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Personal Flotation Devices (PFD)

Safety requirements and test methods

(This is a working document only. The structure of the coming standard will be decided later)

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Foreword CEN/WD 393-399

This Standard was prepared by CEN/TC 162 "Protective clothing including hand and arm protection and lifejackets" which secretariat is held by DIN.

This Standard has been prepared under a Mandate given to CEN by the Commission of the European Communities (and the Secretariat of the European Free Trade Association), and supports essential requirements of EC Directive(s).

Foreword ISO/CD 12402

ISO (the International Organisation for Standardisation) is a world-wide federation of national standards bodies (ISO member bodies). The work or 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 organisations, 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 Standardisation.

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.

Introduction ISO

This ISO standard is one of a series dealing with different classes of PFD (A to E).

The basis for this series are the CEN Standards EN 393, EN 394, EN 395, EN 396 and EN 399 (under revision) and the related amendments prA 1.

This ISO standard has been elaborated in co-operation with CEN/TC 162/WG 6 and ISO/TC 188/WG 14.

Introduction CEN/ISO

This standard has been prepared to meet the needs of persons engaged in activities, whether in relation to their work or their leisure, in or near water. Lifejackets manufactured and maintained to this standard will give a reasonable assurance of safety from drowning to a person who is immersed waters.

This standard allows for the buoyancy of a lifejacket 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, this broad group of buoyant devices is divided into two main types, those which require the user to initiate the buoyancy provision (whether by oral or gas inflation), and those which provide full buoyancy without any user intervention (i. e. those with inherently buoyant materials, or inflated by a fully automatic method), as well as combinations thereof. Automatically-operated lifejackets are those suited to persons likely to enter the water unexpectedly, whereas manually-operated lifejackets should only be used if it is certain that the wearer will have sufficient time to produce full buoyancy. In every circumstance, the user should ensure that the correct operation of the lifejacket is suited to the specific application. The compliance of a lifejacket with this standard does not imply that it is suitable for all circumstances. The requirement for regular maintenance is another factor of paramount importance in the choice and application of specific lifejackets.

This standard 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 stowed in a locker for emergency use.

This standard specifies the requirements for construction, performance, sizing, marking, test methods and product reliability based on quality assurance either by regularly follow up procedure of products and production or by quality management of the manufacturer based on ISO 9000.

The primary aims in wearing a PFD are:

a) to support the wearer in reasonable safety in the water. In the case of automatically-operated lifejackets, to perform in this way without any intervention on the part of the wearer, except in initially donning the lifejacket;

b) to enable the wearer to propel himself in the water without it being an encumbrance;

c) to support the wearer, enabling his efforts to be expended in recovery rather than in remaining afloat;

d) to assist the recovery of the wearer.

A PFD should provide a sufficient degree of buoyancy in a garment which is light in weight, not unnecessarily bulky, and allows freedom of movement. It should be secure when worn, providing positive support in the water, allowing the wearer to swim or actively assist himself or others. The amount of buoyancy specified, and its distribution, should ensure that the wearer is supported with his mouth and nose clear of the water.

Certain circumstances of the environment (such as waves), the wearing of garments which provide (intentionally or otherwise) additional buoyancy, (such as immersion suits) or the use of equipment with additional weight, like toolbelts, may 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 extremes of temperature, although fully approved under this standard. 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. If the user intends taking a PFD into such conditions, he shall satisfy himself that it will not be adversely affected. The standard also allows a PFD to be an integral part of a safety harness designed to comply with the European standards or an integral part of a more substantial garment, for example to provide thermal protection during immersion, in which case the complete assembly as worn is required to comply with this standard.

In compiling the standards required of a PFD, consideration has also been given to the potential length of service which the user might expect. Whilst a PFD which complies with the specification should be of substantial construction and material, its potential length of service depends mainly 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 are not intended to be accurate simulations of it. For example, the fact that a device which passes the self-righting tests described herein does not guarantee that it will self-right an unconscious user wearing waterproof clothing, neither should it be expected to protect the airway of an unconscious person in rough water.

These standards exist for a range of five types of PFDs. The five are each intended as being suitable for different activities in different risk situations, and include:

a) offshore-lifejackets, high performance

these have a buoyancy of no less than 275 N for the average adult and are intended for use offshore in extreme conditions, when heavy protective clothing is being used, or additional loads such as toolbelts are being carried;

b) offshore-lifejackets

these have a buoyancy of no less than 150 N for the average adult and are intended for use offshore or when foul weather clothing is being used;

c) inland-lifejackets

these have a buoyancy of no less than 100 N for the average adult and are intended for use in relatively sheltered waters;

d) buoyancy aids

these have a buoyancy of no less than 50 N for the average adult and are intended for use in sheltered waters with help and rescue close at hand and the user is a swimmer, in circumstances where more bulky or buoyant devices would impair the user's activity or actually endanger him.

e) PFD for special purposes

devise performing in above classes, but having modifications related to a special application in use.

It is essential that owners, users and employers choose those PFDs which 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 product properties and alternative choice and the limitations to normal use, prior to the purchase. Similarly, those framing legislation regarding the wearing of these garments should consider carefully which type is most appropriate for the foreseeable conditions of use, allowing for the more severe circumstances which often pertain in emergencies. For more information refer to the guidelines for application and use.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

EN 22768-1
General tolerances – Part 1: Tolerances for linear and angular dimensions without individual tolerance indictions (ISO 2768-1 : 1989)

ISO 105 : B04 : 1988
Textiles – Tests for colour fastness – Part B04: Colour fastness to weathering: Xenon arc

ISO 105 : E02 : 1989
Textiles – Tests for colour fastness – Part E02: Colour fastness to sea water

ISO 105 : X12 : 1987
Textiles – Tests for colour fastness – Part X12: Colour fastness to rubbing

ISO 188 : 1982
Rubber, vulcanized – Accelerated ageing or heat-resistance tests

ISO 1421 : 1977
Fabrics coated with rubber or plastics – Determination breaking strength and elongation at break

ISO 2231 : 1989
Rubber- or plastics-coated fabrics – Standard atmospheres for conditioning and testing

ISO 2411 : 1991
Rubber- or plastics-coated fabrics – Determination of coating adhesion

ISO 3801 : 1977
Textiles – Woven fabrics – Determination of mass per unit length and mass per unit area

ISO 4674 : 1977
Fabrics coated with rubber or plastic – Determination of tear resistance

ISO 5081 : 1977
Textiles – Woven fabrics – Determination of breaking strength and elongation (Strip method)

ISO 5082 : 1982
Textiles – Woven fabrics – Determination of breaking strength – Grab method

ISO 7854 : 1984
Rubber- or plastics-coated fabrics – Determination of resistance to damage by flexing (dynamic method)

ISO 9227 : 1990
Corrosion tests in artificial atmospheres – Salt spray tests

ISO/CD 394
Personal flotation devices (PFD) – Additional items – Safety requirements and test methods

AATCC Method 30 : 1981
Fungicides, evaluation on textiles: mildew and rot-resistance of textiles

3 Definitions and classes

3.1 Definitions

For the purposes of this standard, the definitions in ISO/CD 394 together with the following apply:

3.1.1 personal flotation device (PFD): A garment or device which, when correctly worn and used in water, will provide a specific amount of buoyancy positioned in the garment to position and maintain an incapacitated wearer with his airways clear of the water, and increase the likelihood of his rescue.

3.1.2 buoyancy: The resultant upthrust of a PFD when totally submerged in fresh water between 15 °C and 25 °C, with its upper part just below the surface.

3.1.3 inherently buoyant material: Material which is less dense than water.

3.1.4 automatically-operated PFD: A PFD which, once donned, requires no further action on the part of the wearer to meet the requirements of this standard. The buoyancy and performance required by this standard are provided by permanent means (inherently buoyant material) or by a temporary means (gas inflation) effected by a purely automatic system.

3.1.5 manually-operated PFD: A PFD which, once donned, still requires the user to take some, but few actions before it meets the requirements of this standard.

3.1.6 with secondary donning: A device which needs further action to bring it into its functioning position from the position it is normally worn, such as pouch-type devices or devices sealed until used for service.

The device has to prove the procedure to be activated into functioning position, both out and in water.

3.1.6 orally inflated PFD: A PFD whose buoyancy is produced by inflating it by mouth only. This is, therefore, a manually-operated PFD with secondary donning.

3.1.7 gas inflated PFD: A PFD whose buoyancy is produced by inflating it with a gas which is provided in a compressed gas cylinder. It shall also be capable of inflation by mouth. This may be a manually-operated or automatically-operated PFD.

3.1.8 manually inflated PFD: A gas inflated PFD in which inflation is normally effected as a result of the wearer operating a mechanism. It shall also be capable of inflation by mouth. This is, therefore, a manually-operated PFD.

3.1.9 automatically inflated PFD: A gas inflated PFD in which inflation is normally effected without the wearer carrying out any action, as a result of immersion in salt or fresh water. It shall also be capable of manual inflation, and inflation by mouth. This is, therefore, an automatically-operated PFD.

3.1.10 emergency lights: Devices which emit light so as to increase the chances of the wearer being located during hours of darkness or in conditions of poor visibility.

3.1.11 whistles: Devices which, when blown by mouth, produce an audible sound which can aid in the location of the wearer during rescue.

3.1.12 multi-chamber buoyancy systems: Multi-chamber buoyancy systems divide 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 wearer when immersed. Multi-chamber buoyancy systems of at least two chambers are required for SOLAS application.

3.1.13 safety harnesses and lines: Devices which allow the wearer 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.

3.1.14 buddy lines: Lengths of cord which can be tied or otherwise fixed to other lifejackets or buoyancy aids, liferafts, 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.

3.1.15 sprayhoods: Covers brought or placed in front of the airways of the wearer in order to reduce or eliminate the splashing of water from waves or the like onto the airways, and thereby promote the survival of the wearer in rough water conditions.

3.1.16 protective covers: Covers which are normally in place over the functional elements of a PFD, for example the inflatable chamber of an inflatable PFD, in order to protect them from physical damage, and may also be used to prevent items within the cover from snagging on external objects. Covers may be used to provide additional protection for any part of the PFD which may become damaged.

3.1.17 industrial resistances: The additional physical properties required of PFD in order for them to be suitable for use in foreseeable conditions of use in which they may be subject to exposure to significant abrasion, molten metal splash, flame and fire, etc., over and above that catered for in the basic CEN standards for such devices.

3.1.18 overpressure relief valve

Valve to be used in multichamber systems, to avoid the likelihood of a destructive pressure, caused by the activating of corresponding inflatable chambers.

3.2 Classes

3.2.1 Class A, offshore-lifejackets, high performance

These have a buoyancy of no less than 275 N for the average adult and are intended for use offshore in extreme conditions, when heavy protective clothing is being used, or additional loads such as toolbelts are being carried.

3.2.2 Class B, offshore-lifejackets

These have a buoyancy of no less than 150 N for the average adult and are intended for use offshore or when foul weather clothing is being used.

3.2.3 Class C, inland-lifejackets

These have a buoyancy of no less than 100 N for the average adult and are intended for use in relatively sheltered waters.

3.2.4 Class D, buoyancy aids

These have a buoyancy of no less than 50 N for the average adult and are intended for use in sheltered waters with help and rescue close at hand and the user is a swimmer, in circumstances where more bulky or buoyant devices would impair the user's activity or actually may endanger him.

3.2.5 PFD for special purposes

Device performing in above classes, but having modifications related to special applications for use.

4 Requirements

4.1 Principles

All classes of PFD's covered by this standard have to meet the requirements spelt out in the following. This is to be proved by testing the devices according to the testmethods specified by this standard.

All tests have to be performed by third party testhouses, according to European rules and regulations. If not covered by European law the testhouses have to be accredited by their national authorities, based on the requirements of ISO Guide 25 and ISO Casco 228.

All classes of PFD's may incorporate additional items compliant with ISO/CD 394 none of which shall impair its performance with respect to the requirements of this standard.

