INTERNATIONAL STANDARD

ISO 12402-10

Second edition
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Personal flotation devices —

Part 10: Selection and application of personal flotation devices and other relevant devices

Équipements individuels de flottabilité —

Partie 10: Sélection et application des équipements individuels de flottabilité et d'autres équipements pertinents

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

This document was prepared by Technical Committee ISO/TC 188, Subcommittee *Small craft*, SC 1, *Personal safety equipment*.

This second edition cancels and replaces the first edition (ISO 12402-10:2006), which has been technically revised.

The main changes compared to the previous edition are as follows:

— the document has been updated to be consistent with ISO 12402-2:2020 to ISO 12402-9:2020 (second editions).

A list of all parts in the ISO 12402 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

ISO 12402 (all parts):2020 has been prepared to give guidance on the design and application of personal flotation devices (hereafter referred to as PFDs) and immersion suits according to ISO 15027 (all parts):2012. This document deals with personal floatation devices for persons engaged in activities, whether in relation to their work or their leisure, in or near water. PFDs manufactured, selected, and maintained to this International Standard give a reasonable level of safety against drowning.

Based on a risk assessment, a PFD according to ISO 12402 (all parts):2020 can be used in combination with other personal protection equipment (PPE) according to the European PPE Regulation (EU) 2016/425.

ISO 12402 (all parts):2020 and ISO 15027 (all parts):2012 neither cover life saving appliances (LSA) on commercial vessels, which are regulated by the International Maritime Organisation (IMO)[1)] under the International Convention for the Safety of Life at Sea (SOLAS), nor devices used in aircraft, which are under IATA rules. All those devices are equipment on board used in case of emergency and not suitable for permanent use.

Rescue devices, throwable devices and flotation cushions are also not covered in ISO 12402 (all parts):2020.

Devices under ISO 12402-2:2020 to ISO 12402-10:2020 and ISO 15027-1:2012 to ISO 15027-3:2012 are regarded as personal protective equipment.

Performance criteria

PFDs can be divided into the following two main classes, based on their performance:

— **lifejackets,** providing face-up in-water support to the user regardless of physical conditions, and

— **buoyancy aids,** requiring swimming and other movements to keep the user with airways free out of the water.

"Buoyancy" is a main criterion to meet those basic performances.

The ISO 12402 series:2020 encourages manufacturers to adopt innovative designs of PFDs providing buoyancy by a wide variety of materials, devices and performance levels.

Buoyancy can be provided by means requiring preparation before entering the water (e.g. inflation of chambers by gas) or inherent materials.

"Inherently buoyant" provide permanent buoyancy; the user needs only to don the PFD to achieve full performance.

"Inflatable PFDs" provide full buoyancy without further intervention other than arming. They can be operated in fully automatic mode or require initiating the inflation (manual mode).

"Hybrid PFDs" provide some minimum inherent buoyancy but rely on additional inflatable buoyancy, such as inflatable PFDs, to achieve full buoyancy.

1) The International Maritime Organization (IMO) is an institution with domicile in London issuing regulations which are then published as laws by its Member States.

Personal flotation devices —

Part 10:
Selection and application of personal flotation devices and other relevant devices

1 Scope

This document provides requirements and recommendations for the selection and application of both personal flotation devices (PFD) complying with the relevant Parts of the ISO 12402 series:2020, and immersion suits according to ISO 15027 (all parts):2012.

It is intended to assist manufacturers, suppliers, users and regulators in the appropriate selection and application of those garments for the circumstances in which they will be used.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 12401:2009, *Small craft — Deck safety harness and safety line — Safety requirements and test methods*

ISO 12402-2:2020, *Personal flotation devices — Part 2: Lifejackets, performance level 275 — Safety requirements*

ISO 12402-3:2020, *Personal flotation devices — Part 3: Lifejackets, performance level 150 — Safety requirements*

ISO 12402-8:2020, *Personal flotation devices — Part 8: Accessories — Safety requirements and test methods*

ISO 12402-9:2020, *Personal flotation devices — Part 9: Evaluation*

ISO 15027-1:2012, *Immersion suits — Part 1: Constant wear suits, requirements including safety*

ISO 15027-2:2012, *Immersion suits — Part 2: Abandonment suits, requirements including safety*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15027-1:2012 and the following apply.

