

4.12.3 Tensile strength of seams

The tensile strength shall be of at least 300 N per 25 mm width. The tensile strength shall be measured on separate samples using the grab method given in ISO 13935-2, using specimens of at least 60 mm width and with at least 100 mm of material on each side of the test point, with four similar seams for each type of seam including the seam between fastening devices (including zip fasteners) and fabric.

4.12.4 Coated fabrics

Coated fabrics shall comply with the following requirements.

a) Coating adhesion shall be tested in accordance with ISO 2411:2000 at 100 mm/min, and shall be not less than 50 N per 50 mm width.

b) Coating adhesion shall also be tested when wet following ageing in accordance with ISO 188, with an exposure of (336,0 ± 0,5) h in fresh water at (70,0 ± 1,0) °C, following which the method in ISO 2411:2000 shall be applied at 100 mm/min, and shall not be less than 40 N per 50 mm width.

c) Tear strength shall be tested in accordance with ISO 4674-1:2003, method A, and shall not be less than 25 N.

d) Resistance to flex cracking shall be tested in accordance with ISO 7854:1995, method A using 9 000 flex cycles, following which there shall be no visible cracking or deterioration.

e) Breaking strength shall be tested in accordance with ISO 1421:1998, Method 1 following conditioning of (24,0 ± 0,5) h at room temperature, and shall be not less than 200 N per 50 mm width when tested.

f) Breaking strength shall be tested in accordance with ISO 1421:1998, Method 1 following conditioning of (24,0 ± 0,5) h immersion in fresh water at room temperature, and shall be not less than 200 N per 50 mm width when tested.

g) Elongation at break shall be tested in accordance with ISO 1421:1998, Method 1 following conditioning of (24,0 ± 0,5) h at room temperature, and shall be not more than 60 %.

h) Elongation at break shall be tested in accordance with ISO 1421:1998, Method 1 following conditioning of (24,0 ± 0,5) h immersion in fresh water at room temperature, and shall be not more than 60 %.

4.12.5 Other fabrics

Other fabrics used in the construction of the component, the failure of which would render the entire item non-conformant with this part of ISO 15027, shall comply with the following requirements.

a) Breaking strength shall be tested in accordance with ISO 13934-1 following (24,0 ± 0,5) h conditioning at room temperature, and shall be not less than 10 N/mm.

b) Elongation at break shall be tested in accordance with ISO 13934-1 following (24,0 ± 0,5) h conditioning at room temperature, and shall be not more than 60 %.

c) Tear resistance shall be tested in accordance with ISO 13937-4, tensile speed (100 ± 10) mm/min, with a pretension of 2 N for materials of up to 200 g/m^2, 5 N for materials of over 200 g/m^2 and up to 500 g/m^2, and 10 N for materials of over 500 g/m^2, and shall be not less than 25 N. The mass per unit area of a fabric shall be measured in accordance with ISO 3801:1977, method 5.

4.12.6 Metal components

4.12.6.1 When tested in accordance with ISO 9227 using the neutral salt spray (NSS) for a period of 96 h, metal components shall not be significantly affected by corrosion. After the test, the components shall still operate as designed.

4.12.6.2 No component shall affect a magnetic compass of a type commonly used in small boats by more than 1 degree, when placed at a distance of 500 mm from it. Test in accordance with ISO 12402-9:2006, 5.4.

5 Marking

Each detachable part of the suit system shall be permanently and legibly marked with the following (which shall be given at least in the official language(s) of the country of destination):

a) identification of the manufacturer;

b) water temperature in which it is designed to operate;

c) one or more of the following statements as applicable:

   1) “WARNING: This suit system has to be worn with a personal flotation device according to ISO 12402-X.”

   NOTE Replace “X” by the relevant part of ISO 12402 for the personal flotation device recommended by the manufacturer.

   The manufacturer shall state the specific type(s) of PFD(s) (inflatable and/or inherent) to be worn with the suit system in order to consider the compatibility.

   2) “This suit system itself meets the performance requirements specified in ISO 12402-X in addition to ISO 15027-1.”

   NOTE Replace “X” by the relevant part of ISO 12402.