4.2 Materials

4.2.1 Materials and components shall not be damaged by storage at temperatures of −30 °C to +65 °C nor shall they be damaged by salt water, when tested according to clause 6.

4.2.2 Resistance for covers or uncovered bladders shall prove resistance to rot and illumination to be tested according to the methods of AATCC Method 30 : 1981 and ISO 105 : B04 : 1988. Illumination shall take place to class 5-6 with 1/2 unit tolerance.

Bladders which are screened by a cover when not in action need not undergo illumination testing. Following exposure to rot and/or illumination, the tensile strength shall be measured using the grab method given in ISO 5082, using specimens of at least 60 mm width and with at least 100 mm of material on each side of the test point, with four similar seams for each type of seam.

4.3 Textile and fabrics

4.3.1 Textiles shall be of sufficient strength to withstand all tests in clause 6 without sustaining damage. After testing of resistance to rot and/or illumination according to 4.2.2, cloth, seams (joints) and fastening devices (including zip fasteners) shall have a tensile strength of at least 300 N per 25 mm, when tested according to the method of ISO 5082.

4.3.2 Coated fabrics used in the construction of inflatable buoyancy chambers shall comply with the following requirements:

1) coating adhesion shall be tested in accordance with ISO 2411 : 1991, using the method described at 5.2.2.1 at 100 mm/min, and shall be not less than 50 N per 50 mm width;

2) coating adhesion shall also be tested when wet following ageing according to ISO 188, with an exposure of (336,0±0,5) h in fresh water at (70,0±1,0) °C, following which the method at ISO 2411 : 1991 5.2.2.1 shall be applied at 100 mm/min, and shall not be less than 40 N per 50 mm width;

3) tear strength shall be tested in accordance with ISO 4674 : 1977 using method A1, and shall not be less than 35 N;

4) resistance to flex cracking shall be tested in accordance with ISO 7854 : 1984 method A using 9 000 flex cycles, following which there shall be no visible cracking or deterioration;

5) breaking strength shall be tested in accordance with ISO 1421 : 1977 using the CRE or CRT methods following conditioning of (24,0±0,5) h at room temperature, and shall be not less than 200 N per 50 mm width when tested;

6) breaking strength shall be tested in accordance with ISO 1421 : 1977 using the CRE or CRT methods following conditioning of (24,0 ± 0,5) h immersion in fresh water at room temperature, and shall be not less than 200 N per 50 mm width when tested;

7) elongation at break shall be tested in accordance with ISO 1421 : 1977 using the CRE or CRT methods following conditioning of (24,0 ± 0,5) h at room temperature, and shall be not more than 60 %;

8) elongation at break shall be tested in accordance with ISO 1421 : 1977 using the CRE or CRT methods following conditioning of (24,0 ± 0,5) h immersion in fresh water at room temperature, and shall be not more than 60 %.

4.3.3 The other fabrics used in the construction of covers of inherently buoyant compartments, the retention system, and any other component the failure of which would render the entire item non-conformant with this standard, shall comply with the following requirements:

1) breaking strength shall be tested to ISO 5081 : 1977 using the CRE or CRT methods, following (24,0 ± 0,5) h conditioning at room temperature, and shall be not less than 10 N/mm;

2) elongation at break shall be tested to ISO 5081 : 1977 using the CRE or CRT methods, following (24,0 ± 0,5) h conditioning at room temperature, and shall be not more than 60 %;

3) tear resistance shall be tested according to ISO 4674 : 1977 [method A2, tensile speed (100 ± 10) mm/min, with a pretension of 2 N for materials of up to 200 g/m^2, 5 N for materials of over 200 g/m^2 and up to 500 g/m^2, and 10 N for materials of over 500 g/m^2], and shall be not less than 10 N.

4.3.4 Where the mass per unit area of a material is required to be measured, then it shall be measured according to method 5 of ISO 3801 : 1977.

4.4 Metal components

4.4.1 Corrosion

When tested in accordance with ISO 9227 : 1990 for a period of 96 h metal components shall not be significantly affected by corrosion. This shall be tested by a functional test following the corrosion test.

4.4.2 Magnetic properties

No component shall affect a magnetic compass of a type commonly used in small boats by more than 1 degree, when placed at a distance of 500 mm from it.

4.5 Oral inflation tubes

4.5.1 An inflatable PFD shall have a simple and rapid method of deflation, which shall also be used for oral inflation. This oral inflation tube shall be free from burrs and shall incorporate an effective non-return valve.

4.5.2 An inflatable PFD shall have a minimum air flow through the oral inflation tube of 85 ℓ/min, and the non-return valve shall open initially at an applied air pressure of between 1,0 kPa and 3,0 kPa, when tested according to 6.4.

4.5.3 If an oral inflation tube protrudes from the surface of the device, and the non-return valve either protrudes from the tube when in normal use or the valve can be separated, from the tube, then it shall be tested according to 6.5. It shall not be removable by a force less than (90^{+1}_{0}) N.

4.6 Inflation operating head

The operation status of the inflation head shall be clearly indicated by green for "ready to use" and red for "not in function".

An inflation operating head shall withstand a force of 220 N applied to it as described in 6.6 without any evidence of fracture, leakage of gas from the buoyancy chamber, or other damage.

4.7 Gas cylinder

4.7.1 A cylinder shall be seamless and of a type which is not rechargeable following release of its contents.

4.7.2 A cylinder excluding the sealing disk shall be capable of withstanding an internal pressure of 54 MPa without bursting.

4.7.3 The material from which a cylinder is made shall resist corrosion in a marine environment or shall be suitably protected to resist corrosion, when tested according to 4.4.1.

4.7.4 A charged cylinder shall not, when conditioned for (96,0 ± 0,5) h at a temperature of (65^{+2}_{0}) °C, lose gas or suffer any permanent change, except that a slight deformation of the cap which does not impair normal performance is permitted.

4.7.5 If filled with carbon dioxide, the maximum acceptable nominal mass in grams of carbon dioxide shall be no more than 75 % of the volume of the cylinder (in ml).

4.8 Types of buoyancy

4.8.1 At least the minimum amount of buoyancy required by this standard for the different classes of PFDs shall be provided by inherently buoyant material, by the inflation of chambers with gas or air, or by a combination of these.

The use of chambers permanently inflated with gas, or filled with inherently buoyant material which does not comply with this standard, shall not be permitted.

4.8.2 If a PFD contains inherently buoyant material which is divided itself into more than 150 separable slides or pieces, then the inherently buoyant material shall be retained in at least six separate compartments in the device, each compartment being of approximately equal size, so as to reduce the risk of physical damage to a part of the device resulting in severe loss of buoyancy. This has to be proved by testing according to 6.10 shock bin test and during the required cleaning procedure.

4.8.3 If the manufacturer claims that the PFD is only partially inherently buoyant, it shall provide by its inherent buoyancy alone at least the buoyancy required of an equivalently sized device under class D.

4.8.4 In the case a PFD is manufactured for use by children of under 25 kg in body weight and or less than 6 years of age, the PFD if inflatable shall be automatically inflated only and shall have additionally inherently buoyancy to class D (a so called hybrid device).

4.9 Inflatable buoyancy chambers

4.9.1 Inflatable buoyancy chambers shall be capable of withstanding an internal pressure of 40 kPa without damage or permanent deformation within a temperature range of −5 °C to 30 °C.

The device shall be tested with 40 kPa at −5 °C and at +30 °C, followed by a buoyancy test according to annex B.

4.9.2 Gas-inflated PFD shall be tested by the double inflation test according to 6.9.3 before the buoyance test of 4.9.1 is performed.

4.10 Inherently buoyant material

4.10.1 Any inherently buoyant material used to provide buoyancy shall be capable of withstanding compression and movement in normal wear without sustaining permanent loss of buoyancy. The maximum loss of buoyancy when three valid samples are tested according to the method at annex H shall not exceed 10 % in any foam material providing inherent buoyancy.

4.10.2 Any inherently buoyant material used to provide buoyancy shall be shown to have thermal stability under the conditions of the test described in 6.7, in which the maximum loss of volume in any sample shall not exceed 5 %.

4.11 Total buoyancy provided

4.11.1 For the purpose of assessment to this standard, items of different size are to be accompanied by stated minimum and maximum weight range equivalents, which shall be in reasonable accord with the marked size ranges (which may actually be set using other dimensions such as height and girth as desired). However, the primary means of indicating the device's size as regards fit shall be one which is appropriate and meaningful to the prospective user, for instance the statement of weight and girth ranges, as required by 8.1.

4.11.2 The minimum amount of buoyancy provided shall be calculated according to table 1.

Table 1: Minimum buoyancy

Wearer's weight in kg	up to 20	over 20 to 30	over 30 to 40	over 40 to 50	over 50 to 60	over 60 to 70	over 70
Min. buoyancy in N							
class A	90	120	140	170	200	230	275
class B	45	60	75	90	110	130	150
class C	30	40	50	60	70	80	100
class D	–	30	35	40	40	45	50

4.11.3 If a PFD is intended for two or more weight classes, the buoyancy shall be at least that stipulated for the heaviest class. Class D PFD shall not be offered to fit sizes smaller than those equivalent to a wearer weight of 20 kg.

4.11.4 The buoyancy of the PFD shall be tested according to annex B. The difference between the measurements 24 h apart shall not exceed 5 % of the original buoyancy. The buoyancy measured in any test carried out for the purpose of ascertaining conformance with this standard shall not be less than that claimed on the marking of the PFD, nor that required by 4.11.2.

4.11.5 Where the PFD is also fitted with additional buoyancy to that required by 4.11.2, it shall be manufactured from materials which are not detrimental to the performance of those used in compliance with this standard.

4.11.6 The total buoyancy measured shall for all tests be sufficient that, when diminished by the greater of the two percentage losses determined for any inherently buoyant material as determined at 4.10, it shall still meet the requirements of the respective category in 4.11.2. For example, if for a given device which requires a minimum buoyancy for its size of 50 N (according to 4.11.2), the lowest buoyancy measured under 4.11.4 is 53 N, and the tests according to 4.10.1 return a maximum loss of 4 % and according to 4.10.2 a maximum loss of 3 %. Then the minimum acceptable buoyancy would be 50 N+ (4 % of 50 N), which equals 52 N.

4.12 Colour

4.12.1 Class D PFD may be of any colour or multiple colours. The colour of the exposed portions of class A, B PFDs when deployed in normal floating position shall be in the range from yellow to red, excluding components such as webbing, zips and other fittings. Class C PFDs shall show 50 % of the area deployed when floating. The colour shall be checked against colour samples from the NCS colour atlas, and comparisons shall be made in daylight. The exposed portions shall, after illumination according to 4.2.2, have easily visible colours within the tolerance range defined by the following ranges:

0070 –
1070 – in tones
0080 – Y 30R – Y 80R
1080 –
0090 –

and

0070 –
0080 – in tones
0090 – Y – Y 20R

4.12.2 The colour of class A, B and C PFD shall be resistant to rubbing, wet and dry, when tested according to ISO 105 : X12 : 1987 to at least class 3, and to salt water when tested according to ISO 105 : E02 : 1989 to at least class 4.

4.13 Retroreflective material

4.13.1 There shall be affixed to the surface of the PFD at least the following:

class A: 400 cm^2;
class B: 300 cm^2;
class C: 100 cm^2

area of material which is retroreflective of light and complies with the specification at annex D. These areas shall be located above waterlevel when the PFD is in use.

4.13.2 If the PFD is sized for a child or small adult, and cannot provide sufficient surface area above water, then it shall be permitted to affix only the following:

class A: 300 cm^2, but not less than 200 cm^2;
class B: 200 cm^2, but not less than 100 cm^2;
class C: 75 cm^2, but not less than 50 cm^2

provided that the highest possible value shall be used for the available surface area.

4.13.3 There is no requirement for retroreflective materials to be affixed to class D PFD.

4.13.4 Exposed to wear and tear the retroreflective materials shall be checked regularly during the maintenance of the PFD and be replaced if necessary, according to manufacturer's recommendations.