Where terms are defined below and in ISO 15027-1:2012, the definitions given below apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
personal flotation device
PFD
garment or device which, when correctly worn and used in water, provides the user with a specific amount of buoyancy which increases the likelihood of survival

3.2
inherently buoyant
permanently less dense than water

3.3
automatic inflation
inflation of the *PFD* (3.1) without the user carrying out any action at the time of water immersion

3.4
emergency position indicating light
device which emits light so as to increase the chances of a user being located

3.5
multi-chamber buoyancy system
PFD (3.1) with buoyancy to meet the applicable PFD performance requirement provided by two or more independent chambers

Note 1 to entry: This excludes supplemental inflation chambers.

3.6
deck safety harness
device that allows a user to be securely attached to a strong point on a vessel or on shore, preventing a fall into the water or, if falling occurs, preventing separation from the vessel or shore

3.7
buddy line
length of cord which can be tied or otherwise fixed to another person or to that person's *PFD* (3.1) 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

3.8
lifting loop
device which facilitates manual recovery of a person from water

3.9
protective cover
cover that is normally in place over the functional elements of a *PFD* (3.1) in order to protect them from physical damage, or snagging on external objects

Note 1 to entry: The protective cover may be designed to provide additional properties, i.e. to make the PFDs suitable for use when the subject is exposed to additional hazards, e.g. significant abrasion, molten metal splash, flame and fire.

Note 2 to entry: The inflatable chamber of an inflatable PFD is an example of a functional element.

3.10
whistle
device which, when blown by mouth, produces an audible sound which can aid in the location of the user

3.11
hybrid PFD
PFD (3.1) of combined buoyancy types, i.e. inherent and inflatable

3.12
sheltered waters
water with protection from significant breaking waves, current, or strong winds, where the possibility of being blown or carried away from shore or a place of safety is minimal

3.13
offshore
water that is unprotected and influenced by a variety of threat conditions such as waves, tide, currents, or wind, at sea or on inland waters

4 Classification; risks and recommended areas of application

4.1 General

ISO 12402-2:2020 to ISO 12402-9:2020 have been developed to set safety requirements and test methods for PFD and to support design and application of PFDs for persons engaged in activities, related to their work or their leisure, in or near water.

A system of various classes and performance levels (see 4.4 and Figure 1) has been established to serve the numerous needs.

The buoyancy of the device is the physical quantity determining its performance level. With regard to the recommended basic application, both the conditions of environment (offshore, near shore, etc.) and the type of clothing worn are the overriding criteria for the selection of PFDs.

The fundamental distinction between lifejackets and buoyancy aids divides the system. Lifejackets provide face-up in-water support in case of unconsciousness in most conditions appropriate to their level. Buoyancy aids require active movements from the user to keep their airway clear of the water.

Figure 1 illustrates a PFD label that conveys this information in plain text. Marking information displaying the same information is shown in Figure 2.

PFDs manufactured, selected, and maintained in accordance with the relevant part of the ISO 12402 series:2020 give a reasonable assurance of safety from drowning to a person who is immersed in water.

None of the PFDs however guarantee rescue.

They are always to be seen as means to reduce the risk of drowning.

PFDs can be provided in a wide variety of materials or designs. Some can require preparation before entering the water, e.g. inflation of a chamber by gas from a cylinder.

PERSONAL FLOTATION DEVICE	ISO 12402-2 to ISO 12402-6		
Application	Performance level		(2)
Offshore, extreme conditions, special protective clothing, heavy equipment	lifejackets	275	(3)
Offshore, heavy weather clothing		150	(4)
Sheltered waters, light clothing		100	(5)
Swimmers only, sheltered waters, help at hand, limited protection against drawing, not a lifejacket	buoyancy aids	50	(6)
Special application device	all performance levels		(7)
Manufactured by: ..... , ... :			(8)
WARNING: FLOTATION DEVICES ONLY REDUCE THE RISK OF DROWNING THEY DO NOT GUARANTEE RESCUE			(9)

