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Personal flotation devices —

Part 9: Test methods

Équipements individuels de flottabilité —

Partie 9: Méthodes d'essai

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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 12402-9 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 Organization (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 or 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. More information on the selection and application is given in ISO 12402-10.

Personal flotation devices —

Part 9: Test methods

1 Scope

This part of ISO 12402 specifies the test methods for personal flotation devices.

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 139:2005, *Textiles — Standard atmospheres for conditioning and testing*

ISO 2768-1, *General tolerances — Part 1: Tolerances for linear and angular dimensions without individual tolerance indications*

ISO 3386-1:1986, *Polymeric materials, cellular flexible — Determination of stress-strain characteristics in compression — Part 1: Low-density materials*

ISO 12401:2004, *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 12402-2:2006, *Personal flotation devices — Part 2: Lifejackets, performance level 275 — Safety requirements*

ISO 12402-3:2006, *Personal flotation devices — Part 3: Lifejackets, performance level 150 — Safety requirements*

ISO 12402-4:2006, *Personal flotation devices — Part 4: Lifejackets, performance level 100 — Safety requirements*

ISO 12402-5:2006, *Personal flotation devices — Part 5: Buoyancy aids (level 50) — Safety requirements*

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

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

1) To be published.

ISO 12402-8:2006, *Personal flotation devices — Part 8: Accessories — Safety requirements and test methods*

ISO 12402-10, *Personal flotation devices — Part 10: Selection and application of personal flotation devices and other relevant devices*

ASTM D471-98:1999, *Standard test method for rubber property — Effect of liquids*

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

3 Terms and definitions

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

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2) IMO is an institution with domicile in London issuing regulations which are then published as laws by the member states.

3.9
yoke-type PFD
PFD in a style worn around the back of 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 of personal flotation devices

An overview of this classification is given in Annex A for information.

5 Test methods

5.1 General

Unless otherwise specified, a new sample of the PFD to be tested may be used for each of the tests.

When material and components of PFDs specified in ISO 12402-7 are conditioned as specified therein and successfully tested according to this part of ISO 12402, they can be assumed to meet the requirements of ISO 12402-7 for the PFD design test.

A combination of PFD and accessories in accordance with ISO 12402-8 shall not impair the performance of either item. This shall be proved during the test required for both PFD and accessories. If necessary, the test sequence shall be arranged accordingly.

The human subject performance tests shall be witnessed by a test panel of at least 2 experts familiar with testing and the products specified in the relevant parts of ISO 12402.

The human subject performance tests shall be carried out under the direction of a test house's test panel that is experienced in these specific test procedures. These tests shall be observed by at least 2 experienced observers from the panel and repeated with 3 experienced observers from the panel if there is any question about the performance observed. An observer is to be qualified by having expertise in observing (or conducting under the supervision of a qualified observer) the specific test on at least 3 occasions.

NOTE 1 Specific test means, for instance, that experience with stability testing would not qualify for self-righting testing or that experience with self-righting testing of inherently buoyant PFDs would not qualify as experience with similar testing of inflatable PFDs.

NOTE 2 It is recommended that the test panel have at least one member of the test house regularly participating in experience exchanges and round robin tests.

All tests according to 5.5 shall be carried out after submitting the samples to the temperature cycling test (see 5.5.3) and the rotating shock bin test (see 5.5.2).

5.2 Sampling and conditioning

5.2.1 Sampling

At least one example of each size of the device to be tested shall be provided.

5.2.2 Conditioning

Prior to testing, the samples shall be conditioned for (24 ± 0,1) h under the appropriate standard atmosphere as defined in ISO 139 according to the specific fabric used for the PFD.

If spelled out to be tested under wet conditions, the sample shall be soaked for at least 5 min in fresh water, or as specified by the test procedure itself.

5.3 Criteria for passing and failure

All required samples shall pass all tests specified in 5.5 for the entire device to meet the requirements of the relevant parts of ISO 12402. Due to the high variability between human subjects and the difficulty in assessing some subjective measures, for tests according to 5.6 a test subject may be disqualified if demonstrated not to perform in accordance with this standard when tested in a reference vest as described in Annex B, C or D.