4.14 Whistle

4.14.1 Class A, B and C PFD shall be provided with a whistle which is not adversely affected by water or humidity, and shall be firmly attached to the PFD by means of a lanyard, and housed in a loop or small pocket on the PFD. The position of the whistle and the length of the lanyard shall be such that the whistle can be deployed and brought to the mouth when the PFD is being worn correctly in the water. The whistle shall be tested according to the requirements of EN 394, 4.3.

4.14.2 If a class D PFD is provided with a whistle, the requirements of 4.14.1 shall apply.

4.15 Becket

4.15.1 For class A and B PFD only, there shall be affixed to the PFD a lifting becket, which shall be constructed of a rot-resistant material and which is suitable for gripping by hand or affixing lifting devices.

4.15.2 It shall withstand a load of 2 600 N for adult sizes, and 1 500 N for children's sizes, when tested in accordance with the method in A.2, following which there shall be no evidence of damage which might impair the function of either the becket or the PFD.

In case of SOLAS approval, the load shall be 3 200 N for adult size and 2 400 N for children's size to be applied for a period of 30 minutes without damage to the device.

4.15.3 The becket shall be positioned over the centre of the chest, anterior to lines from each axilla to midway between the lower end of the sternum and umbilicus, and within 100 mm of the midline.

4.15.4 The minimum length of the loop of the becket shall be 100 mm, as measured from one side of the loop to its furthest point on the loop from that side.

4.15.5 The minimum width of the becket shall be 25 mm.

4.15.6 The colour shall be distinctive from that of the PFD.

4.15.7 The becket shall be conspicuous when the wearer is floating normally, but may be enclosed within a cover when the PFD is being worn but is not deployed to aid flotation.

4.16 Strength

The strength of assembly shall be tested according to annex A for (5,0±0,1) min for both wet and dry conditions. No damage shall result which would result the PFD failing to function in accordance with this standard. The means of adjustment shall not have a slippage of more than 25 mm when supposed to the test. They shall be marked accordingly (e. g. at the position of webbing passing through a buckle).

The required load shall correspond to double the body weight, but not more than 2 000 N for horizontal and 750 N for vertical load.

For SOLAS application the load shall be 3 200 N and 900 N for adult size, respectively 2 400 N and 700 N for children's size and be applied for 30 min without damage to the device.

4.17 Performance of PFD

4.17.1 The PFD shall not be uncomfortable in design nor weight when worn, nor unnecessarily bulky, when tested according to 6.8.

4.17.2 It shall not unduly restrict the vision, hearing or breathing of the wearer when tested according to 6.8.4 and 6.8.9.

4.17.3 It shall not contain nor have attached any component which in normal use is capable of causing injury or discomfort to the wearer or damage due to hazardous attachments. This shall be tested according to 6.8.5 and 6.8.7.

4.17.4 The device shall not hinder the wearers dexterity. It shall be possible to swim whilst wearing the PFD, tested to 6.8.8, and to climb a ladder as tested to 6.8.9.

4.17.5 It shall be simple to maintain in a fully serviceable condition whether in continuous or repeated use or if stowed for long periods in reasonable conditions. It shall be resistant to crushing and compression as tested to 6.10.

4.17.6 It shall not form channels having a tendency to direct water into the face or to the head of the wearer.

4.18 Sprayhood

If any form of sprayhood is fitted to cover the face in whole or in part (e.g. to protect mouth and nose from water splash), then it shall not result in excessive levels of carbon dioxide forming within it, when tested to 6.11.

Sprayhoods shall normally be stowed in a position which puts them clear of the face of the wearer, which does not interfere with the normal operation of the lifejacket, and which is not a hazard, for example snagging on other objects. They shall be able to be unstowed and deployed to protect the airway whilst the wearer is in the water, with the PFD fully deployed and inflated, if inflatable. When deployed, they shall not impair the performance of the PFD in such a way as to render it no longer compliant with the relevant standard. In particular, they shall be fitted with a clear area to enable the wearer to see sufficient of his surrounding as to aid his rescue. If when deployed, the sprayhood reduces the effectiveness of any retroreflective material on the lifejacket itself, then the sprayhood shall itself provide an additional area at least equal to that obscured. Sprayhoods shall be easily removable from their protective position, and shall be capable of being restowed so that they do not fall back to their deployed position. PFDs including sprayhoods complying with this standard shall be marked with the number of the EN standard to which they conform, postfixed with the word "sprayhood".

4.19 Donning, adjustment and fit

4.19.1 Donning shall be obvious and simple on the briefest of instructions. If shall be possible without assistance, except in PFD intended for use by children. The ease in donning and discarding the PFD shall not be unduly affected by adverse conditions in use such as poor light, cold or wet. When tested in accordance with 6.8.3, donning shall take no longer than 1 min.

4.19.2 The means of adjustment within the stated size range shall be obvious and easy to carry out to ensure a secure fit. This shall be assessed to 6.8.3, 6.8.8 and 6.8.9. Security of fit shall not be dependent upon highly elastic material. If crotch straps or other non-elastic devices for improving the security of fit and retention are provided, and it is possible (without physically damaging the PFD) to wear the PFD with and without the straps or devices, then all tests in 6.8 shall be performed with and without the straps or devices in place.

4.19.3 The PFD shall allow the wearer freedom in action and movement when assessed to 6.8.4, 6.8.9 and 6.8.10.

4.19.4 The PFD shall not show any tendency for the wearer to slip out of it whilst in use during the tests in 6.8.

4.19.5 If a PFD requires further actions by the wearer, such a manual activating, oral inflation or secondary donning, this has to be proved by a related test procedure in and out of water.

4.20 Inflation system

4.20.1 Gas inflated PFD shall inflate sufficiently within 5 s of operating the inflation mechanism when tested to 6.9.3. Orally inflated PFD shall be capable of being fully orally inflated by a healthy young adult within a 1 min period, when tested to 6.9.2. This shall also be proved, performing in water and to top up the inflation orally when in water, as tested to 6.8.10.

4.20.2 The force required to operate the pull toggle on an inflation operating head shall not exceed 75 N, but shall exceed 20 N when tested according to 6.9.3.2.

4.20.3 An automatically inflated class A, B, C and D PFD shall be subjected to the spray test described in annex G, during which the inflation mechanism shall not operate.

4.20.4 Automatically inflated PFD shall initiate firing in automatic mode within 5 s of testing according to 6.9.4.

4.21 In-water performance

4.21.1 Class A, B and C PFD shall provide lateral and occipital support of the wearer's head so that the mouth of a well relaxed individual is held well clear of a still water surface, with the trunk of the body inclined backwards from the vertical at an angle of between 30° and 90°, when tested as described in 6.8.6. The freeboard measured using the method described at annex F shall not be less than the following:

class A 100 mm;
class B 80 mm;
class C 80 mm

in any subject. When testing small children, see 6.8.1.

If SOLAS approval will be required the freeboard shall not be less than:

all classes 120 mm

4.21.2 The PFD (if inflatable, when inflated) shall automatically turn a well relaxed person into the position required by 4.21.1 when tested to 6.8.6.

4.21.3 Class D PFD shall keep the wearer in a near-vertical or slightly backwards-inclined position and not tend to tilt the wearer from an initial vertical position forward onto his stomach. Assessment of the wearer's clearance shall be performed when balancing in the initial near-vertical position, as described in 6.8.6 and 6.8.7. The wearer shall breathe normally. Class D PFD shall maintain the airways (mouth and nose) clear of the water in all tests in 6.8.

4.22 Multi-chamber buoyancy systems

4.22.1 Principles

Multi-chamber buoyancy systems of at least two independent chambers are required under SOLAS application.

Multi-chamber buoyancy systems shall be of one of three types:

a) the buoyancy system can consist of two or more independently operating chambers which can be separated from each other. In this case, each operating chamber shall when tested separately meet at least the requirements of EN 395, as regards material strength, inflation characteristics, performance standards, etc.;

b) the buoyancy system can consist of two or more independently operating chambers which cannot be separated from each other, and any one of which is capable of filling the entire PFD in the absence of

inflation from others (most employ a 'diaphragm' technique to achieve this). In this case, each operating chamber shall, when tested with the others uninflated, meet at least the requirements of EN 395. Each chamber shall be capable of providing a minimum of 100 % of the buoyancy required under the applicable PFD standard. Each PFD shall be tested by first inflating one chamber fully to a pressure of (0,05 ± 0,01) kPa and then left for (30^{+}) min at a temperature of 15 °C to 25 °C. Each operating head shall then be fired in turn, allowing a (30^{+}) min period between each, until all the chambers have been fully inflated, and the first has been inflated using two means (oral and gas). No rupture or visible damage shall result. In the event that both chambers can be inflated orally, this test shall be repeated in full with the other chamber being inflated prior to firing each operating head;

c) the buoyancy system can consist of two or more independently operating chambers which cannot be separated from each other, and each of which provides a different and individual buoyancy, and all of which shall be capable of simultaneous inflation. In this case, each operating chamber shall meet at least the requirements of EN 395. However, inflating all the available buoyancy chambers will result in a much higher total buoyancy than inflating any single one.

4.22.2 Buoyancy value

PFDs which achieve the requirements of this standard shall be classified as having reached the standard appropriate to that of the combined maximum total buoyancy (i. e. the maximum buoyancy resulting from the inflation of all the chambers simultaneously), provided that they meet the requirements of that standard in all other respects.

4.22.3 Marking

PFDs containing buoyancy systems complying with this standard shall be marked with the number of the EN standard to which they conform, postfixed with the words "multi-chamber buoyancy system".

4.23 Overpressure relief valve

Overpressure relief valves may be only provided to one compartment of multi-chamber buoyancy devices, such as SOLAS PFDs, to provide the likelihood of a pressure causing damage to corresponding compartments, i. e. based on the membrane-technique. If provided, the valve shall be located and arranged to reduce the likelihood the valve becoming blocked or otherwise rendered ineffective.

4.24 Quality of PFD

The quality of product and production has to be proved by the manufacturer in a follow up procedure, whereas the products and/or the production are inspected regularly by the testhouse on an annual base. Otherwise the manufacturer may establish a quality management system according to ISO 9000 supervised by an accredited testhouse. This may be superseded by national regulations.

5 Sampling

5.1 Materials and components

5.1.1 Samples

Materials and components common to a range of samples may be presented as one sample of each item.

5.1.2 Conditioning

Prior to testing materials and components shall be conditioned for 24 hours ±0,1 hour under standard atmosphere.

5.2 Performance tests using human subjects

Performing tests with human subjects the Declaration of Helsinki has to be taken into account. Most performance tests are subject to influence of natural variation, particularly in the morphometry of individual subjects. It is always possible to find, within the requirements below, subjects who are sufficiently different from the average as to behave unusually. Every effort must therefore be made to ensure that, within the weight ranges stipulated, subjects are close to average in morphometry.

5.3 Subject requirements

PFD's of classes A, B, C, D and PFD's for special purpose shall be tested by at least six subjects if the device is unilarge. If the manufacturer offers different sizes at least five subjects for classes A, B and C and three subjects for class D PFD shall be used to test each of the manufacturer's size ranges, but no more than 18 subjects in total, according to the restrictions of table 2.

