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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

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 12402-10 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*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

ISO 12402 consists of the following parts, under the general title *Personal flotation devices*:

— *Part 1: Lifejackets for seagoing ships — Safety requirements*

— *Part 2: Lifejackets, performance level 275 — Safety requirements*

— *Part 3: Lifejackets, performance level 150 — Safety requirements*

— *Part 4: Lifejackets, performance level 100 — Safety requirements*

— *Part 5: Buoyancy aids (level 50) — Safety requirements*

— *Part 6: Special purpose lifejackets and buoyancy aids — Safety requirements and additional test methods*

— *Part 7: Materials and components — Safety requirements and test methods*

— *Part 8: Accessories — Safety requirements and test methods*

— *Part 9: Test methods*

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

Introduction

ISO 12402 has been prepared to give guidance on the design and application of personal flotation devices (hereafter referred to as PFDs) 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 standard should give a reasonable assurance of safety from drowning to a person who is immersed in water.

Requirements for lifejackets on large, commercial seagoing ships are regulated by the International Maritime Organisation (IMO) under the International Convention for the Safety of Life at Sea (SOLAS). ISO 12402-1 addresses lifejackets for seagoing ships.

ISO 12402 allows for the buoyancy of a PFD to be provided by a wide variety of materials or designs, some of which may require preparation before entering the water (e.g. inflation of chambers by gas from a cylinder or blown in orally). However, PFDs can be divided into the following two main classes:

— those which provide face up in-water support to the user regardless of physical conditions (lifejackets), and

— those which require the user to make swimming and other postural movements to position the user with the face out of the water (buoyancy aids).

Within these main two classes there are a number of levels of support, types of buoyancy, activation methods for inflatable devices, and auxiliary items (such as location aids), all of which will affect the user‘s probability of survival. Within the different types of buoyancy allowed, inflatable PFDs either provide full buoyancy without any user intervention other than arming (i.e. PFDs inflated by a fully automatic method) or require the user to initiate the inflation. Hybrid PFDs always provide some buoyancy but rely on the same methods as inflatable PFDs to achieve full buoyancy. With inherently buoyant PFDs, the user only needs to put the PFD on to achieve the performance of its class.

PFDs that do not require intervention (automatically operating PFDs) are suited to activities where persons are likely to enter the water unexpectedly; whereas PFDs requiring intervention (e.g. manually inflated PFDs) are only suitable for use if the user believes there will be sufficient time to produce full buoyancy, or help is close at hand. In every circumstance, the user should ensure that the operation of the PFD is suited to the specific application. The conformity of a PFD to this part of ISO 12402 does not imply that it is suitable for all circumstances. The relative amount of required inspection and maintenance is another factor of paramount importance in the choice and application of specific PFDs.

ISO 12402 is intended to serve as a guide to manufacturers, purchasers, and users of such safety equipment in ensuring that the equipment provides an effective standard of performance in use. Equally essential is the need for the designer to encourage the wearing of the equipment by making it comfortable and attractive for continuous wear on or near water, rather than for it to be stored in a locker for emergency use. Throwable devices and flotation cushions are not covered by this part of ISO 12402. The primary function of a PFD is to support the user in reasonable safety in the water. Within the two classes, alternative attributes make some PFDs better suited to some circumstances than others or make them easier to use and care for than others. Important alternatives allowed by ISO 12402 are the following:

— to provide higher levels of support (levels 100, 150, or 275) that generally float the user with greater water clearance, enabling the user’s efforts to be expended in recovery rather than avoiding waves; or to provide lighter or less bulky PFDs (levels 50 to 100);

— to provide the kinds of flotation (inherently buoyant foam, hybrid, and inflatable) that will accommodate the sometimes conflicting needs of reliability and durability, in-water performance, and continuous wear;

— to provide automatically operating (inherently buoyant or automatically inflated) PFDs that float users without any intervention on their part, except in initially donning the PFD (and regular inspection and rearming of inflatable types), or to provide user control of the inflatable PFD's buoyancy by manual and oral operation; and

— to assist in detection (location aids) and recovery of the user.

PFDs provide various degrees of buoyancy in garments that are light in weight and only as bulky and restrictive as needed for their intended use. They will need to be secure when worn, in order to provide positive support in the water and to allow the user to swim or actively assist herself/himself or others. The PFD selected shall ensure that the user is supported with the mouth and nose clear of the water under the expected conditions of use and the user's ability to assist.

Under certain conditions (such as rough water and waves), the use of watertight and multilayer clothing, which provide (intentionally or otherwise) additional buoyancy, or the use of equipment with additional weight (such as tool belts) will likely alter the performance of the PFD. Users, owners and employers need to ensure that this is taken into account when selecting a PFD. Similarly, PFDs may not perform as well in extremes of temperature, although fully approved under this part of ISO 12402. PFDs may also be affected by other conditions of use, such as chemical exposure and welding, and may require additional protection to meet the specific requirements of use. If the user intends taking a PFD into such conditions, she/he has to be assured that the PFD will not be adversely affected. This part of ISO 12402 also allows a PFD to be an integral part of a safety harness designed to conform to ISO 12401, or an integral part of a garment with other uses, for example to provide thermal protection during immersion, in which case the complete assembly as used is required to conform to this part of ISO 12402.