Figure 1 — Label specification

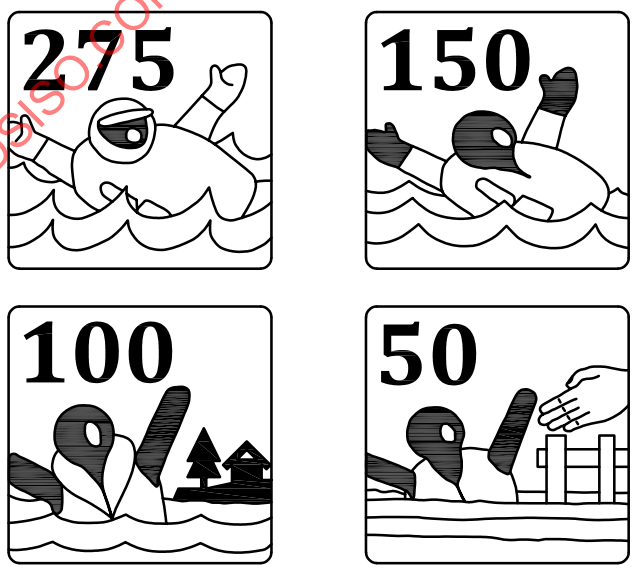

Figure 2 — Marking information

4.2 Performance criteria

Lifejackets and buoyancy aids according to ISO 12402 (all parts):2020 cover a number of performance levels, which require a suitable type of buoyancy, activation methods for inflatable devices, and auxiliary items (such as location aids). The selection of products should be based on a risk evaluation considering the following factors, which will affect the user's probability of survival.

Automatically operating PFDs should be required and worn in activities where persons are likely to enter the water unexpectedly.

Manual-only operated PFDs should be used only under certain circumstances, allowing for sufficient time to activate the PFD, and with either prior training of the user or help close at hand.

In any case, the user shall ensure that the operation mode of the PFD is suited to the specific application.

The required inspection and maintenance is another factor to be regarded for the choice and application of specific PFDs.

The conformity of a PFD to ISO 12402 (all parts):2020 does not imply that its performance is appropriate to all possible situations.

This document is intended to guide and encourage manufacturers, purchasers, and users to choose the safety equipment providing an effective level of performance in practical use.

It encourages designers to create a comfortable and attractive device for continuous wear on or near water, rather than to be stored in a locker for emergency use.

PFDs shall also fit to the different applications and uses by supporting a reasonable safety.

PFDs under ISO 12402 (all parts):2020 offer the following alternatives to manufacturers, designers and users:

— provision of different levels of buoyancy (levels 100, 150, or 275), that generally float the user with greater freeboard to ensure a safe floating position, or use of buoyancy aids (level 50) for activities requiring good mobility as in leisure activities such as canoeing or wake boarding for people with swimming capability;

— provision of different methods of buoyancy (inherently buoyant material, hybrid or inflatable devices) to accommodate the needs of reliability and durability, in-water performance, and continuous wear;

— provision of automatically operating (inherently buoyant or automatically inflated) PFDs to float users without any intervention except an initial donning (regular inspection and rearming of inflatable types requested) covering the risk of unexpected immersion;

— provision of controlled inflation by manual and oral operation for special application only, based on a risk assessment requiring special training of the user;

— assistance in detection, rescue and recovery by additional active (lights, radio beacon etc.) or passive (retroreflective materials) location aids;

— provision of attachment devices, like lifting loops and buddy lines to ease recovery.

4.3 Interaction with other devices or equipment

PFDs, in their effectiveness as personal protective equipment, shall provide the performance level (see 4.4) for the intended use, but also shall be lightweight and only as bulky and restrictive as needed. This requires PFDs in accordance to ISO 12402 (all parts):2020 to be safe when worn and to provide positive support in the water.

Under certain environmental conditions, such as rough water, waves and water spray,

— the use of watertight or multilayer clothing, creating additional buoyancy by trapped air and impeding the self-righting action of a lifejacket, or

— the use of equipment with additional weight or counteracting buoyancy (such as tool belts),

alter the performance of the PFD.