Table 2: Subject

Size range	Subject requirements
class A, B and C	
up to 20 kg	1 subject under 15 kg; 3 subjects 18 kg to 20 kg; at least 1 subject up to 20 kg
ranges 20 kg to 70 kg	1 subject in the lowest 10 % of the manufacturer's stated size range; 3 subjects in the upper 10 % of the range; at least 1 other subject within the stated range
less than 20 kg to less than 70 kg	1 subject under 15 kg; 1 subject 18 kg to 20 kg; in the upper 10 % of the range; at least 1 other subject within the stated range
70 kg and over	70 kg to 80 kg; 1 subject 80 kg to 90 kg; 1 subject 90 kg to 100 kg; at least 2 other subjects of 70 kg
less than 70 kg to 70 kg and over	2 subjects in the lowest 10 % of the manufacturer's stated size range; 1 subject 80 kg to 90 kg; 1 subject 90 kg to 100 kg; at least 1 other subject within the stated range
class D	
30 kg to 70 kg	1 subject in the lowest 10 % of the manufacturer's stated size range; 1 subject in the highest 10 % of the range; at least one other subject within the stated range
70 kg and over	1 subject 70 kg to 77 kg; 1 subject 85 kg to 100 kg at least one subject of over 70 kg
30 kg to 70 kg and over	1 subject in the lowest 10 % of the manufacturer's 1 subject 85 kg to 100 kg; at least one other subject within the stated range

EXAMPLE 1:
A single PFD claimed to be suitable for sizes equivalent to a 40 kg to 60 kg weight range requires 1 subject 40 kg to 44 kg and 3 subjects 54 kg to 60 kg, and at least one other subject to make a total of five.

EXAMPLE 2:
A single PFD claimed to be suitable for sizes equivalent to less than 20 kg to 40 kg weight range requires 1 subject under 15 kg, 1 subject 18 kg to 20 kg, 2 subjects 36 kg to 40 kg, and at least one other subject to make a total of five.

EXAMPLE 3:
A single PFD claimed to be suitable for sizes equivalent to greater than 50 kg weight range requires 2 subjects 50 kg to 55 kg, 1 subject 80 kg to 90 kg, and 1 subject 90 kg to 100 kg, and at least one other subject to make a total of five.

EXAMPLE 4:
A single class D PFD claimed to be suitable for sizes equivalent to a 40 kg to 60 kg weight range requires 1 subject 40 kg to 44 kg, 1 subject 54 kg to 60 kg, and at least one other subject to make a total of three.

EXAMPLE 5:
A single class D PFD claimed to be suitable for sizes equivalent to greater than 50 kg weight range requires 1 subject 50 kg to 55 kg, 1 subject 85 kg to 100 kg, and at least one other subject to make a total of three.

5.4 Sex and dress

Subjects shall include both males and females and no more than 2/3 of one sex, and they shall wear bathing costumes.

5.5 Criteria for passing and failure

All required samples shall pass all objective tests for the entire device to meet the requirements of this standard. However, due to the high variability between subjects and the difficulty in assessing some subjective measures, it is permitted that a device does not completely meet the requirements of a subjective test in a single example and in no more than one test subject. In these circumstances, another two examples or subjects (within the same weight category, if applicable), as appropriate, should be subjected to the same test and before the same test panel as at 6.8.1. If this additional test is still not clearly passed as required in this standard, then the device shall be deemed to have failed, whilst if it is clearly passed, the test panel may deem that the device has passed the test procedures.

6 Test methods

6.1 Principles

All tests procedures described hereafter shall be performed by thirdparty testhouses only, which shall comply with the requirements of EN 45.0xx and or ISO Guide 25 or ISO CASCO 228. This may be overruled by national or European rules and regulations such as accreditation of notification of testhouses by governmental authorities. Testhouses and members of the test panel shall be experienced in testing PFDs.

6.2 Temperature cycling

The PFD shall be conditioned, in its normal storage state, and then exposed for (24,0 ± 0,5) h at a temperature of (−30 ± 2) °C, then for (24,0 ± 0,5) h at a temperature of (65 ± 2) °C. If the PFD is inflatable, it shall be inflated to the designated working pressure and maintained at that pressure for (10 ± 1) min at the end of each period. Any leakage and damage shall be assessed by visual and aural examination and be reported. The device shall undergo ten cycles and tested afterwards for buoyancy loss according to annex B.

6.3 Oil and water resistance

The PFD (if inflatable, in the uninflated condition) shall be immersed completely in a series of three tanks of water, spending (7,0 ± 0,1) h in each, in between each being allowed to dry for (17,0 ± 0,1) h. The first tank shall contain fresh water, the second sea water (salinity approximately 5 % m/m NaCℓ), and the third sea water

with a (3 ± 1) mm surface layer of light diesel oil. This cycle shall be repeated a total of four times, following which it shall be assessed for damage and, if inflatable, the PFD shall be inflated and then assessed by visual and aural examination. If the PFD is automatically inflated, the mechanism producing automatic activation shall be removed prior to this test, and it shall be inflated using the manual mechanism on completion.

6.4 Oral inflation tube flow

The oral inflation tube shall be removed and connected in parallel with a manometer. Air shall be provided under pressure to the end normally used for inflation, and the other end connected to an air flow meter capable of measuring flows of the order of 0,17 m^3/min. The inflation tube shall be mounted vertically. The air supply shall be turned on and the pressure of the supply gradually increased until the oral inflation valve opens, the pressure of which recorded on the manometer shall be taken as the initial opening pressure. The air supply shall then be increased until a reading of (7,0 ± 0,1) kPa is recorded on the water manometer. When steady conditions supervene, the reading on the air flow meter is taken as the flow through the tube.

6.5 Security of protruding oral inflation valve

Following the conditioning of the PFD at (−10 ± 2) °C for (48,0 ± 0,5) h the stiction (initial sticking friction) between the oral inflation tube and valves which rely entirely on friction only for retention, shall then be broken by rotating the valve within the tube using pliers. Then, a force of (90 ± 1) N shall be applied to the valve in an attempt to extract it from the inflation tube, within 20 s of removal from the conditioning temperature. The security of the valve shall be observed. This test shall then be repeated following conditioning of the PFD at standard atmosphere.

6.6 Security of operating head

The fully inflated PFD shall be mounted on a manikin, and a steady force of (220 ± 10) N applied to the operating head as near as possible to the point where it enters the buoyancy chamber. This load shall be maintained for (5,0 ± 0,1) min, during which the direction and angle in which it is applied shall be continuously varied. The PFD shall be examined for signs of deflation.

6.7 Thermal stability of buoyancy material

Three test specimens of dimensions (200 ± 2) mm by (200 ± 2) mm of a thickness of (20 ± 2) mm shall be conditioned initially in air at (23 ± 2) °C and (50 ± 5) % relative humidity for at least 24 h before carrying out the test. If the buoyancy material is of a granular form, or consists of sheets thinner than 20 mm, then either a number of layers shall be used to achieve a minimum total thickness of 20 mm, or a minimum volume of material of 1 ℓ shall be tested, as appropriate.

Each specimen shall then be weighed in air, and undergo measurements described in annex C. After measurement in water the specimens shall be conditioned in air at (23 ± 2) °C and a relative humidity of (50 ± 5) % for (24,0 ± 0,1) h.

They shall then be placed on a flat surface in an oven maintained at an even temperature of (60 ± 1) °C with air circulating at the rate of 3 to 10 changes per hour, for a period of (7,0 ± 0,1) h. Only test specimens from the same device shall be conditioned in one oven at a time.

Following removal from the oven, specimens shall be laid on a flat surface for (17,0 ± 0,1) h at (23 ± 2) °C and (50 ± 5) % relative humidity.

They shall then be exposed in a similar container to an even temperature of (−30 ± 1) °C for a period of (7,0 ± 0,1) h, then removed and laid on the flat surface for (17,0 ± 0,1) h at room temperature as before.

This cycle of exposure to alternating high and low temperatures shall be repeated until the samples have been exposed to each temperature for ten periods. The measurements of annex C shall then be repeated, and the percentage volume change calculated.

6.8 Performance tests

6.8.1 General

To perform the following test procedures, the Declaration of Helsinki has to be taken into account.

The PFD shall be tested by the subjects selected according to clause 5, in front of an assessment panel experienced in assessing PFD, and consisting of not less than three persons acting on behalf of the testhouse, in a swimming pool containing fresh water, treated as necessary for hygienic purposes, as follows. The tests may be modified according to the age of child subjects so as to ensure their complete safety and co-operation. When assessing childrens' sizes, the panel shall make greater use of subjective indicators, as self-righting and jumping are often hazardous and meaningless measures when applied to small children: however, the position in the water and support afforded are much more useful indicators in this case than e.g. freeboard measurement.

6.8.2 Combinations

Where the PFD forms an integral part of a safety harness or other garment tested to a European or International standard, the performance shall be tested in conjunction with the safety harness or other garment.

6.8.3 Donning

After reading instructions printed on the PFD the test subject shall don and securely adjust the PFD within 1 min. The PFD shall then be removed. If the PFD is an integral part of another garment, then this test shall only apply to its donning and doffing for its function as a PFD.

6.8.4 Ergonomics

The subject shall assess comfort in wear, and the PFD shall be demonstrated to allow adequate head and limb movement, and that it shall not interfere with vision, hearing or breathing, wearing the device ashore and in the water.

There shall be no hard protrusions nor sharp edges.

6.8.5 Water entry test

An inflatable PFD shall then be donned and inflated, others shall be donned, in which condition it shall remain for the rest of the performance tests below. The test subject, initially with arms at his/her sides, shall stand sideways to the water and fall or step into the water from the side of the pool, which shall be no more than 500 mm above water level. The panel shall observe that the PFD brings the wearer to the surface and permits the subject to maintain a vertical or backwards inclined attitude without having to carry out any movement other than postural adjustment or small head movements.

6.8.6 Self righting test

The test subject shall then carry out the following two tests of self-righting for class A, B and C PFD:

6.8.6.1 The test subject, with arms at his sides, shall lie in the water and take a full breath, then turn or be turned until face down. The subject shall then relax the body and arms fully and exhale. The PFD shall be seen to bring the wearer face up within 5 s of relaxation without him having to carry out any voluntary movement, which time shall be measured as that between the subject relaxing fully in the face down position, and the mouth and nose being brougth clear of the water surface.

6.8.6.2 The test subject shall then carry out the following sequence of actions:

a) swim three very gentle strokes so as to make hardly any progress through the water, using breast stroke and take a full breathe;

b) calmly move his arms to his sides so that they are along the length of his body and held against it;

c) calmly bring his legs together so that they are in line with his body;

d) stretch his body out straight, but not held rigidly so;

e) exhale completely.

The subject shall then remain passive but maintain this alignment of the body whilst the panel measures the time taken from e) until such time as the mouth and nose are brought finally clear of the water and the subject can breathe normally again. This time shall not exceed 10 s, after which the test shall be terminated even if unsuccessful.

The device has to pass at least one of the procedures successfully.

6.8.6.3 For determination of the floating position of class D PFD, the initial position shall be the near-vertical one achieved by each individual, and the subject shall breathe normally for a person in repose. The righting tendency of the PFD is determined from this initial position. For assessment of clearance the subject may balance in the vertical position by means of small head movements.

6.8.7 Jump test

The test subject shall jump into the water from a height of at least 3 000 mm without displacement of, or damage to, the lifejacket.

Related to SOLAS approval, 4 500 mm will be required.

To perform the jump the subject shall be trained accordingly.

For the purposes of this test, the subject shall brace arms on the PFD as recommended by the manufacturer (or, failing any such recommendations, as is standard practice). Any elastic used to improve the fit of the garment shall be cut prior to the test.

Devices shall be tested according to there designed designation, means automatically inflated devices shall be used uninflated, manually inflated devices both inflated and uninflated combined with the correlated activating procedure.

6.8.8 Swim test

The test subject shall demonstrate his ability to swim at least 25 m without undue restriction. Observations shall be made by the panel during the swimming on the security of the lifejacket, comfort in wear and freedom of movement. The stability test at 6.8.6 shall then be repeated.

6.8.9 Dexterity

Observations shall be made by the panel during the swimming on the security of the PFD, comfort in wear and freedom of movement.

In case of an inflatable PFD the wearer shall demonstrate that its inflation can be topped up by mouth while in the water.

The wearer shall demonstrate that he/she can reach and activate any additional item such as whistle, buddy line, light etc.

Manually-operated PFDs or PFDs requiring secondary donning shall prove this in and out of the water.

All PFDs shall be demonstrated, that whilst wearing the device, the test subject can climb out of the water by a vertical ladder which extends at least 2 500 mm and board a platform as shown in Annex L.