In compiling the attributes required of a PFD, consideration has also been given to the potential length of service that the user might expect. Whilst a PFD needs to be of substantial construction and material, its potential length of service often depends on the conditions of use and storage, which are the responsibility of the owner, user and/or employer. Furthermore, whilst the performance tests included are believed to assess relevant aspects of performance in real-life use, they do not accurately simulate all conditions of this. For example, the fact that a device passes the self-righting tests in swimming attire, as described herein, does not guarantee that it will self-right an unconscious user wearing waterproof clothing; neither can it be expected to completely protect the airway of an unconscious person in rough water. Waterproof clothing can trap air and further impede the self-righting action of a lifejacket.

It is essential that owners, users and employers choose those PFDs that meet the correct standards for the circumstances in which they will be used. Manufacturers and those selling PFDs have to make clear to prospective purchasers the product properties, alternative choices and the limitations to normal use, prior to the purchase.

Similarly, those framing legislation regarding the use of these garments should consider carefully which class and performance levels are most appropriate for the foreseeable conditions of use, allowing for the higher risk circumstances. These higher risk circumstances should account for the highest probabilities of occurrence of accidental immersion and the expected consequences in such emergencies.

Personal flotation devices —

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

1 Scope

This part of ISO 12402 gives guidance for the selection and application of personal flotation devices complying with the other relevant parts of ISO 12402 and immersion suits according to ISO 15027-1 to ISO 15027-3.

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.

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

ISO 12402-1, *Personal flotation devices — Part 1: Lifejackets for seagoing ships — Safety requirements*

ISO 12402-2, *Personal flotation devices — Part 2: Lifejackets, performance level 275 — Safety requirements*[1)]

ISO 12402-3, *Personal flotation devices — Part 3: Lifejackets, performance level 150 — Safety requirements*[1)]

ISO 12402-4, *Personal flotation devices — Part 4: Lifejackets, performance level 100 — Safety requirements*[1)]

ISO 12402-5, *Personal flotation devices — Part 5: Buoyancy aids (level 50) — Safety requirements*[1)]

ISO 12402-6, *Personal flotation devices — Part 6: Special purpose lifejackets and buoyancy aids — Safety requirements and additional test methods*[1)]

ISO 12402-7, *Personal flotation devices — Part 7: Materials and components — Safety requirements and test methods*[1)]

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

ISO 12401-9, *Personal flotation devices — Part 9: Test methods*[1)]

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

1) To be published.

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

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

International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended, International Maritime Organization[2)]

3 Terms and definitions

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

NOTE The terms and definitions from ISO 15027-1 are reproduced in Annex A for the convenience of the user. Where terms are defined below and in ISO 15027-1, the definitions given below apply.

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

3.2
inherently buoyant material
material which is permanently less dense than water

3.3
automatically operating PFD
PFD in which buoyancy is provided by permanent means (inherently buoyant material) or by suitable means (gas inflation) effected by a system which automatically activates upon immersion and which, except for the inspection and rearming of inflatable types, when correctly donned requires no further action by the user

3.4
automatically inflated PFD
PFD in which inflation is effected as a result of immersion without the user carrying out any action at the time of immersion

3.5
manually inflated PFD
PFD in which inflation is effected as a result of the user operating a mechanism

3.6
orally inflated PFD
PFD inflated by mouth to produce buoyancy

3.7
PFD with secondary donning
PFD for which additional donning or adjustment that is needed to place the PFD in its functioning position from the position it is normally worn

NOTE Pouch-type devices are examples of the type of PFDs which usually require such additional positioning.

3.8
vest-type PFD
PFD covering the upper trunk of the user like a vest

2) IMO is an institution with domicile in London issuing regulations which are then published as laws by its Member State.

3.9
yoke-type PFD
PFD worn around the neck and secured by a waist strap

3.10
emergency light
device which emits light so as to increase the chances of a user being located

3.11
multi-chamber buoyancy system
system that divides the buoyancy provided by an inflatable lifejacket into two or more separate compartments, such that if mechanical damage occurs to one, others can still operate and provide buoyancy so as to aid the user when immersed

3.12
deck safety harness and safety line
device that allows a user to be securely attached to a strong point on a vessel or on shore, so as to prevent him from falling into the water, or, if he does fall into the water, to prevent him from being separated from the vessel or shore

3.13
buddy line
length of cord which can be tied or otherwise fixed to another person or to that person's PFD 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

3.14
lifting loop
device which facilitates manual recovery of a person from water

3.15
sprayhood
cover brought or placed in front of the airways of a user in order to reduce or eliminate the splashing of water from waves or the like onto the airways and thereby to promote the survival of the user in rough water conditions

3.16
protective cover
cover that is normally in place over the functional elements of a PFD in order to protect them from physical damage, or snagging on external objects

NOTE 1 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 The inflatable chamber of an inflatable PFD is an example of a functional element.