Inflation devices and inflation time can be influenced by extreme temperature.

The exposure to chemical substances or to effects caused by mechanical work, such as welding, requires additional protection of the PFD to cover those specific uses and applications as listed above.

A PFD under ISO 12402 (all parts):2020 may also be an integral part of a safety harness designed to conform to ISO 12401:2009 or equivalent industrial harnesses.

Furthermore, the PFD may be used with, or be an integral part of, a garment with other uses, for example an immersion suit for thermal protection according to ISO 15027 (all parts):2012.

In those applications, the complete assembly as used is required to conform to ISO 12402 (all parts):2020.

4.4 Performance levels

4.4.1 Level 50

This level is intended for use by those who have help or a means of rescue close at hand, and who are able to swim. This device often has minimal bulk, but requires active participation by the user and cannot be expected to keep the user safe for a long period of time.

As tested in swimming attire (when fully inflated, if inflatable) the device helps to support the user in a position with the mouth and nose clear of the water. It can support a fully clothed user in this position.

4.4.2 Level 100

This level is intended for use in sheltered or calm water, where users may have to wait for rescue.

As tested in swimming attire (when fully inflated, if inflatable) the device has some turning ability to bring the user into a position with the mouth and nose clear of the water. It is intended to maintain a fully clothed user in this position without active participation.

4.4.3 Level 150

This level is intended for general, offshore, and rough water use.

As tested in swimming attire (when fully inflated, if inflatable) the device is capable of turning an unconscious user into a position with the mouth and nose clear of the water. It is intended to maintain a fully clothed user in this position without active participation.

4.4.4 Level 275

This level is intended primarily for offshore use under severe weather or sea conditions. It is of value to those who are wearing clothing which traps air and adversely affects the self-righting capacity of the lifejacket. It is also intended for a user who requires a high level of buoyancy, for example when carrying heavy objects.

As tested in swimming attire, (when fully inflated, if inflatable) it is capable of turning an unconscious user into a position with the mouth and nose clear of the water. It is intended to maintain a fully clothed user in this position without active participation.

4.5 Selection and use

PFDs according to ISO 12402 (all parts):2020 offer different levels of buoyancy, performance and use. By allowing intermediate steps within the range of each performance level, there is the opportunity to design and manufacture PFDs which meet the diverse needs of commercial applications or for participating in leisure activities in or on water.

Before purchasing a lifejacket or buoyancy aid, the users shall evaluate the risks to which they would likely be exposed. Risks of sudden immersion due to falls overboard or capsizing or caused by an accident have to be taken into account.

When selecting a PFD, the users, owner organisations, employers and regulators have to ensure that those aspects are taken into account, based on a risk assessment.

The length and conditions of service, individual use and storage of the PFD should also be considered.

These conditions are the responsibility of the owner, user and/or employer but should be evaluated by the manufacturer and shall be part of a risk assessment.

It is essential to choose a PFD that meets the performance level corresponding to its intended use.

Manufacturers, sellers and retailers have to provide information about the product properties, offer alternative choices and clearly spell out the limitations of normal use, prior to purchase of the PFD.

Associations, societies and regulators considering the use of PFDs shall consider the most appropriate PFD for the foreseeable conditions in use, also considering higher risk circumstances such as the probability of accidental immersion and the expected consequences in the case of an emergency. Such evaluations should be based on a risk assessment.

Figure 3 illustrates a PFD label with information for its selection.

PERSONAL FLOTATION DEVICE		ISO 12402-2 to ISO 12402-6
Application		Performance level
Offshore, extreme conditions, special protective clothing, heavy equipment	lifejackets	275
Offshore, heavy weather clothing	lifejackets	150
Sheltered waters, light clothing	lifejackets	100
Swimmers only, sheltered waters, help at hand, limited protection against drowning, not a lifejacket	buoyancy aids	50
Special application device		all performance levels
Manufactured by:		
WARNING: FLOTATION DEVICES ONLY REDUCE THE RISK OF DROWNING THEY DO NOT GUARANTEE RESCUE		