6.8.10 Secondary donning

All devices requiring additional action by the wearer, such as oral inflation or other activities in a way of secondary donning, shall prove the required action to be performed in water within 30 sec.

6.9 Inflation tests

6.9.1 General

Where necessary, the following tests shall be carried out using normal air.

6.9.2 Orally inflated PFD shall be inflated by each test subject, none of which shall have any impairment of normal pulmonary function, from the completely uninflated status to that which provides sufficient buoyancy to comply with this standard, in no more than 1 min. This shall be performed out of the water and in normal room temperature.

6.9.3 Gas inflated PFD

6.9.3.1 Gas inflated PFD shall achieve sufficient buoyancy to comply with this standard, including correct distribution through the chambers, within 5 s of the inflation mechanism being activated when held at a temperature of 15 °C to 25 °C. This shall be assessed visually, except in cases of doubt the procedure described in annex B shall be modified to use a load cell to record mass against time on a chart recorder, and the operating head of the PFD adapted so that it can be fired whilst it is immersed. The chart shall be started prior to firing, and the time measured between operation of the inflation mechanism and achievement of the buoyancy prescribed according to 4.11.2.

6.9.3.2 The PFD shall be placed securely on a manikin and a force of $(20^{\ 0}_{-2})$ N applied in the correct direction to the pull toggle to fire the operating head. The head shall not fire, but shall fire correctly when a force of $(75^{+5}_{\ 0})$ N is applied in the same manner.

6.9.3.3 Gas-inflated PFD shall be inflated to an internal pressure of air of 3,5 kPa in an ambient temperature of (20 ± 5) °C. Following this, the operating head shall be fired manually, using a fully-charged gas cylinder according to the manufacturer's recommendations.

The pressure shall then be increased to 1,2 of the pressure achieved before and kept for 5 min. The buoyancy chambers shall then be examined for visible signs of damage.

6.9.3.4 Automatically inflated class A, B and C PFD shall first be conditioned by exposing them for (5,0 ± 0,1) h to an air temperature of (0 ± 1) °C. Then, without any period in warmer air, they shall be plunged rapidly until the operating head is at a depth of (300 ± 50) mm beneath the surface of fresh water at a temperature of $(0^{+2}_{\ 0})$ °C.

The time from immersion until initiation of inflation in automatic mode has to be reported. It shall not exceed 5 s.

6.10 Crushing and compression tests

The PFD, uninflated if inflatable, shall be subjected to the test described in annex J. Following this, inflatable PFDs shall be inflated for inspection.

There shall be no visible signs of damage which could make the PFD incapable of further repeated use.

6.11 Sprayhood test

If any form of hood or sprayhood is fitted to cover the face in whole or in part to protect mouth and nose from water splash, then it shall be demonstrated, that the carbon dioxide level within the hood does not exceed 5 % at any place at any time when tested according to annex K.

6.12 Flammability

The complete PFD, if inflatable then tested in the inflated state, shall be subjected to the test in annex E. The PFD shall not burn or melt for more than 6 s following removal from the flames. If inflatable, it shall remain inflated throughout the test. No damage shall be visible to the PFD following the test other than discolouration of the exposed parts, and it shall be apparent that it remains structurally sound, that the effective buoyancy is unaffected, and that its performance to the relevant European Standard for PFDs is unaffected.

7 Explanatory leaflet

Each PFD shall be supplied with an explanatory leaflet, and written in at least the official language(s) of the member state of destination, containing at least the following items:

1) items given at 8;

2) the recommendation that the wearer should try out the PFD in water to ascertain its performance before use;

3) full donning and use instructions;

4) details of the recommended limitations to use, including sea conditions, temperature limits, and any other pertinent information; especially related to device for special purpose;

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

6) the names and addresses of manufacturers agents within at least the member state of destination;

7) compatibility with safety harnesses and other clothing and equipment as relevant;

8) such other general advice on the care and use of PFD as the manufacturers see fit.

8 Marking

8.1 Information related to the PFD

8.1.1 Consumer information on the device

The PFD shall be permanently and legibly marked with the following (which shall be given at least in the official language(s) of the member state of destination). Information shall be given as pictograms, or as text combined with pictograms, or, if defined pictograms do not exist, as text alone.

1) identification of the manufacturer; at least name of manufacturer or distributor and mailing address;

2) title of the PFD according to annex K and whether manually or automatically operated;

3) on inflatable PFD, the statement that it is not a PFD until fully inflated;

4) size range of the PFD, e.g. range of chest or waist girth and mass of wearer;

5) minimum buoyancy provided and amount of inflatable buoyancy if provided;

6) storage, care, cleaning and maintenance instructions in brief;

7) simple donning and adjustment instructions;

8) simple instructions for use;

9) if inflated by gas, the correct size and charge of the cylinder; to be near the place where the cylinder is actually fitted.

10) a warning that gas-cylinders are dangerous goods and to be kept away from children and misuse.

11) the manufacturer's model, designation, serial number, and quarter (or month) and year of manufacture. Months are to be given as Arabic numerals (1 to 12), and quarters as Roman numerals (I to IV) in order starting from 1st January;

12) the number of this International Standard;

13) pictograms or words indicating other risks catered for or not provided for;

14) the text "Do not use as a cushion";

15) "Train yourself using the device"

16) and if intended for a child of less than 6 years age, the text "Teach the cild to float in this PFD";

17) if intended for children of less than 6 years age "use automatically operating devices only".

18) for class D, the text "For those who can swim and are close to help";

19) devices for special purpose have to spell out their range of application exclusively;

20) the expected servicing interval assuming average use, and a space for servicing dates to be marked, including additional items and their replacement, such as retroreflective tapes;

21) compatibility with safety harnesses and other clothing and equipment as relevant;

22) the text "Full performance may not be achieved using certain clothing or in other circumstances. Refer to the leaflet."

Any label bearing this information shall be permanently affixed to the PFD, shall be resistant to salt water to the same requirement as in 4.12.2, and stand at least 10 washes carried out in accordance with the manufacturer's recommendation. Neither shall the label shrink so as to affect the appearance or performance of the PFD or its own legibility.

8.1.2 Consumer information at point of sale

For satisfying the requirements concerning consumer information there are two options available: A plain text version and a pictogram version.

The information shall be clearly visible and legible when the device is presented ready for sale, either by ensuring visibility of a marking on the PFD itself or by additional labelling on the packaging. If the presentation of information is divided in various sections they shall be given such that the consumer can perceive all sections together.

8.1.2.1 Plain text version

Personal flotation device	ISO/CD	(1)
Standard application	Class	(2)
Offshore, extreme conditions Heavy protective clothing	A	(3)
Offshore, extreme conditons Foul weather clothing	B	(4)
Sheltered waters	C	(5)
Swimmers only, sheltered waters Help at hand	D	(6)
MANUFACTURER:		(7)
PERSONAL FLOTATION DEVICES ONLY REDUCE THE RISK OF DROWNING! THEY DO NOT GUARANTEE RESCUE		(8)

Figure 1: Label specification

Personal Flotation Device	CE	Special features						
ISO/CD		Application			Canoeing, dinghy sailing, surfing			
Standard Application	class	Fully automatic	Manual operation	Only oral inflation	Inflatable buoyancy	Inherent buoyancy	Integrated harness	May not be used with harness
Offshore extreme conditions, heavy protective clothing	A							
Offshore, foul weather clothing	B							
Sheltered waters	C							
Swimmers only, sheltered waters Help at hand	D					X		X
MANUFACTURER:		Fit	Size	Chest		Weight	Minimum buoyancy	
				cm		kg	N	
			large	112 to 127		70 to	'50/100/150/275	
PERSONAL FLOTATION DEVICES ONLY REDUCE THE RISK OF DROWNING! THEY DO NOT GUARANTEE RESCUE		↓	medium	99 to 112		60 to 70	45/80/130/230	
			small	86 to 99		50 to 60	40/70/110/200	
			child	76 to 86		40 to 50	40/60/90/170	
			child	66 to 76		30 to 40	35/50/75/140	
			child	50 to 66		20 to 30	-/40/60/120	
			child	34 to 50		to 20	-/30/45/90	

Figure 2: Example of consumer information label for class D (combination of figure 1 and date list in table configuration)

If the plain text version was chosen, the table as shown in figure 1 shall be laid out according to that figure and be of minimum dimensions 7,5 cm × 7,5 cm. Colours may vary, but shall be always contrasting to the background. Information completing row 7, "MANUFACTURER", may be given by plaintext data or by representing suppliers logo.

The table shown in figure 1 may form the left hand side of a complete label presenting all stipulated data (see figure 2).

The data list below includes all variable data enabling the consumer to be informed about performance and size of the device. All data shown as contents of the list may be given in the way as shown in figure 2 or by any other format and layout satisfying the requirements under 8.1.2.

8.1.2.2 Data list

The following information shall be given, if applicable:

1) the generic terms specified in annex K shall be used for designation.

2) statement or the relevant standard and type

3) The minimum height of letters and figures for 1) and 2) shall be 5 mm.

4) "SPECIAL FEATURES"*)

5) "SPECIAL APPLICATION"**)

6) Whether the PFD is:

7) fully automatic inflatable

8) manually inflatable

9) only orally inflatable

10) Whether the buoyancy is provided by:

11) inherent buoyant material

12) gas, air [see also 7) to 9)]

13) inherent buoyant material and gas or air.

14) Amount of buoyancy:

15) in total

16) as parts of inherent and inflatable buoyancy

17) Whether a lifebelt:

18) is intergrated in the device

19) can be worn on the body with the flotation device above

20) Size of the device:

21) by ticking in the relevant size of a given size table (see figure 2) or

22) by giving the relevant body dimension of the person concerned (body height, chest circumference or body weight or an adequate combination of these).

---

*) special features are given if the device offers more than the equipment and performance required by the standard, e.g.: integrated spray cap, performance under extreme climatic conditions, etc.

**) description of special applications, e.g.: applicable for working place conditions including stesses, like arising from welding, metal grinding or "not applicable for leisure use", etc.

If the recommended diagram as shown in figure 2 is applied, data on this diagram which are applicable to the device shall be clearly marked to indicate their presence, or the appropriate figures inserted, as exemplified in figure 2.

8.1.2.3 Pictogram version

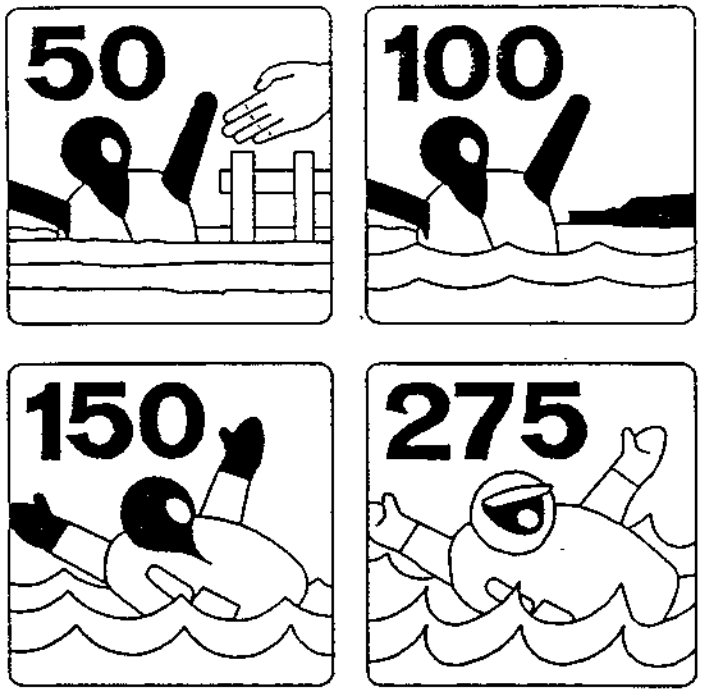


Figure 3: Pictograms

The section "STANDARD APPLICATION", rows 2 to 6 of figure 1, may be replaced by the pictograms shown in figure 3. The minimum dimensions of these pictograms shall be 50 mm x 50 mm. The remaining contents of rows 1; 7 and 8 of figure 1 shall be presented according to the requirements under 8.1.2.