   3) “WARNING: This suit system will not turn an unconscious user to the face-up position.”

d) type of constant wear suit, being a dry- or wet-type suit system;

e) recommended size range, height and chest measurements in line with the recommendations laid down in EN 340;

f) storage, care, cleaning and maintenance instructions;

g) simple donning and use instructions;

h) manufacturer’s model designation, and quarter (or month) and year of manufacture and an individual serial number for the suit or batch of suits. Months are to be given as Arabic numbers (1…12), and quarters as Roman numbers (I…IV) in order starting from 1st January;

i) numbers of the Standards to which it conforms;

j) pictograms or words indicating other risks catered for;

k) compatibility with safety harnesses and other equipment as relevant;

l) required underclothing to be worn with the suit.

Information shall be given as pictograms or as text combined with pictograms, or, if defined pictograms do not exist, as text alone.

Any label bearing this information shall be permanently affixed to the suit system and withstand at least 10 cleaning cycles carried out in accordance with the manufacturer’s recommendations. The label shall remain legible.

6 Information supplied by the manufacturer

Each constant wear suit system shall be supplied with information written in at least the official language(s) of the country of destination. The information shall contain at least the following items:

a) items given in 5 a), 5 e) and 5 f) in full;

b) full donning and use instructions including the required underclothing to be worn with the suit system;

c) details of recommended limitations to use, including the temperature range for which the constant wear suit system was designed; any limitations shall be spelled out explicitly on warning labels;

d) “WARNING: The suit system may increase the risk of heat stress.”;

e) description of any spare parts and their replacement, and instructions for servicing and maintenance, and packing (if applicable);

f) names and addresses of manufacturer’s agents within at least the country of destination;

g) compatibility with safety harnesses and other equipment as relevant;

h) such other general advice on the care and use of constant wear suits as the manufacturers see fit.

For consumer choice the information label as shown in Figure 1 shall be presented at the point of sale.

7 Consumer information at point of sale

7.1 Data list

The following information in Figure 1 shall be given via a consumer information label:

a) designation of relevant International Standard;

b) type of suit;

c) application as written on the sample label;

d) performance classes A …D;

e) required underclothing to achieve or improve thermal protection;

f) size of suit;

g) special features (e.g. that the suit has to be used with a personal flotation device (PFD) of type xxx, that the suit performs itself as a PFD of type xxx, the use of additional items, etc.);

h) WARNING as given in the sample label.

Any information not listed in the above data list as well as the layout of the label is voluntary.

7.2 Consumer information label

In order to satisfy the requirements in 7.1 for consumer information, a uniform informative label is recommended. It shall be clearly visible when the suit is presented ready for sale, either by ensuring the visibility of the required marking on the suit itself or by labelling on the packaging. The label layout shown in Figure 1 constitutes an example for the layout of the label. It shall be presented at point of sale. The dimensions of the label shall not be less than 150 mm × 120 mm. Colours may vary, but shall always be contrasting to the background. If the recommended label as shown in Figure 1 is applied, data as specified in 7.1 shall be clearly marked in the box adjacent to the relevant feature to indicate its presence or quantity. The marking shall be made by a hook symbol.

Immersion suit according to ISO 15027-1 or ISO 15027-2								
Type of suit	**as Part 1**	constant wear suit			dry suit		wet suit	
	as Part 1	helicopter transit suit			dry suit		wet suit	
	as Part 2	abandonment suit			dry suit		wet suit	
PERFORMANCE Level		**A**		**B**	**C**		**D**	
Application		Protection against cold water depends on the insulation of the suit in correlation with water temperature. Thermal protection time provided by this suit can be identified from the table below:						
Period of immersion (h)		6		4	2		2	
Water temperature (°C)		2		2	5		10	
Required underclothing		*see instructions for use (system components)*						
Size of suit		*to be given by manufacturer/supplier*						
Body height / Waist		*to be given by manufacturer/supplier*						
Special features		*to be given by manufacturer/supplier*						

WARNING

Estimated thermal protection time according to performance level A ... D is based on standard testing conditions in accordance with ISO 15027-3.

Other environmental conditions and personal characteristics may change thermal protection time.

IN WATER PERFORMANCE	
This immersion suit does not turn the user into a safe face-up position in water.	
Protection against drowning may be achieved by the use of a personal flotation device approved to the appropriate level of performance in accordance with ISO 12402.	