SPECIAL FAEATURES			Integrated emergency position–indicating light and spray hood					
SPECIAL APPLICATION			Use in extreme climate conditions (−50 °C)					
OPERATION MODE			DESIGN					
Auto-matically operating	Manually operated	Oral inflation	Multi-chamber system	Amount of inflatable buoyancy (N)	Amount of inherent buoyancy (N)	Integrated harness	Use with harness	
							yes	no
✓	✓			180	100	✓	✓	

Size	Chest (cm)	Body mass (kg)	Buoyancy for specified body mass (N)	
			Actual value	Nominal value
Medium		70	280	275

Figure 3 — Example of a PFD label with additional information for its selection

5 Essentials that should be observed

5.1 Personal flotation devices (PFDs)

5.1.1 General

The performance of a PFD can be altered when it is worn in addition to, or in combination with, other personal protective equipment (PPE) or additional components. For example, the interaction between protective clothing, in particular immersion suits, and PFDs shall be considered. The amount of buoyancy created from insulating material is always likely to be a problem.

Occupational use such as welding or other processes can damage the PFD. PFDs according to ISO 12402-2:2020 to ISO 12402-5:2020 are not intended for such specific applications. To assure their basic performance, the use of protective covers according to ISO 12402-6:2020 and multi-chamber buoyancy devices is encouraged; it is a requirement if any contact with corrosive or noxious chemicals are expected. The additional items detailed in ISO 12402-8:2020 are designed to cope with the most common hazards. PPE manufacturers should be informed by the purchaser of special circumstances to co-operate in specifying the equipment needed for such applications.

The PFD shall be worn when the risk of immersion is a possibility, preventing to enter into water without a PFD donned. This requires that the PFD does not hinder the mobility of the user and does not endanger the user's safety in other respects. Where working in confined spaces or where rigging or other elements can entrap, the PFD shall provide means to reduce snagging hazards and to provide easy removal. A cover as an additional item and quick release closures may be a solution. Inherently buoyant devices can be too bulky and risky as inflatable PFDs shall be required.

To minimize the risk of an accidental immersion, consideration shall, in general, first be given to technical means of protection, such as rails, safety harnesses or other technical solutions, before requiring the use of a PFD.

PFDs shall be simple to don and to doff. The relevant standards include timed tests for donning, but it can be necessary in certain circumstances to consider additional requirements. In special applications, the requirements to ensure rapid and reliable donning in complete darkness or in confined spaces or when using gloves or mittens have to be considered. Donning can also be affected by the compatibility of the PFD with other equipment. Those special applications have to be considered and trained with the dedicated user group.

Physical or environmental circumstances are also important for the selection of a PFD.

Inflatable PFDs stored or worn in temperatures below –5 °C can show a reduced inflation performance, the CO_2-inflation gas being adversely affected and inflation slowing down. Other components such as nylon poppers can become rigid and difficult to open.

Meeting the basic requirements of ISO 12402 (all parts):2020 ensures a reasonable performance of all PFDs in climates from tropical to cold temperate, except under extreme climatic conditions. Therefore, it is important to specify the lowest performance temperature to select the adequate PFD. Short day length in winter or reduced visibility, and current or rough waters can influence the tracking of a victim in emergency situations. Those circumstances require the use of emergency lights complying with ISO 12402-8:2020.

5.1.2 Risk assessment

Occupational health and safety guidelines, legal requirements such as the EU Directive for Occupational Health and Safety (89/391 EEC) and the EU Directive 89/656/EEC for the use of personal protective equipment in the workplace require a risk analysis that evaluates all surrounding conditions and influences. As a result, emergency management activities and the choice of adequate PPE will be required.

Contrary to popular belief that most cases of drowning result from hypothermia and exhaustion after a lengthy time in cold water, research has shown that the first seconds or minutes are most critical due to shock or cold shock responses of the body. Cardiac shock, inspiratory gasp, hyperventilation, uncontrolled cold shivering, disorientation, local confusion and amnesia or uncontrolled reactions under panic require that a PFD be worn.

Cold shock arises if water is below 15° C (cold water) or if the gradient between skin temperature and water is greater than 20° C.