3.17
overpressure relief valve
valve which may be used in an inflatable system to avoid the likelihood of destruction caused by overpressure

3.18
whistle
device which, when blown by mouth, produces an audible sound which can aid in the location of the user

3.19
hybrid-type PFD
PFD of combined buoyancy types, i.e. inherent and inflatable

4 Classification, risks and recommended areas of application of PFDs

4.1 General

ISO 12402-1 to ISO 12402-9 have been developed to set minimum safety requirements and test methods for PFDs as well as to give support for design and application of PFDs for persons engaged in activities, whether in relation to their work or leisure, in or near water.

Requirements for lifejackets on large, commercial seagoing ships are regulated by the International Maritime Organization (IMO) under the *International Convention for Safety of Life At Sea* (SOLAS). IMO/SOLAS requires such ships to have primary lifesaving appliances — lifeboats and/or liferafts — which are intended to allow those onboard to evacuate the ship dry. SOLAS lifejackets are therefore backup equipment and designed to be compatible with the primary lifesaving appliances. ISO 12402-1 is intended for evaluation of lifejackets which may comply with SOLAS regulations.

A system of various classes and performance levels (see 4.3 and Figure 1) was established to serve the numerous needs. The buoyancy of the device is the ruling factor to indicate performance level. With regard to the recommended standard application, the conditions of location (offshore, near shore, etc.) in which the PFD will be used and the type of clothing worn are the overriding criteria for the range of PFDs. The fundamental distinction between lifejackets and buoyancy aids divides the system into PFDs which are more suitable in the case of an unconscious victim and those which are more likely to be used but may require more effort by the victim to keep the airway clear of the water. Figure 1 conveys this information in a plain text version. Pictograms visualizing this information are shown in Figure 2. PFDs manufactured, selected, and maintained in accordance with the relevant part of ISO 12402 shall be used to provide 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 design. Some of them may require preparation before entering the water, e.g. inflation of chamber by gas from a cylinder or blown in orally.

Lifejackets provide face-up in-water support to the user in most conditions appropriate to their level. Buoyancy aids require the user to be conscious to orientate herself/himself with the face out of the water.

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, foul weather clothing	lifejackets	150	(4)
Sheltered waters, light clothing	lifejackets	100	(5)
Swimmers only, sheltered waters, help at hand, limited protection against drowning, not a lifejacket	buoyancy aids	50	(6)
Special purpose device	all performance levels		(7)
Manufactured by:			(8)
WARNING: FLOTATION DEVICES ONLY REDUCE THE RISK OF DROWNING THEY DO NOT GUARANTEE RESCUE			(9)

NOTE Clause 6 in ISO 12402-1 does not specify a label layout.

Figure 1 — Label specification

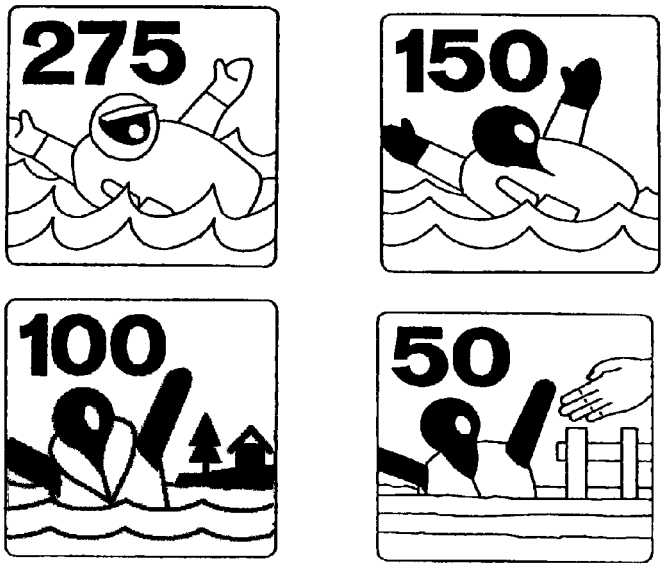

Figure 2 — Pictograms

4.2 Performance criteria

Among lifejackets and buoyancy aids there are a number of performance levels, types of buoyancy, activation methods for inflatable devices, and auxiliary items (such as location aids), all of which will affect the user's probability of survival. Within the different types of buoyancy allowed, inflatable PFDs either provide full buoyancy without any user intervention at the time of immersion (e.g. those inflated by a fully automatic method) or require the user to initiate the inflation. In particular, all inflatable PFDs require the user to regularly service them and require checks of the status indicators before each donning/use of the PFD. Hybrid PFDs always provide some buoyancy but rely on these same methods to achieve full buoyancy. With inherently buoyant PFDs, the user only needs to put the PFD on to achieve the performance required.

PFDs that do not require intervention are suited to activities where persons are likely to enter the water unexpectedly; whereas PFDs requiring intervention (e.g. manually inflated PFDs) are only suitable for use if the user believes there will be sufficient time to produce full buoyancy, or help is close at hand. In every circumstance, the user shall ensure that the operation of the PFD is suited to the specific application. The conformity of a PFD to the relevant part of ISO 12402 does not imply that it is suitable for all circumstances. The relative amount of required inspection and maintenance is another factor of paramount importance in the selection and application of PFDs.