The designation of the relevant standard may be added under the pictogram. For a period of introduction and transition of five years the pictrograms shall be presented together with at least the text given in rows 3 to 6 of figure 1.

8.2 Gas cylinders

Gas cylinders shall be marked indelibly with at least the following:

1) minimum gross weight of cylinder in g;

2) nominal gas charge contained within the cylinder in g;

3) the chemical formula of the gas contained (e. g. CO^2);

4) a warning, that gas cylinders are dangerous goods to be kept away from children.

Annex A (normative)

Load tests

A.1 Vertical and horizontal load tests of PFD

A.1.1 Principles

Subject the PFD to tension via the integral waistbelt, girder or harness arrangement, by means of a specified load. Perform a vertical load test consecutively to a horizontal load test on the same PFD sample.

The load shall be applicated for 5,0 ± 0,1 min for both wet and dry condition. No damage shall result in the PFD failing its function. The means of adjustment shall be marked and the maximum acceptable movement of the mark during each test period shall be not more than 25 mm.

The load can be applicated as described in the following or in comparable arrangements such as hydraulic test jigs.

A.1.2 Apparatus

The apparatus consists of a horizontally suspended upper cylinder, of diameter (50 ± 5) mm for the PFD wearer sizes up to 30 kg, or of diameter (125 ± 10) mm for PFD wearer sizes of 30 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 vertical load tests shown in figures A.1 and A.3 the lower apparatus shall have the dimensions as indicated in figures A.5 and A.6. The diameter of the tube shown in figure A.6 for PFD wearer sizes up to 30 kg shall be (50 ± 5) mm and shall be (125 ± 10) mm for wearer sizes of 30 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. The total test mass for all sizes shall be (750 ± 5) N.

For the horizontal load test shown in figures A.2 and A.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 A1A2 and B1B2 respectively, shown in figures A.2 and A.4.

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

An additional test load shall be applied. The total load shall either be equivalent to that load exerted by two times the maximum body mass of the PFD wearer body weight, or (2 000 ± 5) N in the case of PFD designed for wearers of over 70 kg.

A.1.3 Vertical load test

The PFD shall be fitted to the upper test cylinder, in the manner shown in figure A.1 for halter types or figure A.3 for vest types.

For halter types adjust the harness to fit the body. For vest types, fasten the PFD in such a way that any adjustment devices are in the mid position, in the manner specified by the manufacturer in his instructions. If either type is inflatable it shall be fully inflated. Mark the position of any adjustment devices relative to the webbing passed through them.

Attach the load suspension cord to the PFD in the appropriate positions shown in figures A.1 and A.3. 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 defects. Measure any adjustment device slippage.

A.1.4 Horizontal load test

Fit the PFD (if inflatable fully inflated) to the upper test cylinder, in the manner shown in figure A.2 for halter types or figure A.4 for vest types. Fasten the PFD such that any adjustment devices are in the same mid position in the manner specified by the manufacturer in his instructions. Mark the positions of any adjustment devices in relation to the webbing passed through them.

Apply the lower test cylinder to the PFD in the appropriate positions shown in figure A.2 and A.4. Add the specified pre-load and adjust the tension in the load application cord such that the axes A1A2 and B1B2 of the upper and lower test cylinders are substantially parallel.

Measure the distance between the axes A1A2 and B1B2 of the upper and lower test cylinders by measuring the distance A1 to B1 and A2 to B2.

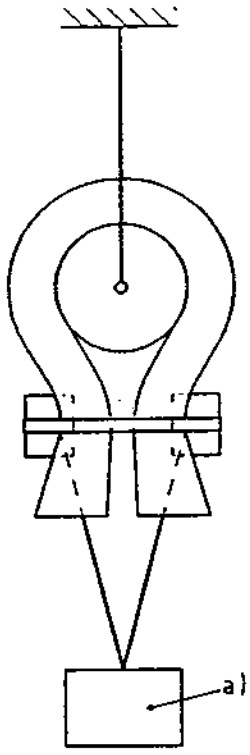
Apply the additional test load steadily without jerking until the PFD is hanging freely. Maintain the load for the specified period. Re-measure the distance between the test cylinder axes A1A2 and B1B2. Remove the test load and examine the PFD for any resultant defects. Measure any adjustment device slippage. Calculate the mean increase in distance between the test cylinder axes A1A2 and B1B2 from the pre-load to total load positions by determining the average of the two increases in distance of A1B1 and A2B2.

A.2 Lifting becket test

If inflatable, the PFD shall first be inflated. It shall then be soaked in fresh water for a period of (1,0±0,1) h, and placed on a manikin and adjusted according to the donning and adjustment instructions. The manikin shall then be lifted, without jerking until it is suspended freely, by means of a cylinder of (50±5) mm diameter passed through the lifting becket. The specified load shall be applied so as to act the mid-point of the manikin, and maintained for (1,0±0,1) min. No damage to the becket of the PFD shall occur.

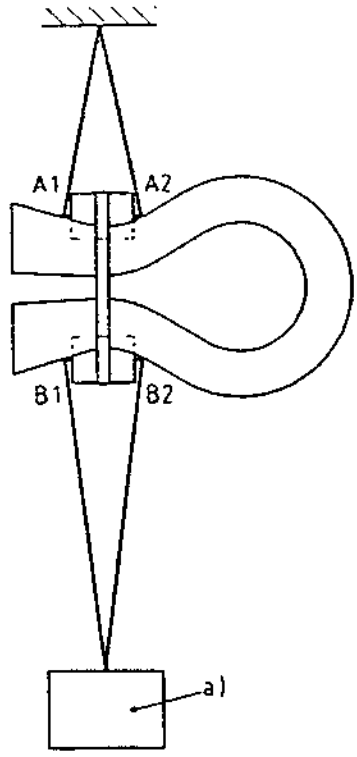
A.3 Buddy line

If a buddy line is attached to a PFD, a load of 750 N shall be applied for (1,0±0,1) min vertically to the attachment point of the buddy line, whilst the PFD is fitted to a manikin. No damage to the buddy line or the PFD shall occur.



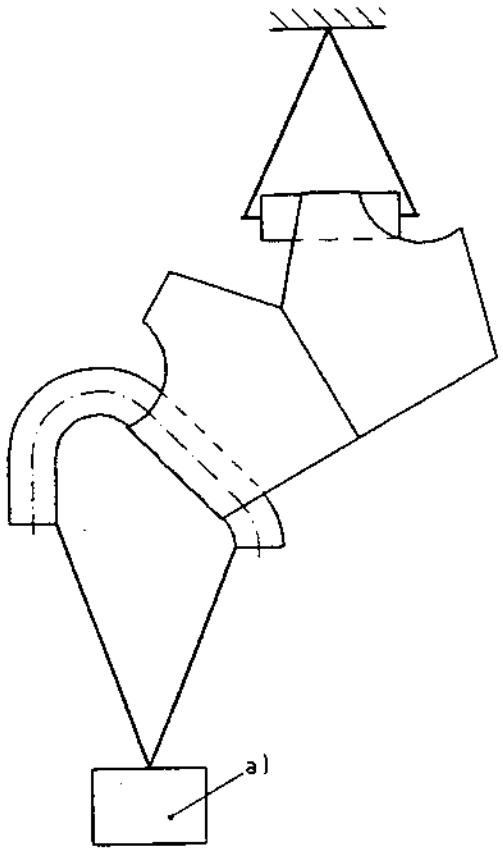
a) Test load

Figure A.1: Halter type PFD – Vertical load test



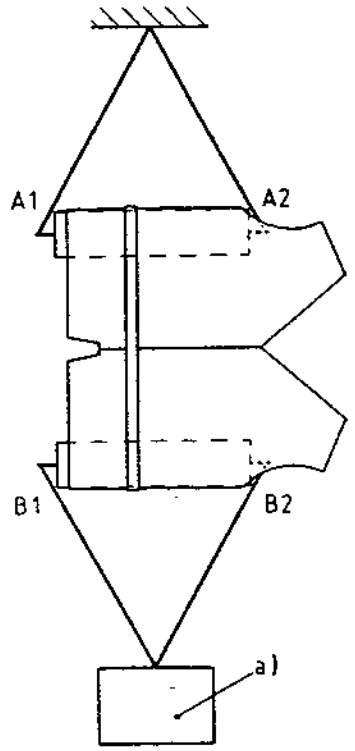
a) Test load

Figure A.2: Halter type PFD – Horizontal load test



a) Test load

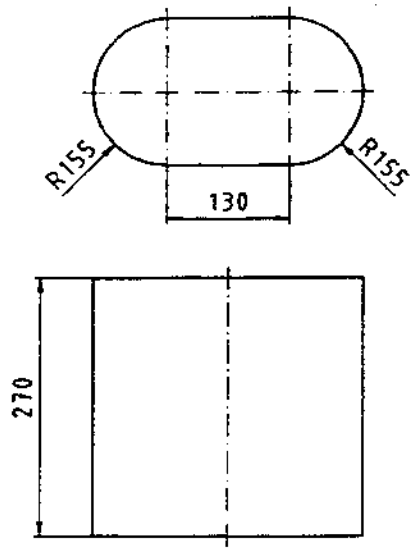
Figure A.3: Vest type PFD – Vertical load test



a) Test load

Figure A.4: Vest type PFD – Horizontal load test

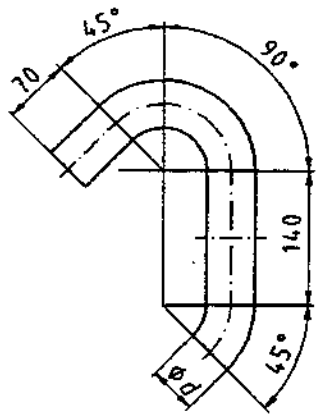
Dimensions in millimetres



General tolerances EN 22768-v.
thickness 3 mm

Figure A.5: Body for vertical load test

Dimensions in millimetres



General tolerances EN 22768-v.
Ø = 125 ± 10 for adult sizes
Ø = 50 ± 10 for children sizes

Figure A.6: Bended tube for vertical load test

Annex B (normative)

Measurement of buoyancy – whole device

B.1 Principle

The buoyancy of the device shall be measured using Archimedes' Principle of weighing the device in air and water, such as spelled out in the following or in a fully comparable way.

B.2 Apparatus

The equipment required consists of a fine mesh net bag attached to a weight, whose mass in kg is greater than 0,1 times the expected buoyancy value in N. Weighing takes place in a bath of water, deep enough to accommodate the device at a depth of 100 mm to 150 mm below the surface, and with a calibrated load cell or balance positioned above it.

B.3 Procedure

If the PFD contains inflatable buoyancy, then it shall first be inflated through the oral inflation tube to a pressure of (7,0±0,1) kPa. The PFD shall then be enclosed in the net bag attached to the weight.

This shall be suspended in fresh water at a temperature of 15 °C to 25 °C from the load cell so that the PFD is submerged at 100 mm to 150 mm below the surface. The immersed weight shall be recorded as A.

The assembly shall remain immersed for (24,0±0,5) h when the weight shall again be recorded as B.

The PFD shall finally be removed from the bag and the weight and the net bag again be immersed and the result again recorded as C.

B.4 Results

The initial buoyancy is obtained by deducting A from C.

The final buoyancy is obtained by deducting B from C.

The buoyancy lost during immersion is obtained by deducting the final buoyancy from the initial buoyancy.

Annex C (normative)

Measurement of buoyancy – material samples

C.1 Each sample of foam shall be weighed in air first, the result being recorded as A.

C.2 An empty weighted cage large enough to contain each specimen shall first be weighed whilst completely immersed in fresh water of a temperature of (20 ± 1) °C, the result being recorded as B. The weight of this cage shall have been adjusted so as to ensure that the samples of foam are completely immersed.