All the effects mentioned above require that the PFD be effective and fully functional, rapidly after entry into the water.

Inflatable PFD's shall be of automatically operating type in case the user can enter cold water suddenly and unexpectedly or be in a disabled or unconscious condition.

Once the PFD has been properly armed, inspected and donned, it requires no further action by the user.

Once it has brought the user to the surface, an effective PFD then has to maintain the user in a safe face-up position.

Rough environment can counteract that ability, as explained in a) and b) below.

a) Waves washing over, and water-splash or spray entering the airways

   — High wind speeds and steeper waves increase the likelihood of water or splash entering the airways, so that even waves of only 30 cm height can threaten an unprotected airway and a spray hood becomes necessary. A spray hood is not required on inland waters; it shall be common at sea.

   — The orientation of the user with respect to waves is an important key of PFD design. A widely split front or keyholes for the head funnels water onto the face.

   — Independent from freeboard between mouth and waves, but related to wind forces, the face can be continually splashed resulting in inhalation of water and drowning.

b) Waves inverting the user

   — The self-righting ability of PFDs is of importance if an unconscious or disabled person is capsized. The buoyancy and the turning moment of a PFD could be inverted if air has been trapped in the clothing. Although lifejackets are tested in swimming costumes, experience has shown that a PFD performing well in these tests is generally good in its overall performance and offers a good stability.

c) With heavy weather gear or cold protection garment, a PFD according to ISO 12402-2:2020 shall be worn.

5.1.3 Interaction with clothing

The development of modern clothing systems for foul weather gear also creates the risk of trapped air, which can produce an unpredictable, counteracting buoyancy distribution in the clothing. This shall be given consideration when selecting a PFD in combination with this gear. If the manufacturer does not recommend a particular combination, a PFD according to ISO 12402-2:2020 shall be worn.

In particular, the selection of lifejackets to infants and children shall be given careful consideration. Counter buoyancy arising from diapers has led to accidents.

The anthropometric differences in the proportions of body configuration and centre of gravity shall be adopted by design.

5.2 Accessories

5.2.1 General

Performance, safety and quality of accessories shall comply with ISO 12402-8:2020, which specifies a selection of accessories from which optional items can be chosen to meet the specific applications and/or reduce risks.

5.2.2 Location aids

5.2.2.1 Emergency lights are an important active location aid during the hours of darkness, when visibility is reduced by rain or fog, or in rough waters. The required retroreflective tape can multiply the chances of detection as opposed to the use of one location aid alone.

5.2.2.2 Retroreflective tape is a required location aid for most devices. It has good but passive visibility. To allow for their location, the section of the retroreflective tape must be pointed at with a search light. This disadvantage minimises the effectiveness in darkness. Nevertheless, the retroreflective tape enforces even minimal light sources and should be used in combination with an emergency light.

5.2.2.3 Whistles are a useful location aid in all situations.

5.2.3 Improved design

5.2.3.1 Multi-chamber buoyancy systems can allow the lifejacket to perform even when one chamber is damaged, and can thus be of value in some occupational uses. Multi-chamber construction adds considerably to the cost and complexity of a lifejacket. Nevertheless, for special applications or in extreme conditions combined with the risk of wear and tear, such as offshore work, coastal fishing or pilot transfer, the responsible authorities should consider making the use of such jackets mandatory.

5.2.3.2 Protective covers are suitable for preventing damage to less robust lifejacket components, such as inflatable chambers and gas inflation heads. They also reduce snagging hazards. Protective covers should be used in addition against risks such as chemical fluids exposure, heat impact, molten metal splash due to welding, or the risks of firefighting. Protective covers can be used to provide tailor-made solutions for special applications. However, the correct functioning of the PFDs used in hazardous working environments shall not in any way be compromised by the use of such a cover.

5.2.4 Harnesses

5.2.4.1 Safety harnesses and lines conforming to ISO 12401:2009 or other industrial standards relevant for fall from a height are useful tools to reduce the risk of immersion. If they are to be used, they shall not compromise the performance of the lifejacket.

5.2.4.2 Buddy-lines are of value if a number of survivors are likely to be in the water together but unlikely to be able to enter a life raft. Buddy-lines can however pose snag and trip hazards.