The primary function of a PFD according to the relevant parts of ISO 12402 is to support the user in reasonable safety in water, enabling his efforts to be expended in recovery rather than in remaining afloat. Alternative attributes make some PFDs better suited to certain circumstances than others or make them easier to use and care for than others. Important alternatives allowed by the relevant parts of ISO 12402 are the following:

a) to provide higher levels of support (level 100, 150, or 275) that generally float the user with greater water clearance, enabling his efforts to be expended in rescue rather than avoiding waves, or to provide lighter or less bulky PFDs (levels 50 and 100);

b) to provide the kinds of flotation media (inherently buoyant foam, hybrid, and inflatable) that will accommodate the sometimes conflicting needs of reliability and durability, in-water performance, and continuous use;

c) to provide automatically operating (inherently buoyant or automatically inflated) PFDs that float users without any intervention on their part, except in initially donning the PFD (and regular inspection and rearming of inflatable types), or to provide user control of the inflatable PFD's buoyancy with manual and oral operation;

d) to provide devices that are easy to use on a continuous basis while on or near water, thus ensuring flotation in the event of sudden immersion, as opposed to having to find and don the PFD when the unexpected happens;

e) to enable the user to propel himself in the water without it being a significant encumbrance;

f) to assist in detection and rescue of the user through the use of location aids and/or buddy lines, lifting loops and the like.

PFDs provide various degrees of buoyancy in garments that are light in weight and only as bulky and restrictive as needed for their intended use. They will need to be secure when worn and to provide positive support in the water, allowing the user to swim or actively assist himself or others. The PFD selected shall ensure that the user is supported with his mouth and nose clear of the water under the expected conditions of use and user's ability to assist.

Under certain conditions (such as rough water and waves), the use of watertight and multilayer clothing, which provide intentionally or otherwise additional buoyancy, or the use of equipment with additional weight (such as tool belts) will likely alter this performance. Users, owners and employers shall ensure that this is taken into account when selecting a PFD. Similarly, certain PFDs may not perform as well in extreme climate conditions, although fully approved under the relevant part of ISO 12402. PFDs may also be affected by other conditions of use, such as chemical exposure and welding, and may require additional protection to meet the specific

requirements of use. If the user intends taking a PFD into such conditions, he shall satisfy himself that it will not be adversely affected.

A PFD can also be an integral part of a safety harness designed to conform to ISO 12401 or of a garment with other uses, e.g. to provide thermal protection during immersion, in which case the complete assembly as used shall conform to the relevant part of ISO 12402.

In compiling the attributes required of a PFD, consideration shall also be given to the potential length of service that the user might expect. Whilst a PFD which conforms to the specification needs to be of substantial construction and material, its potential length of service often depends on the conditions of use and storage, which are the responsibility of the owner, user and/or employer. Furthermore, whilst the performance tests included are believed to assess relevant aspects of performance in real-life use, they do not accurately simulate all conditions of use. For example, the fact that a device passes the self-righting tests described herein does not guarantee that it will self-right an unconscious user using waterproof clothing, nor can it be expected to completely protect the airway of an unconscious person in rough water.

4.3 Performance levels

It is essential that owners, users and employers select those PFDs that conform to the relevant part of ISO 12402 for the circumstances in which they will be used. Manufacturers and those selling PFDs shall make clear to prospective purchasers the product properties and alternative choices, and the limitations to normal use, prior to the purchase.

Similarly, those framing legislation regarding the use of these PFDs shall consider carefully which PFD and performance level and/or intended application is most appropriate for the foreseeable conditions of use, allowing for the wide variety of use and for the higher risk circumstances. These higher risk circumstances shall account for the highest probabilities of occurrence of accidental immersion and the expected consequences in such emergencies. Apart from the sea conditions and distance to shore, the type of clothing likely to be worn shall be considered because clothing will probably impair the performance of the lifejacket.

ISO 12402 specifies different performance levels and design features to satisfy the need of different users. If properly maintained and used, once deployed, the classes and performance levels are as follows.

a) Lifejackets for seagoing ships in accordance with ISO 12402-1 are intended primarily for use on seagoing ships under IMO rules.

b) Lifejackets, performance level 275, in accordance with ISO 12402-2 are intended primarily for offshore use and by people who are using items of significant weight and thus require additional buoyancy. They are also of value to those who are using clothing which traps air and which will adversely affect the self-righting capacity of the lifejacket. They are designed to ensure that the user is floating with his mouth and nose clear of the surface at an angle and with sufficient freeboard to limit mouth immersions in waves.

c) Lifejackets, performance level 150, in accordance with ISO 12402-3 are intended for general offshore and rough weather use where a high standard of performance is required. As tested, they will turn an unconscious person in swimming attire into a safe position. Additionally they should maintain a fully clothed person in a safe position with no subsequent action by the user.

d) Lifejackets, performance level 100, in accordance with ISO 12402-4 are intended for those who may have to wait for rescue, but are likely to do so in sheltered and calm water. Whilst these lifejackets may be less bulky than other types of lifejacket, they should not be used in rough conditions or when there is wave splash.

e) Buoyancy aids (level 50) in accordance with ISO 12402-5 are intended for use by those who are competent swimmers and who are near to bank or shore, or who have help and a means of rescue close at hand. These devices have minimal bulk and cost, but they are of limited use in disturbed water and cannot be expected to keep the user safe for a long period of time. They do not have sufficient buoyancy to protect people who are unable to help themselves. They require active participation by the user.

f) PFDs (both lifejackets and buoyancy aids) may also be approved in accordance with ISO 12402-6, which recognizes that ISO 12402-1 to ISO 12402–5 are required to be general in their nature and real-world needs may conflict. ISO 12402-6 provides general requirements for the approval of special purpose devices such as those for use in white water.