Completion by ticking (✓) in relevant empty box and by adding appropriate text.

Figure 1 — Consumer information label

Annex A
(informative)

Guidelines for manufacturers, users, regulators and industrial inspectors about immersion suits with respect to the application of thermal protection times relevant to the ISO 15027 series

Immersion of a person in cool or cold water, accidentally or otherwise, carries the risk of harmful physiological effects which include cold shock, gasp reflex, hypothermia, unconsciousness and cardiac arrest, in addition to the obvious drowning hazard.

Immersion suits, as defined by ISO 15027-1, are intended to be worn by persons in circumstances where there is exposure to a risk of accidental immersion in water. Immersion suits are intended to provide thermal protection which will reduce or delay the harmful physiological effects and therefore extend the survival time of the wearer, thus providing emergency services with a greater opportunity to effect a rescue.

Unless the immersion suit has been additionally tested and certified as a lifejacket, protection against drowning may not be present and a suitable lifejacket will be required to be used in conjunction with the immersion suit. However, it should be noted that the air trapped in a suit will affect the performance of any lifejacket worn with the suit. Care should therefore be taken to ensure that the lifejacket and suit combination are compatible and that the lifejacket will turn the wearer to the face-up position.

The ISO 15027 series is general in nature, prescribing performance requirements only, rather than specifying any particular type or design of immersion suit for any particular application. There are extremely diverse considerations which will affect the selection of an immersion suit depending upon the application. The ISO 15027 series limits itself to differentiating suits only in terms of whether they are intended for constant wear (wearing the suit during normal activities for occupational or leisure applications, ISO 15027-1) or abandonment (suitable for emergency donning when being forced to abandon the boat, ship or other offshore installation, ISO 15027-2) and the degree of thermal protection provided.

The ISO 15027 series is mainly intended to define protection requirements where hypothermia is identified as the major risk. Other risks such as cold shock or the gasp reflex are highly influenced by an individual's physical condition and fitness. Those conditions are difficult to reproduce and are not part of the test sequence for a type approval. It can be assumed that an improvement of the level of thermal protection provided by an immersion suit will also minimise the risk of cold shock. Cold shock will also be reduced by increasing the area of skin protected from cold water exposure.

Hypothermia protection is normally provided in immersion suits by thermal insulation. Higher values of insulation indicate greater levels of protection, leading to longer survival times in water at any given temperature.

The thermal protection performance of a suit can be measured either by testing using human test subjects or by the use of thermal manikins. Human testing provides rather inconsistent results due to the variability of human test subjects, the results being affected by factors such as gender, body build, subcutaneous fat, physical fitness, and previous exposure to cold. The use of a thermal manikin could help to reduce variability, but differences in the design and functioning of the different manikins currently available means that it may still be difficult to achieve reproducible results between test laboratories. Work is therefore progressing to demonstrate the validity and reproducibility of testing using thermal manikins. Meanwhile the ISO 15027 series relies on testing with human test subjects. Thermal performance tests are specified in ISO 15027-3, taking care of the safety of the human test subjects by medical check-up, monitoring, reporting and supervision of these tests by a physician. Test laboratories must select human test subjects with varying body builds to ensure that the test results reflect the user population.

The prediction of "survival potential" for a person wearing an immersion suit is very complex and depends on a number of highly variable factors. These include both water temperature and sea state. Rough water and breaking waves will increase the risk of drowning throughout the period of immersion. The immersion suit may provide only limited protection from the risk of drowning. Cold water temperatures will greatly increase the risk

of cold shock during the first few minutes of immersion, and the gradual development of hypothermia (defined as a deep body temperature below 35 °C).