When a reference vest is used, the test report shall state the model of reference vest(s). Whenever a subject is disqualified from this test, another two subjects with similar weight, height and anatomic build shall be subjected to the same test and before the same test panel. If these additional tests are still not clearly passed in accordance with this standard and the part of ISO 12402 applicable to the performance level of device, the device shall be deemed to have failed.

5.4 Magnetic properties testing

Place a direct-reading magnetic compass in an undisturbed magnetic area (i.e. an area in which magnetic items and d.c. electrical cables are not continually moved or switched). Check the compass to ensure that it has negligible pivot friction. This can be done by deflecting the compass card 10° by means of a magnet and then removing the deflecting force, when the card should return to within 0,5° of its original position.

Present the metal components (with any hooks closed) individually to the compass on an approximately east-to-west line, to a position where the nearest point of the component is (300 ± 10) mm horizontally from the center of the compass. Lightly tap the compass to eliminate the effect of friction. Record the angle, in degrees, of any deflection of the compass from its position before the metal components were brought near the compass.

5.5 Mechanical properties tests

5.5.1 Horizontal and vertical load tests

5.5.1.1 Principles

The PFD shall be subject to tension via its integral structure, such as waist belt or harness arrangement, by means of a specified load. The tests shall be carried out in the following order and be applied to the same PFD sample:

a) horizontal load test wet;

b) vertical load test wet.

NOTE Test houses may use other test arrangements as described in 5.5.1.3, i.e. by means of a hydraulic jig, if the load maintained and the same accuracy of results can be achieved.

5.5.1.2 Apparatus

The apparatus consists of a horizontally suspended upper cylinder, of diameter (50 ± 5) mm for PFD user masses less than 40 kg, or of diameter (125 ± 10) mm for PFD user masses of 40 kg and above, to which the PFD is fitted. The length of the test cylinder shall be sufficient to accommodate the full width of the portion of the PFD under test.

For the horizontal load test shown in Figures 2 and 4, an additional lower test cylinder of similar size to the upper cylinder shall be placed in the PFD in the position indicated. The axes of the upper and lower cylinders shall be regarded as the datum positions A1-A2 and B1-B2, respectively, shown in Figures 2 and 4.

For the horizontal load test shown in Figures 2 and 4, a pre-load is required. The total pre-load shall be (20 ± 2) N.

For the vertical load tests shown in Figures 3 and 5, the lower apparatus shall have the dimensions as indicated in Figures 6 and 7. The diameter of the tube shown in Figure 7 shall be (50 ± 5) mm for PFD user masses less than 40 kg and (125 ± 10) mm for user masses of 40 kg and above.

For these vertical load tests, a test mass shall be applied to the attachment positions indicated by means of webbing (25 ± 5) mm in width.

5.5.1.3 Procedure

5.5.1.3.1 General

The webbing or movable part of the assembly shall be marked at each point of adjustment prior to application of each test load. This includes tie tapes, draw cords, and lacing, as well as webbing-hardware adjustments.

5.5.1.3.2 Horizontal load test

The PFD shall be fitted (if inflated by its primary means of inflation (30 ± 5) min prior the test being carried out) to the upper test cylinder, in the manner shown in Figure 2 for halter types or Figure 4 for vest types. If inflatable, it shall be tested both when uninflated and when inflated by its primary means of inflation. The PFD shall be attached to the cylinders such that all adjustment devices are tested. The position of the webbing relative to the adjustment devices it passes through shall be marked.

The lower test cylinder shall be fixed in the appropriate positions shown in Figures 2 and 4. The specified pre-load shall be added and the test arrangement shall be adjusted such that the axes A_1-A_2 and B_1-B_2 of the upper and lower test cylinders are substantially parallel and horizontal.

The additional test load shall be applied steadily until the PFD is hanging freely. The load shall be maintained for the specified period.

The PFD shall be examined for any failures resulting in functional damage of the PFD.

5.5.1.3.3 Vertical load test

The PFD shall be fitted to the upper test cylinder, in the manner shown in Figure 3 for halter types or Figure 5 for vest types. If inflatable, it shall be tested both when uninflated and when inflated by its primary means of inflation.

For halter types, adjust the harness to fit the test body according to Figure 6. For vest types, fasten the PFD in such a way that any adjustment devices are tested. Mark the position of the webbing relative to any adjustment devices it passes through.