4.4 Selection and use

These different devices conform to different levels of buoyancy, performance and use. By allowing intermediate steps within the range of performance level, they create the opportunity to design and manufacture PFDs which meet the diverse needs of everyone working or participating in leisure activities on water. For seagoing ships, IMO rules apply.

Before purchasing a lifejacket or buoyancy aid, the user shall evaluate the risks to which he or she is likely to be exposed. Certain activities present a somewhat higher risk of sudden immersion due to falls overboard, capsizing and the like. Certain users, e.g. dinghy sailors, may be better served by devices of less than 100 N buoyancy, if help is close at hand.

In principle, national bodies, in particular those responsible for making recommendations, should be left to determine what is appropriate for the activities under their jurisdiction. The advice of such bodies should be sought by groups, clubs or authorities in order to select a suitable device.

Having made a decision about the appropriate class, detailed information with regard to operational sizes, design and buoyancy has to be considered. When selecting a lifejacket, it has to be taken into consideration whether this device shall be usable over foul weather clothing. Manufacturers are encouraged to provide additional information for selection of PFDs, as shown in Figure 3.

Performance tests shall be undertaken under conditions which can be replicated, i.e. under calculable and controllable standard conditions. The unforeseeable circumstances of an emergency are neither known nor can they be simulated in laboratories.

PERSONAL FLOTATION DEVICE		ISO 12402-2 to ISO 12402-6
Application		Performance level
Offshore, extreme conditions, special protective clothing, heavy equipment	lifejackets	275
Offshore, foul 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 purpose device		all performance levels
Manufactured by:		
WARNING: FLOTATION DEVICES ONLY REDUCE THE RISK OF DROWNING THEY DO NOT GUARANTEE RESCUE		

SPECIAL FEATURES			Integrated emergency light and spray cap					
SPECIAL APPLICATION			Use in extreme climate conditions (–50 °C)					
OPERATION MODE			DESIGN					
Auto-matically operating	Manually operated	Oral inflation only	Multi-chamber system	Amount of inflatable buoyancy (N)	Amount of inherent buoyancy (N)	Integrated harness	Use with harness	
							yes	no
√	√			90	70	√	√	

Size	Chest (cm)	Body mass (kg)	Buoyancy for specified body mass (N)	
			Actual value	Nominal value
Medium		> 70	160	150

Figure 3 — Example of additional information for selection of PFDs

5 Essential items to be observed by legislative authorities, manufacturers, retailers and users

5.1 Personal flotation devices (PFDs)

5.1.1 General

The performance of a PFD may be altered when it is worn in addition to or in combination with other personal protective equipment (PPE). For example the interaction between protective clothing, in particular immersion suits, and PFDs is difficult. Furthermore, attempting to specify the amount of buoyancy protection of a PFD in isolation is always likely to be a problem when integrated assemblies are used. The ideal situation is one in which it is possible to identify the buoyancy of an integrated assembly intended for an individual in a specified water environment.

Certain occupational uses, such as welding, need special attention to avoid damaging the PFD. There is no protective value in a PFD if it has become damaged in normal use so that it no longer functions as intended. The use of protective covers and multi-chamber buoyancy devices are ways to protect the PFD. A user can come into contact with some corrosive or noxious chemicals and it may be that they require elaborate PPE. No two applications are precisely the same; but the additional items detailed in ISO 12402 are designed to cover most common hazards. PPE manufacturers have to be advised by the purchaser of special industrial circumstances when specifying equipment for such applications.

Another fundamental decision which influences all requirements for PFDs is whether or not the item will be worn all the time that immersion is a possibility. The aim is to ensure that no one enters the water without having donned a PFD. Once more, however, some element of compromise may be necessary. If a device is to be worn for prolonged periods, then it should not hinder the mobility of the user and it shall not endanger his safety in other respects. Persons working in confined spaces, or where there is rigging or other material which could entrap them, should also have provisions for reducing snagging hazards and provide easy removal, such as a cover specified as an additional item and quick release closure. They may also not be able to use inherently buoyant devices and inflatable PFDs may be required. Consideration should be given first to the use of a safety harness or other technical means to minimize the risk of an accidental immersion.

PFDs shall be simple to don and to doff. Although the relevant standards include timed tests for donning, it may be necessary in certain circumstances to consider additional requirements beyond those required by the standards; for example, the requirement to ensure rapid and reliable donning in complete darkness or in confined spaces or when using gloves or mittens. Donning is also affected by the compatibility of the PFD with other equipment.