The level of thermal protection provided by an immersion suit will depend upon the type, design and performance level of the immersion suit, as well as the size, weight, general fitness and physiology of the individual. Consideration may also be given to the body build of the suit wearer, as a thin individual will cool much more rapidly than an individual with a good layer of body fat. The greater the area of skin covered by the suit, the greater should be the level of protection from cold shock. Protection from body cooling and the development of hypothermia is provided by the insulative value of the immersion suit itself, and the insulation of the clothing worn under the suit, as long as the clothing remains dry. This part of ISO 15027 allows for both 'dry' and 'wet' suits. Dry suits are designed to be sealed, preventing water entry into the suit as far as is possible. The insulation of the suit is provided by the material from which the suit is made and the clothing worn under the suit. Maximum levels of insulation are achieved when the suit remains dry inside. While small amounts of water entry will not have a significant effect upon body cooling, significant water entry, particularly over the body trunk area, will reduce the effective insulation of the suit, thereby reducing the level of thermal protection provided. Dry suits may be either insulated or uninsulated. Insulated dry suits are made from a material with inherent insulation and it is generally the case that the thicker the material, the greater the level of insulation provided. Uninsulated suits are made from a material with little inherent insulation, relying on the insulation provided by the clothing worn under the suit to provide insulation. Wet suits are usually made from a material with inherent insulation, but allow water to enter the space between the suit and the body surface. Wet suits thus largely rely upon the insulation of the suit material alone. Due to the initial entry of water into the suit, wet suits provide very limited protection from cold shock. If a wet suit is close fitting, the water trapped under the suit will warm up with time, allowing levels of thermal protection to be maintained thereafter. A poorly fitting or damaged wet suit will allow water to flush in and out of this layer, greatly reducing the level of thermal protection offered by such a suit.

The thermal protection time referred to in this part of ISO 15027 relates to the time that suit users might be expected to survive without suffering from an irreversible fall in deep body temperature. Generally a body temperature of 35 °C is considered to be survivable, although mental and physical performance will be impaired. With the development of hypothermia, the victim becomes increasingly incapacitated. As body temperature falls below 34 °C, consciousness may be lost, leading to drowning.

When immersion suits are tested in accordance with ISO 15027-3, thermal performance is measured by immersing human test subjects in calm stirred water at a given temperature. Dependent upon the suit performance level, the deep body temperature must not fall more than 2 °C, and skin temperature must not decrease below 10 °C for more than 15 minutes, during the period of immersion shown in Table A.1. The aim of this is to ensure that for the period of time and water temperature specified, the user of a suit should not be at risk of developing hypothermia.

Table A.1 — Test conditions for the different suit performance levels

	Suit thermal performance level			
	A	B	C	D
Period of immersion (h)	6	4	2	2
Water temperature (°C)	2	2	5	10

Tests are performed in calm water. Rough conditions (e.g. wind, waves) will decrease the stated period of immersion.

These tests are conducted under controlled conditions in calm water. When considering the likely performance of the suit system under realistic conditions, other factors must be taken into account.

Consideration must be given to the fact that the thermal performance of a suit will be impaired by wave action, with higher levels of heat loss under these conditions compared to calm water. The risk of water leakage will also increase under these circumstances. Use of a suit in potentially rough or offshore environments will therefore indicate the need for a higher level of thermal performance to achieve the same level of thermal protection.

When used offshore or in circumstances where help is not close at hand, consideration must also be given to likely rescue times. A margin of safety is needed to ensure that thermal protection times exceed the likely rescue time.

Manufacturers have to take these effects in consideration when evaluating the predicted time of survival using a risk assessment.

It is obviously desirable for the victim of accidental cold water immersion to be provided with the highest level of protection attainable. However, it is in the nature of thermal insulation to be bulky and encumbering, to the extent that the wearer may be prevented from carrying out their normal and essential functions. In the case of a constant wear suit, it might not be unusual for immersion suits providing the highest level of insulation to be totally impractical for many functions. Therefore when specifying the required level of immersed insulation for any particular application, due consideration should be given to the level of activity expected or the work environment. When selecting a constant wear suit, the problem of heat strain during normal activities has also to be taken into account. The more insulation provided in a suit to protect from cold immersion, the greater the heat strain that may be experienced if the wearer is active or if the suit is normally being worn for use in a warm air environment. A balance must therefore be achieved to provide sufficient protection in the event of accidental immersion whilst not causing thermal discomfort during constant use.

A full risk assessment must therefore be undertaken when selecting an immersion suit to ensure that all conditions of use have been considered and that an appropriate level of protection is provided to the user.

Bibliography

[1] ISO 13688:—[4], *Protective clothing — General requirements*

4) To be published. Revision of ISO 13688:1998.

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