Attach the load suspension cord to the PFD in the appropriate positions shown in Figures 3 and 5. Apply the test load steadily without jerking. Maintain the test load for the specified period. Remove the test load and examine the PFD for any resultant failures. Measure any adjustment device slippage.

5.5.1.4 Lifting loop test

All PFDs equipped with a lifting loop shall be soaked in fresh water for a period of 5 min. The PFD shall then be fitted to the appropriate test dummy according to the manufacturer's donning and adjustment instructions. If inflatable, the lifejacket shall be inflated prior to load application.

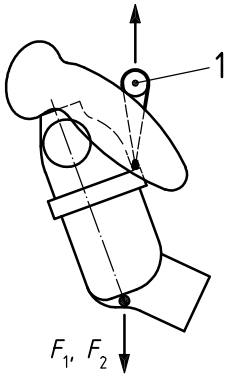
Then apply the loads F_1 or F_2 (see Figure 1) to the lower attachment point of the dummy in accordance with ISO 12401:2004, 5.2.2.1. Lift the dummy by means of a cylinder of (50 ± 5) mm in diameter, which is put through the loop without jerking until it is suspended freely.

Maintain the load for (1 ± 0,1) min.

See also 5.5 in the relevant parts of ISO 12402.

5.5.1.5 Buddy line test

If a buddy line is attached to a PFD, a load of 750 N shall be applied for (1,0 ± 0,1) min perpendicular to the PFD, whilst the PFD is fitted to a torso in accordance with ISO 12401. No damage shall occur to the buddy line or to the PFD.



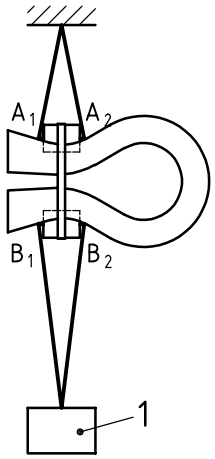
Key

F_1 load for adult size (according to 5.5 in the relevant part of ISO 12402)

F_2 load for child size (according to 5.5 in the relevant part of ISO 12402)

1 test load

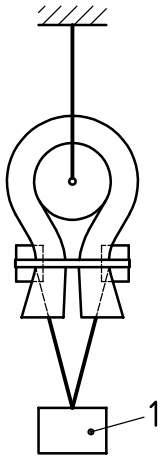
Figure 1 — Test dummy



Key

1 test load

Figure 2 — Horizontal load test of yoke-type PFD



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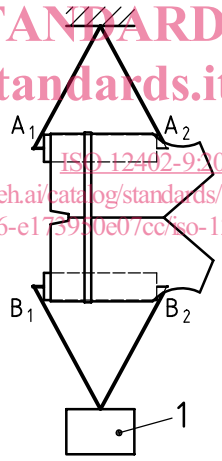
1 test load

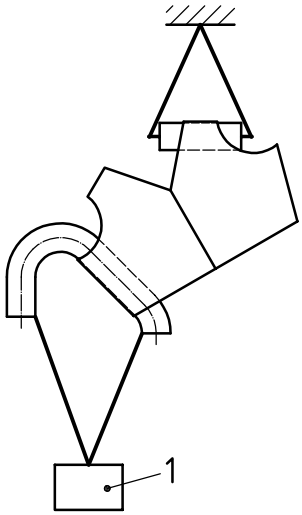
Figure 3 — Vertical load test of yoke-type PFD



Key

1 test load

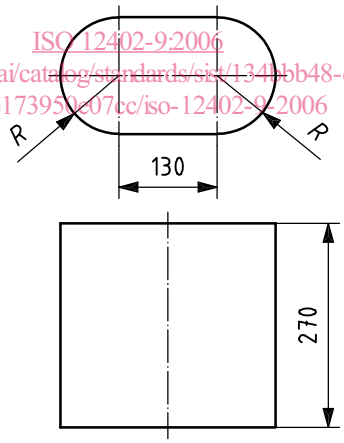
Figure 4 — Horizontal load test of vest-type PFD



Key
1 test load

Figure 5 — Vertical test of vest-type PFD

Dimensions in millimetres



Key
R = 155 mm

Figure 6 — Body for vertical load test (general tolerances ISO 2768-1, v)