5.2.5 Sprayhood

Sprayhoods are of important value in protecting the user's airways in rough water with spray, but add to the cost and complexity of the lifejacket. They should not trap water or restrict the user's vision excessively, and shall be easy to don and doff. Spray hoods complying with ISO 12402-8:2020 are tested to ensure that there is no excessive CO_2 build up within the hood.

5.3 Immersion suits

5.3.1 General

Immersion suits are intended to protect against cold shock, swimming failure and hypothermia.

Immersion of a person in water, accidental 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 in ISO 15027-1:2012 and ISO 15027-2:2012, are intended to be worn by persons in circumstances where there is exposure to a risk of immersion in water. Immersion suits according to ISO 15027-1:2012 — constant wear suits — are designed as work suit or cold weather gear for constant wear during activities on board or onshore and give protection in case of unexpected immersion. Suits according to ISO 15027-2:2012 — abandonment suits — offer a higher level of protection. They are intended to be worn in case of a predicted abandonment of a vessel or an offshore installation. They provide thermal protection reducing or delaying the harmful physiological effects, therefore extending the survival time of the user and providing emergency services with improved prospects for successful rescue.

Unless the immersion suit has been additionally tested and certified as a lifejacket, it will possibly not afford protection against drowning and a suitable lifejacket is required to be used in conjunction with the immersion suit. However, it should be noted that the air trapped in a suit affects the performance of any lifejacket worn with the suit. Care should therefore be taken to ensure that the lifejacket and suit combination is compatible and that the lifejacket turns the user into a face-up position.

ISO 15027-1:2012 and ISO 15027-2:2012 specify general requirements for immersion suits. They do not specify any particular type or design of immersion suit for any specific application.

There are extremely diverse considerations which can affect the selection of an immersion suit depending upon the application. ISO 15027-1:2012 and ISO 15027-2:2012 differentiate suits only in terms of whether they are intended for constant use (using the suit during normal activities for occupational or leisure applications) or for abandonment (suitable for emergency donning when being forced to abandon, for example, a boat, ship or offshore installation), and in terms of the degree of thermal protection provided.

The justification for using a constant wear suit would be to provide protection in the event of an accidental immersion, to prolong life and aid rescue. An individual's estimated thermal protection time when wearing this type of equipment depends upon the water temperature, weather conditions, clothing, the cold tolerance of the person and the person's behaviour. ISO 15027 (all parts):2012 specifies the minimum levels of insulation provided by the different ranges of suits in particular water temperatures.

ISO 15027 (all parts):2012 allows for the thermal protection to be provided by a variety of methods and materials, some of which can require action when the suit wearer enters the water (e.g. inflation of chambers by gas from a cylinder).

The compliance of a constant wear suit with ISO 15027 (all parts):2012 does not imply that it is suitable for all circumstances.

ISO 15027 (all parts):2012 cannot make detailed provision for all the special uses to which a constant wear suit can be put, such as special working conditions, i.e. slip resistance or fire resistance or special leisure applications.

ISO 15027 (all parts):2012 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 performance in use.

ISO 15027 (all parts):2012 recommends that designers encourage the wearing of this equipment by making them 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 self-propulsion of the user in the water and self-extrication from the water without the suit becoming an encumbrance;

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

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

A suit system may be comprised of one or more pieces provided that in all cases it meets the requirements of this document as a complete system.

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

5.3.2 Rationale

ISO 15027 (all parts):2012 is general in nature, prescribing performance requirements only, rather than specifying any particular type or design of immersion suit for any particular application.