The physical circumstances of intended use are also of importance in determining the specification required of a PFD. If inflatable PFDs are stored or worn in temperatures below 0 °C, CO_2, the traditional inflation gas, will usually be adversely affected and result in only partial inflation. Other components such as nylon poppers may become rigid and difficult to open. ISO 12402 is intended to provide a reasonable performance for all PFDs in climates from the tropics to cold temperate but do not require all devices to meet extreme climatic conditions. Temperatures have a considerable influence on the performance of the inflation mechanism. They can not only slow down CO_2 inflation, but also increase activation times of the firing heads. It is very important to specify the lowest performance temperature for firing tests, if the PFD is to be exposed to temperatures much below 0 °C. Another feature of the environment of higher latitudes in winter is short day length. All those who are at all likely to use their PFDs during the hours of darkness should also use emergency lights that comply with the additional items specified in ISO 12402-8.

5.1.2 Risk assessment

Occupational health and safety guidelines or requirements such as the EU Directive for Occupational Health and Safety (89/391 EEC) and the EU Directive 89/656/EEC on the minimum health and safety requirements for the use by workers of personal protective directive equipment at the workplace may recommend or require a risk analysis that evaluates all surrounding conditions and influences. The outcome has to be a system of management activities and at least a proposal for the choice of adequate PPE.

It is a popular belief that most immersion deaths result from hypothermia and exhaustion after some time in water, but in fact recent research has shown that it is often the first seconds or minutes that are most critical because of shock or cold shock responses of the body. Not only is it essential that the PFD be worn, but also in order for the PFD to be effective, it should be fully functional rapidly after entry into the water.

For 'inflatables', therefore, the most obvious feature which needs careful consideration is the mode of inflation, as it is this that determines how rapidly and effectively the lifejacket can perform. In foreseeable conditions of use in which the user can enter cold water suddenly, or in a disabled or unconscious condition, the PFD should be of an automatically operating type. Thus once it has been properly armed, inspected and donned, it requires no further action by the user.

NOTE Freezing weather and near freezing water will delay inflation of the PFD.

Once it has brought the user to the surface, an effective PFD then has to maintain the user in a safe position so that he or she can continue to breathe. The water has two main ways in which to counteract that ability:

— by waves, water-splash and spray entering the airways, and

— by waves inverting the user.

The wave height above which a spray hood becomes necessary varies according to many factors. In the first instance, higher wind speeds and steeper waves increase the likelihood of water entering the airways, so that even waves of only 30 cm height may constantly threaten the unprotected airway.

The design of the PFD and the orientation of the user with respect to waves are also very important. A PFD with a widely split front or keyholes through which the head is inserted may funnel water onto the face in the right circumstances. However, it is generally accepted that conditions in which a spray hood is required are very seldom encountered in inland waters; although such conditions are relatively common in the sea. No matter how high the freeboard between mouth and waves, if the conditions are right the face may be continually splashed. This results in inhalation of water and drowning if the victim is unconscious, or if breathing is rapid and uncontrollable — as occurs on first being immersed in water below about 20 °C without good immersion protective garments. This process has the additional effect of accelerating body cooling.

The self-righting ability of PFDs is of importance if an unconscious or disabled person is capsized. The reason for self-righting is to try to provide for this event. An unconscious person with the buoyancy of a PFD could surface inverted following initial entry into the water if air has been trapped in their everyday clothing. Although lifejackets are tested without such clothing, experience has shown that if an otherwise well-designed PFD performs well in this test, it is generally good in its overall performance in water in the sense of having good stability. The tests shall be undertaken on subjects using swimming costumes in order to ensure conditions which can be replicated, although it is recognized that self-righting is usually a much greater problem when using clothing.

5.1.3 Interaction of devices

The development of modern clothing systems for foul weather gear also creates the risk of trapping air, which may produce an undesirable buoyancy distribution. This shall be taken into consideration by selecting a PFD in combination with this gear. In particular, application of lifejackets to infants and children needs careful consideration. Counter buoyancy arising from napkins has led to accidents. The anthropometric differences in the proportions of body configuration and centre of gravity shall be adopted by design. Furthermore, the user shall be aware of the risk of hypothermia, the principles of temperature loss, the reaction of his body to temperature loss such as uncontrolled cold shivering, disorientation, local confusion and amnesia. See also 5.3.

5.2 Accessories

5.2.1 Performance, safety and quality of accessories shall comply with ISO 12402-8, which specifies a construction kit from which optional items can be chosen to meet special applications and or risks.

5.2.2 Emergency lights are an important location aid during the hours of darkness, when they are much more effective than retro-reflective tape alone. Lights not necessarily conforming to ISO 12402-8 are also useful aids, particularly when legislation does not demand the fitting of a conforming light.

5.2.3 Whistles are a useful location aid at all times.

5.2.4 Multi-chamber buoyancy systems can allow the lifejacket to perform even when one chamber is damaged, and may thus be of value in some occupational uses. Multi-chamber construction adds considerably to the cost and complexity of a lifejacket. Nevertheless, for special application 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. Alternatively, inherent buoyancy is unlikely to be damaged. It may be bulky to be worn with comfort, but will provide the needed level of buoyancy and performance.

5.2.5 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.

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

5.2.7 Protective covers are suitable for preventing damage to less robust lifejacket components, such as inflatable chambers and gas inflation heads. They reduce snagging hazards, but add to the cost and complexity of lifejackets. Protective covers should be used in addition against risks such as chemical fluids, heat impact, molten metal splash due to welding, or the risks of fire fighting. 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. The materials out of which protective covers are made may make them less popular with certain potential users.