C.3 Each sample of foam in turn shall then be placed in the cage and fully immersed to a minimum depth of 50 mm below the level of the water surface, and the air adhering to surfaces carefully brushed off. The weight shall then be recorded as C.

C.4 The volume, D, shall be calculated as being equal to (B + A) − C.

C.5 The percentage volume change is the difference between the initial and final D, divided by the initial D, multiplied by 100.

Annex D (normative)

Specification of retro-reflective materials

Technical specification shall be as per IMO SOLAS 83, Chapter III, Resolution A.658(16), Annex 2.

Annex E (normative)

Test for resistance to burning

E.1 Inherent buoyant devices

E.1.1 Keep to hand a fire extinguisher throughout the following test and ventilate thoroughly the room used to conduct it immediately following it.

The specimen holder (illustrated in figure E.1), a crude manikin made of 3 mm non-inflammable material of breadth across the shoulders of 350 mm, thickness 200 mm, and height above the ground 1 500 mm, shall then have the PFD fitted to it in accordance with the donning instructions. This shall then be placed in a draught-free space in normal air.

E.1.2 Keep at least two examples of the adult size PFD at room temperature for at least three days prior to the test. Mark a horizontal line passing about 50 mm from the lower edge of the PFD using chalk and one a further 300 mm higher up and parallel to it. Mark ignition points as the centre of circles of 300 mm radius (mark also the arcs of which using chalk), at the following points:

1) half the width of the float;

2) the front edge of the central fastening, if any;

3) the vertical boundaries between floats and corresponding points on the back and sleeves, if any.

If any ignition point would be placed on a cord, clasp or other fitting, then move it 10 mm above that point. Examples of markings are shown in figure E.2.

E.1.3 The specimen holder shall comply with (illustrated in figure E.1) and shall be made of non-inflammable material. Then fit the PFD to it in accordance with the donning instructions. Then place this in a draught-free space in normal air.

E.1.4 Adjust a flame of burning butane gas, generated using a medical number 5 needle (inside diameter 0,3 mm), to produce a 13 mm high flame when held vertically. Apply this to each ignition point in succession, with the needle nozzle horizontal to the specimen, and a distance from the tip of the needle to the ignition point of 10 mm. Hold the flame in that position for a maximum of 30 s or until the sample is seen to burn properly with a flame.

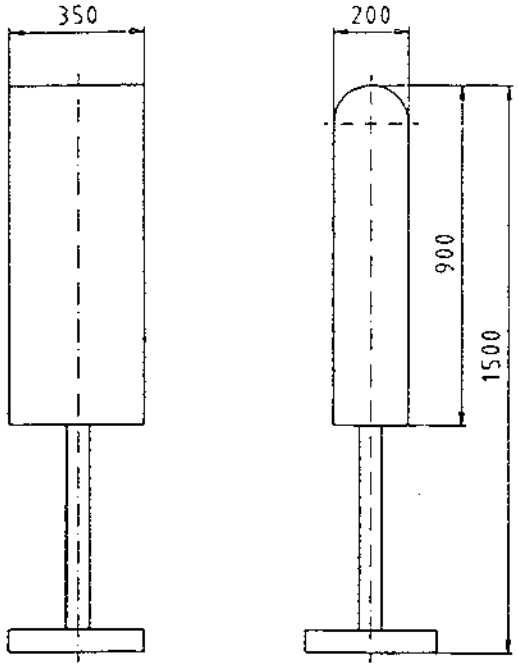
E.2 Inflatable PFD

E.2.1 Subject one uninflated adult size PFD to the fire test.

E.2.2 Place a test pan 30 cm × 35 cm × 60 cm in an essentially draught-free area. Put water in the bottom of the test pan to a depth of 1 cm followed by enough petrol to make a minimum depth of 4 cm. Ignite the petrol and allow it to burn freely over 30 s.

E.2.3 Then move the PFD through the flames in an upright, forward, free hanging position with the lower edge of the device 25 cm above the top edge of the test pan. Secure loose parts, e. g. crotch straps, above the lower edge of bottom of the device.

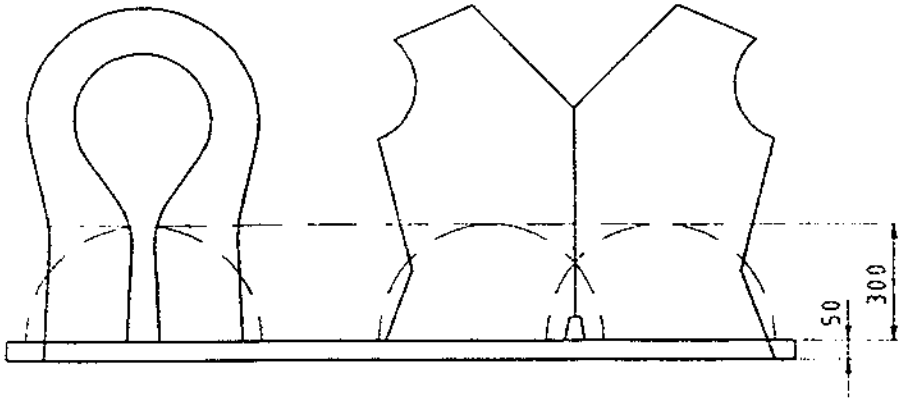
Dimensions in millimetres



General tolerances: EN 22768 – v.

Figure E.1: Specimen holder

Dimensions in millimetres



General tolerances: EN 22768 – v.

Figure E.2: Examples of the positions of ignition points

Figure E.3: Arrangement for test method E.2

Annex F (normative)

Test method for the measurement of freeboard

F.1 Principle

The freeboard shall be measured as the difference between the distance from the water surface to a mark floating above it, and the distance from the mouth to that same mark.

F.2 Apparatus

The measuring device, shown in figure F.1, shall consist of two floats made of closed-cell foam, connected by a rigid bridge at such a height that a test subject wearing a PFD in the water has approximately 100 mm clearance between the top of his head and the bridge. On the bridge, one third of the way along from one end, a measuring tape roll or drum (A) shall be placed, in such a way that the tape is free to drop below the bridge as shown. This roll or drum shall contain a locking mechanism to permit the tape to remain at a fixed length protruding. At the free end of the tape, a plastic disk (C) of (100 ± 5) mm diameter shall be fixed in a perpendicular position. There shall also be a measuring mark (B) made along the bottom edge of the bridge.

F.3 Procedure

Two measurements of distance shall be made using the measuring device. The first shall be that between the measuring line and the fresh water surface, which shall be still and calm. The test subject shall then be positioned floating in a relaxed position, inclined backwards, between the two floats of the device. The distance between the measuring line and the lower corner of the mouth of the subject shall then be measured. These two measurements shall be performed twice on each subject, once with the subject having exhaled completely, and once following maximal inspiration.

F.4 Result

The two freeboard measurements shall be added together and divided by 2 to give the mean freeboard.

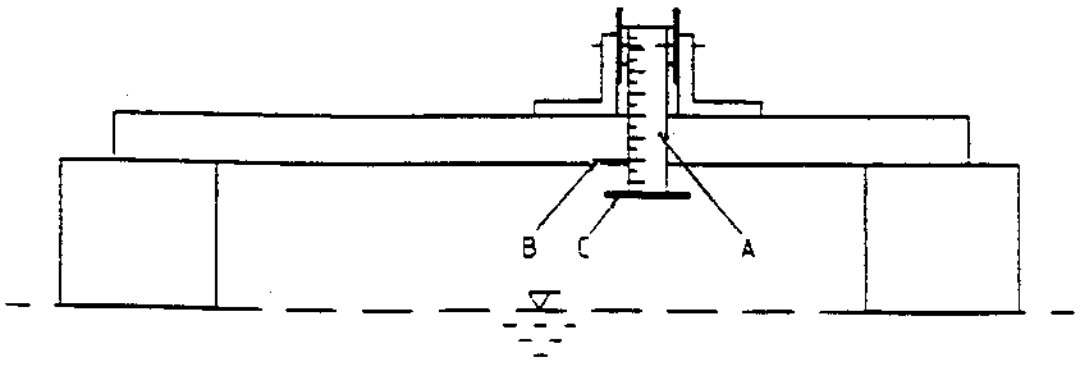


Figure F.1: Device for measuring freeboard

Annex G (normative)

Test method for resistance to inadvertent inflation

G.1 Principle

The resistance of an automatic inflation device to inadvertent operation shall be assessed by exposing the entire PFD to sprays of water for a fixed period.

G.2 Apparatus

The PFD shall be fitted correctly to a free-standing rotatable manikin of adult size, with a minimum shoulder height of 1 500 mm. The PFD shall be deployed in the mode in which it is worn ready for use but not deployed as used in the water (i.e. if it is equipped with a cover which is normally worn closed, then the cover shall be closed for the test) see figure G.1.

Two spray nozzles shall be installed so as to spray fresh water onto the PFD, as shown in figure G.1. One shall be positioned 500 mm above the highest point of the PFD, and points at an angle of 15° from the vertical centreline of the manikin and the bottom line of the PFD. The other nozzle shall be installed horizontally at a distance of 500 mm from the bottom line of the PFD, and points directly at the PFD. These nozzles shall have a spray cone of 30°, each orifice being (1,5 ± 0,1) mm in diameter, and the total area of orifices on each shall be (50 ± 5) mm^2, the orifices being evenly spread over the spray nozzle area.

The air temperature shall be (20 ± 3) °C, and water shall be supplied to the sprays at a pressure of 0,3 kPa to 0,4 kPa, a flow of 600 ℓ/h, and a temperature of (12 ± 3) °C.

G.3 Procedure

The sprays shall be turned on, and the PFD exposed to the following series of spray exposure:

1 min with high spray on the front of the PFD;

2 min with high spray on the left side of the PFD;

3 min with high spray on the back of the PFD;

4 min with high spray on the right side of the PFD.

During exposures a), b) and d), the horizontal spray shall be applied for 10 periods of 3 s each to the front, left or right sides (but not the back) as with the high spray.

Dimensions in millimetres

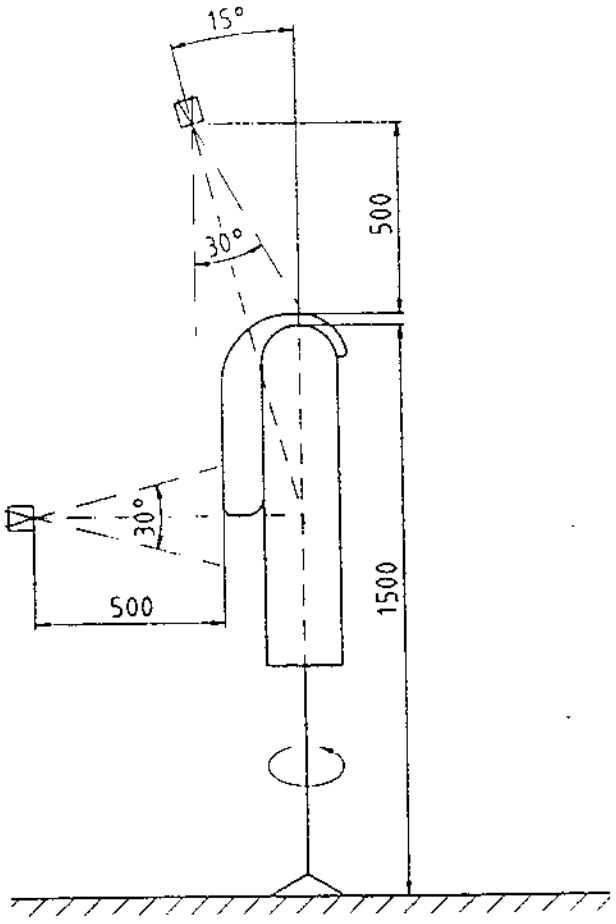


Figure G.1: Test set-up for test of automatic inflation device

Annex H (normative)

Test method for the compressibility of inherently buoyant material

H.1 Examine three specimens of each sample of foam of dimensions (100 ± 2) mm by (100 ± 2) mm and of a thickness of (20 ± 2) mm. If the material consists of granules, then fill three cloth sacks with the granules to the same filling density as the PFD. Fit them into a metal frame of dimensions (100 by 100) mm and a height equivalent to the thickness of the buoyancy of the test PFD. Prior to the test, they shall have been stored at (23 ± 2) °C and a relative humidity of (50 ± 5) % for 24 h, in which conditions they shall be tested.