ISO 15027 (all parts):2012 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 also minimises the risk of cold shock. Cold shock is also 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 by testing with either human test subjects or 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 due to differences in the design and functioning of the different manikins currently available, it is still difficult to achieve reproducible results between test laboratories. Work is therefore progressing to demonstrate the validity and reproducibility of testing using thermal manikins. Meanwhile, ISO 15027 (all parts):2012 relies on testing with human test subjects. Thermal performance tests are specified in ISO 15027-3:2012, taking care of the safety of the human test subjects through medical check-up, monitoring, reporting and supervision of these tests by a physician. Test laboratories shall 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 conditions at sea. Rough water and breaking waves increase the risk of drowning throughout the period of immersion. The immersion suit can provide only limited protection from the risk of drowning. Cold water temperatures 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 depends 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 should also be given to the body build of the suit wearer, as a thin individual will cool down 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 the level of protection from cold shock will also be expected. Protection from body cooling and the development of hypothermia is provided by the isolative value

of the immersion suit itself, and the insulation value of the clothing worn under the suit, as long as the clothing remains dry. ISO 15027 (all parts):2012 allows for both 'dry' and 'wet' suits. Dry suits are designed to be sealed so as to limit water entry into the suit as far as 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 do not have a significant effect upon body cooling, significant water entry, particularly over the body trunk area, reduce the effective insulation of the suit, thereby reducing the level of thermal protection provided. Dry suits can 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 warms up with time, allowing levels of thermal protection to be maintained thereafter. A poorly fitting or damaged wet suit allows 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 ISO 15027 (all parts):2012 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 is impaired. With the development of hypothermia, the victim becomes increasingly incapacitated. As body temperature falls below 34° C, consciousness can be lost, leading to drowning.

When immersion suits are tested in accordance with ISO 15027-3:2012, 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 shall not fall by more than 2° C, and skin temperature shall not decrease below 10° C for more than 15 min, during the period of immersion. 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. These tests are conducted under controlled conditions in calm water. When considering the likely performance of the suit system under realistic conditions, other factors shall be taken into account.

It requires that consideration shall be given to the fact that the thermal performance of a suit is impaired by wave action, with higher levels of heat loss under these conditions compared to calm water. The risk of water leakage also increases under these circumstances. Use of a suit in potentially rough or offshore environments therefore indicates the need for a higher level of thermal performance to achieve the same level of thermal protection. For use offshore or in circumstances where help is not close at hand, consideration shall also be given to likely rescue times. A margin of error is needed to ensure that thermal protection times exceed the likely rescue time.

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 it might prevent wearers 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 to the work environment. When selecting a constant wear suit, the problem of heat strain during normal activities shall also be taken into account. The more insulation provided in a suit to protect from cold immersion, the greater the heat strain that can be experienced if the wearer is active or if the suit is normally being worn for use in a warm air environment. A balance shall 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 shall 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.

6 Guidance for risk management

6.1 General

This guidance aims to assist decision makers to take the best risk-reducing actions available on exposure to drowning risk, and other consequences of unwanted water entry. In addition, it aims to optimize the use of PPE and PFDs as risk-managing measures.

6.2 Description of operation and environment

a) Define the actual operation/activity and state the objective for the organization and the individual, the responsibility and liability for the individual and for the organization. Show the operative and strategic decision-making process;

b) define the area of operation geographically. Describe the prevailing weather conditions with due regard to wind, waves, and water and air temperature. Identify search-and-rescue (SAR) resources and anticipated exposure time before rescue. List all other rescue resources available to estimate a conservative exposure time;

c) define the level of relevant training, fitness and age of exposed personnel. Define criteria for abortion of activity.

6.3 Identification of risk areas and establishment of safety levels

a) Define the areas and actions that induce risk of uncontrolled water entry;

b) define all potential water entry situations with regard to worst intended environmental exposure, conservative SAR time and post-rescue services;

c) define the target number of exposures, exposure times, and acceptable loss.

6.4 Guidance for the identification of risk managing measures

6.4.1 General

Risk management philosophy rests on three principles: reduction of frequency, reduction of consequence and systematic monitoring of effectiveness.

a) Identify the available measures to prevent identified risks for uncontrolled water entry;

b) identify the available measures to reduce identified consequences of uncontrolled water entry;

c) describe the applied system for management and control of safety level.

6.4.2 Measures to reduce risk

a) Safety awareness and risk knowledge;

b) abort activities under certain conditions;

c) identify physical barriers;

d) secure personnel with technical means like rails, lines and harnesses;

e) consider a safe job analysis.

6.4.3 Measures to reduce consequences

a) Perform emergency training;