5.2.8 Safety harnesses and lines conforming to ISO 12401 are useful tools to reduce the risk of immersion. If they are to be used, they shall not compromise the performance of the lifejacket or hinder survival.

5.3 Immersion suits

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

Immersion of a person in 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 in ISO 15027-1 and ISO 15027-2, 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 user, 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 is compatible and that the lifejacket will turn the user to the face-up position.

ISO 15027-1 and ISO 15027-2 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 effect the selection of an immersion suit depending upon the application. ISO 15027-1 and ISO 15027-2 differentiate suits only in terms of whether they are intended for constant use (using the suit during normal activities under occupational or leisure applications) or 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.

6 Guidance for drowning 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 consequences of unwanted water entry. In addition, it aims to optimize the use of PPE and PFD as risk-managing measures.

6.2 Description of operation and environment

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

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

6.2.3 Define 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

6.3.1 Define areas and actions that induce risk of uncontrolled water entry.

6.3.2 Define all potential water entry situations with regard to worst intended environmental exposure, conservative SAR time and post-rescue services.

6.3.3 Define target number of exposures, exposure times, and acceptable loss.

6.4 Guidance on 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.

— Identify available measures to prevent identified risk for uncontrolled water entry.

— Identify available measures to reduce identified consequences of uncontrolled water entry.

— Describe applied system for management and control of safety level.

6.4.2 Frequency reducing measures

6.4.2.1 Safety awareness and risk knowledge.

6.4.2.2 Abortion of activities under certain conditions.

6.4.2.3 Physical barriers.

6.4.2.4 Securing personnel with lines and harnesses.

6.4.2.5 Safe job analysis.

6.4.3 Consequence reducing measures

6.4.3.1 Emergency training.

6.4.3.2 Drowning protection.

6.4.3.3 Cold shock protection.

6.4.3.4 Swimming failure protection.

6.4.3.5 Hypothermia protection.

6.4.3.6 Impact protection.

6.4.3.7 Minimizing exposure and rescue time.

6.4.3.8 Rescue efficiency.

6.4.3.9 Post-rescue services.

6.4.4 Safety level management system

6.4.4.1 Reporting system.

6.4.4.2 Data processing.

6.4.4.3 Credibility.

6.4.4.4 Authority.

6.5 Guidance on selection of risk managing measures

6.5.1 General

After relevant frequency reducing measures have been applied to the process the remaining exposure risk should be described and quantified. Relevant consequence reducing measures should then be optimized.

6.5.2 Training

Level of safety training and procedures for drills should be described for all individuals involved with drowning risk. Relevant training should include knowledge of human reaction to immersion in water, especially cold water, as well as procedures for survival and rescue. Training should be regarded as a process of increasing awareness and motivation.

6.5.3 Personal protective equipment

Selection of personal protective equipment such as PFDs or immersion suits.

6.5.4 Rescue services

SAR services and post-rescue services should be described. Time to rescue should be established. The remaining drowning risk should be quantified and compared to the safety level decided on.

6.6 Guidance on selection of personal protective equipment

The primary objective of this part of ISO 12402 is to give guidance on selection of the most effective personal protective equipment (PPE). It contains information intended to guide users to the best decision. A condensed version of the decision is shown in Figure 4.

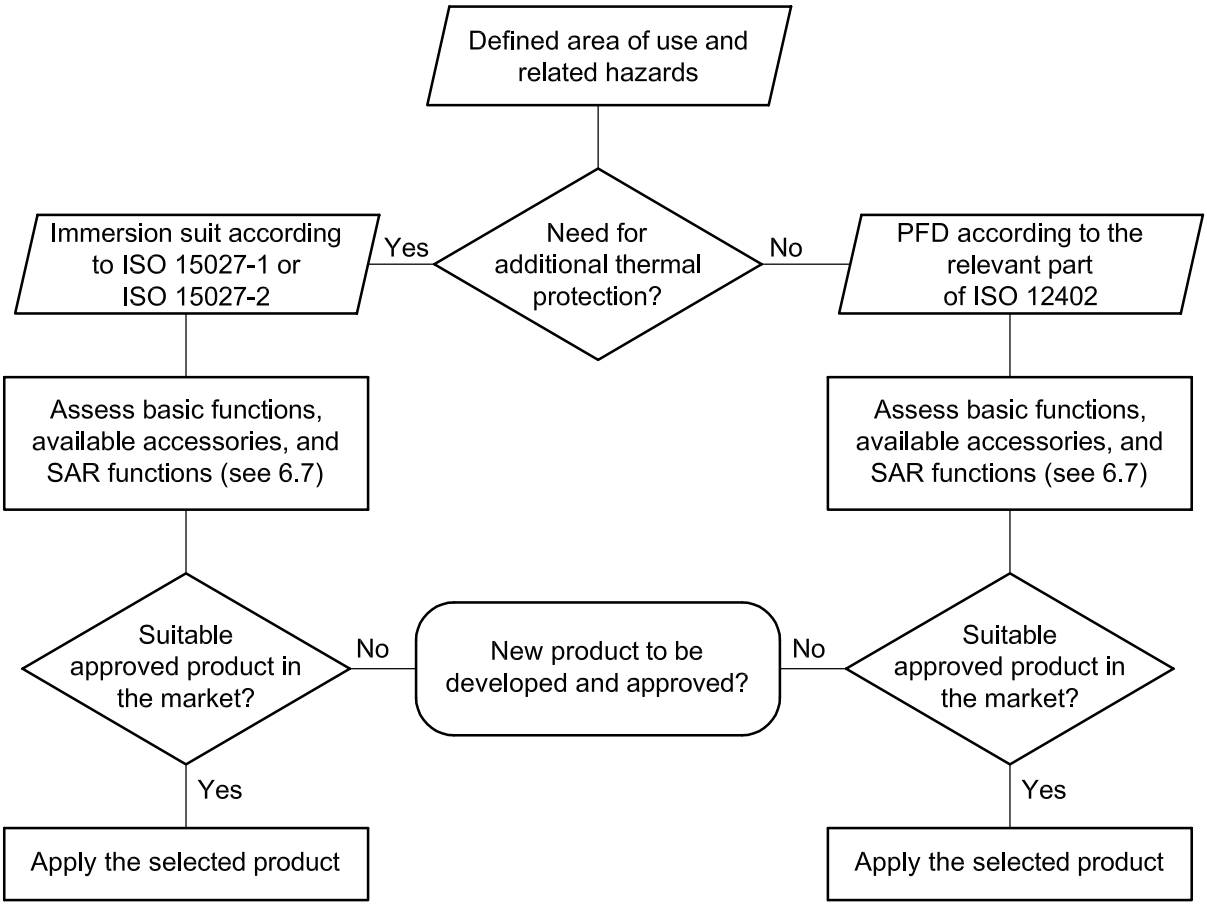

Figure 4 — Condensed version of the decision

6.7 Checklists

6.7.1 Typical exposure hazards

6.7.1.1 Staying or falling into or remaining in water or other fluid.

6.7.1.2 Being unconscious at the time of water entry by:

a) an injury causing the fall;

b) injury caused by or in the fall;

c) chemical injury by gas or liquid.

6.7.1.3 Cold shock.

6.7.1.4 Swimming failure.

6.7.1.5 Exhaustion.

6.7.1.6 Hypothermia.

6.7.1.7 Post-rescue syndrome.

6.7.2 Constant-use comfort and ergonomics

6.7.2.1 Acceptance by user.

6.7.2.2 Compatibility of PFDs with other protective equipment or gear.

6.7.2.3 Multi-purpose PPE.

6.7.2.4 Sizing and fit for personal application.

6.7.2.5 Wear and tear in normal and extreme applications.

6.7.2.6 Ambient temperature.

6.7.2.7 Children as users.

6.7.3 Basic in-water safety functions

6.7.3.1 Immediate action of the PFD in an emergency.

6.7.3.2 Desired operation mode (manual to fully automatic, inherently buoyant or inflatable).

6.7.3.3 Self-righting capability.

6.7.3.4 Compatibility of PFDs with other protective equipment or gear.

6.7.3.5 Freeboard and sprayhoods.

6.7.4 Search-and-rescue functions

6.7.4.1 Means to alert the crew.

6.7.4.2 Means to be located at day and night.

6.7.4.3 Means to be recovered and rescued.

6.7.5 Additional hazards by emergency donning

6.7.5.1 Acceptance by user.

6.7.5.2 Training and exercising, donning and doffing.

6.7.5.3 Storage and maintenance.

6.7.5.4 Misuse and inadequate devices.

6.7.6 Factors that reduce performance

6.7.6.1 Mechanical forces.

6.7.6.2 Dust and dirt.

6.7.6.3 Chemical hazards.

6.7.6.4 Thermal influences, like heat or cold or hot or cold fluids.

6.7.6.5 Combination with other PPE.

6.7.6.6 Combination with clothing, especially clothing that traps air.

Annex A
(informative)

List of terms defined in ISO 15027-1

3.1
immersion suit
suit designed to protect the wearer from the cooling effects of unintended immersion in water

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 by the wearer to such an extent that actions may be undertaken without undue encumbrance

3.3
abandonment suit
immersion suit, designed to permit rapid donning in the event of an imminent unintended immersion in water

3.4
dry suit
garment designed to preclude the entry of water upon immersion

3.5
wet suit
garment designed to permit 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 may be operated by the wearer in the water

3.8
inherent buoyant material
buoyancy provided by a material, 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 wearer in order to reduce or eliminate the splashing of water onto the airways, thereby promoting the survival of the wearer in rough water conditions

3.12
buddy line
length of cord which can be tied or otherwise fixed to another person's suit, or lifejacket, or to a liferaft or other objects, so as to keep the wearer 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. One clo is equal to 0,155 $K \cdot m^2 \cdot W^{-1}$

3.14
immersed clo value
clo value measured when a clothing assembly is immersed and subjected to the effect of hydrostatic compression

3.15
hypothermia
condition where body core temperature is below 35 °C

3.16
working environment
environment in which the wearer of a suit system would engage in normal work

3.17
helicopter transit suit
constant wear suit worn by helicopter occupants

3.18
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 under other international regulations

3.19
suit system
combination of a suit and any other products which are used in conjunction with it

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

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