H.2 Procedure

Each specimen shall be placed in fresh water under a flat metal plate at least 20 % larger than the specimen size and then compressed at a speed of 200 mm/min until a load of 500 kPa has been reached. This lower position shall be set for further compressions. The specimen shall then be completely decompressed, and the cycle of compression repeated a further four times, using the lower set point as the limit of compression.

H.1.1 The specimen shall then be kept under the metal plate such that it is only just weighted by the plate to remain under water. The load required to achieve this shall be recorded as the original buoyancy A (note that it will almost certainly be necessary to use a different load cell from that required by H.2).

H.1.2 The specimen shall then be dried for 7 days in air at a temperature of (23 ± 2) °C and a relative humidity of (50 ± 5) %. The compression cycle at H.2 shall then be repeated without water, and for a total of 500 times. If deformation occurs, then the upper set point may need to be reset in order to keep the decompression time equal during the whole period.

H.1.3 The specimen shall then be returned to the atmosphere at H.4 for at least three days, and the buoyancy measurement at H.2 and H.3 repeated, giving the value B. The loose of buoyancy (as A-B) shall then be expressed as a percentage of the original buoyancy (A).

Annex J (normative)

Rotating shock bin method

J.1 Apparatus

The equipment used shall be that shown in figure J.1, and consists of a box of unusual design made from plywood board, the inside surface of which shall be coated with a hard plastic laminate or similar. The bearing of the bin shall be in the centre of its mass, as shown in the figure, and permits the bin to be rotated freely. This rotation can be effected mechanically, using a motor, or manually.

J.2 Procedure

The test specimen shall be placed in the bin through a flush panel in one of its faces, which shall then be closed and secured. The bin shall then be rotated for a total of 150 revolutions at a steady rate of 6 revolutions per minute.

On completion of the rotations, the specimen shall be removed through the panel and examined.

Dimensions in millimetres

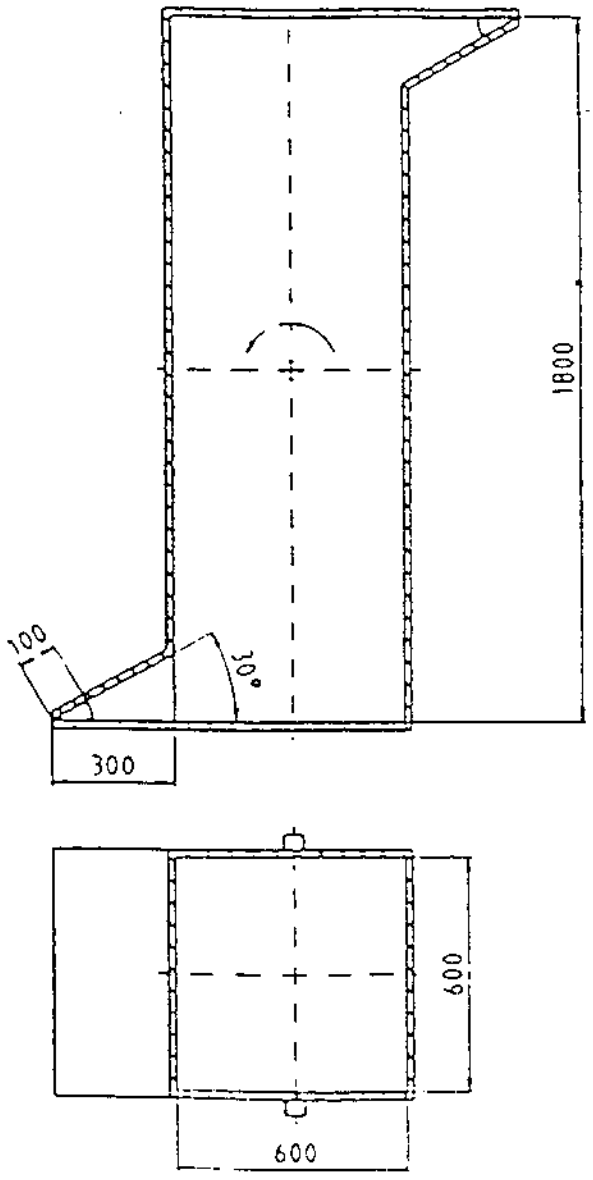


Figure J.1: Design of rotation shock bin apparatus

Annex K (normative)

Test of sprayhood

K.1 Procedure

If any form of hood or sprayhood is fitted to cover the face in whole or in part to protect mouth and nose from water splash then it shall be demonstrated, by analysing samples of gas using a fast-response carbon dioxide analyser, that in calm air and calm water, using a minimum of 6 subjects over test periods of at least 5 min each, that the carbon dioxide level within the hood does not exceed 5 % at any place at any time and does not average more than 2,5 % in any one minute. The gas analyser used shall be capable of indicating continuous measurements of the percentage of carbon dioxide gas within a continuously flowing sample, with a time constant short enough to give accurate measures of end-tidal carbon dioxide levels. The samples shall be taken at a distance between 50 mm and 100 mm from the nostrils, when the subject is holding breath. The longest averaging period shall not exceed 60 s.

Alternatively the O_2 level may be measured according to above procedure, whereas the average O_2-content shall not be below 16 % and not below 14 % as single value.

Annex L (normative)

Boarding test

According to the dexterity testing in 6.7 the subjects have to prove their capability to board platform as shown by figure L.1.

Figure L.1: Boarding platform

Annex M (informative)

Translation of terms

For the purposes of this standard, the naming and marking of any items complying with this standard, and correct usage, the following equivalent terms shall apply:

The generic term (all items covered by this standard):

Danish:
Dutch:
English: Personal Flotation Device A, B, C, D
Finnish:
French:
German:
Greek:
Icelandic:
Italian:
Norwegian:
Portugese:
Spanish:
Swedish:

Differentiated terms (major types covered by this standard):

Danish:
Dutch:
English: Manually-operated and automatically-operated PFD
Finnish:
French:
German:
Greek:
Icelandic:
Italian:
Norwegian:
Portugese:
Spanish:
Swedish:

Annex N (informative)

A guide to the application of lifejackets, buoyancy aids and safety harness

N.1 Introduction

This paper provides guidelines for the choice and application of the European Standards for lifejackets and buoyancy aids related to the Council Directive 89/656 EEC.

This paper should be of value to those responsible for specifying the carriage or use of lifejackets and to those who are contemplating the purchase of such garments. The primary aim of the paper is to increase awareness of those factors which should inform a purchaser or user choice of a lifejacket or a buoyancy aid. There is much that can be done at the point of sale to provide information by the packing, swing tags, or labelling to bring important information to the attention of the consumer or end user. However, the most important factor in the application of PPE such as lifejackets is to ensure that they are sufficiently comfortable in wear and attractive to the user, so that they are not just purchased but are actually used.

Lifejackets and buoyancy aids are remarkably recent innovations. In spite of various well-intentioned attempts to design personal flotation gear during the 18th and 19th centuries, it was not until 1852, that Alexander Carte introduced a cork lifejacket, and the First World War before that apparatus was issued to sailors in an attempt to protect them. However the basic requirements of personal flotation devices were not properly investigated until the Second World War, and most National Standards were evolved in the 1960s and later.

To date there have been three main groups who have specified requirements for lifejackets and buoyancy aids.

The International Maritime Organisation's Safety of Life at Sea (IMO SOLAS) for those lifejackets to be used internationally in larger surface vessels operating in the open sea.

The US Federal Aviation Authority. UK Civil Aviation Authority, and other associated national bodies for those lifejackets to be carried and used in Civil aviation settings.

Various national Standards Bodies (such as AFNOR, DIN, and BSI) have produced specific national Standards which have then been applied to certain national circumstances for lifejackets and buoyancy aids required by national law or by the rules of the governing bodies of sports.

Preparations for the implementation of a single market within the EU have led to the requirement that such National Standards be superseded by European ones. This in turn led to the EU-Council Directive on Personal Protective Equipment (PPE) in December 1989. The work to produce harmonised European Standards was started in June 1989 by experts from nearly all nations of EN and EFTA, representing all the different interests from researchers, Standard Setting Bodies, test houses, manufacturers, supplies, users, consumer-organisations and sporting associations.

It should be noted however, that it was not the intention that the European Standards would replace the IMO SOLAS or FAA/CAA or ISO Standards. However these European Standards achieved what is required, the specification of lifejackets and buoyancy aids which are practical, economical and effective in use.

N.2 The European standards for lifejackets and buoyancy aids

– **The 50 N Standard** buoyancy aid is intended for use by those who are competent swimmers and who are near to bank or shore, or who have help and rescue close at hand. These garments have minimal bulk and cost, but they are of limited use in disturbed water, and cannot be expected to keep the wearer in safety for 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 wearer.

– **The 100 N Standard lifejacket** is intended for those who may still have to wait for rescue, but are likely to do so in sheltered and calm water. Whilst these lifejackets are less bulky than other typs of lifejackets, they should not be used in rough conditons, or when there is wave splash.

– **The 150 N Standard lifejacket** is intended for general offshore and rough weather use where a high standard of performance is required. It will turn an unconscious person into a safe position and requires no subsequent action by the wearer to maintain this position.

– **The 275 N Standard lifejacket** is intended primarily for offshore use, by people who are carrying significant weights (thus requiring additional buoyancy) or those who are wearing clothing which traps air and which may adversely affect the self-righting capacity of a lifejacket and its ability to ensure that the wearer is floating on the correct position with his mouth and nose clear of the surface.

These Standards set four main levels of buoyancy, but also encourage and allow intermediate steps within the defined performance criteria which may enhance the performance of a device and make it suitable for special conditions or applications.

Before purchasing a lifejacket or buoyancy aid the user shall evaluate the risks to which he or she is likely to be exposed. Trained and experienced users may consider the use of devices with less buoyancy. Examples include experienced canoeists, dinghy and wind surfing sailors, who may be able to use garments of less than 100 N buoyancy, if help or other buoyant devices is to hand.

In principle, national bodies, in particular those responsible for making recommendations, should be left to determine what is appropriate for the user's activities under their jurisdiction. The advice of these bodies should be sought by groups, clubs or authorities, to select a suitable device out of this set of Standards.

A further Standard EN 394 specifies the requirements for a number of additional items.

– **Emergency lights,**
to the Standard EN 394, are an important location aid during the hours of darkness, when they are much more effective than retoreflective tape alone.

Lights not necessarily to this Standard are also useful aids particularly when legislation does not demand the fitting of a compliant light.

– **Whistles**
to the Standard for additional items are a useful location aid at all times.

– **Multi-chamber buoyancy systems**
to EN 394, may ensure that even damaged or punctured lifejackets can still save the life of the wearer, 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 but it is extremely bulky to be worn with comfort.

– **Safety harnesses and lines,**
to EN 1095 are useful tools to reduce the risk of immersion. If they are to be used they must not compromise the performance of the lifejacket or hazard survival.

– **Buddy-lines,**
to EN 394 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 a snag and trip hazard.

– **Spray hoods,**
to EN 394 are of great value in protecting the airways, in rough water, but add significantly to the cost and complexity of the lifejacket. They should not restrict the vision and must be easy to don and to remove.

– **Protective covers,**
to EN 394 are suitable for preventing damage to less robust lifejacket components, such as inflatable chambers and gas inflation heads. They reduce snag hazard, but add to the cost and complexity of lifejackets.

Protective covers must be used in addition against certain 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.

It is essential, however, that the correct functioning of the lifejackets used in harzardous working environments is not in any way 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 wearers.

N.3 Problematic matters for consideration by legislators and purchasers

There are specific areas which remain a problem. The interaction between protective chlothing, particularly immersion suits and lifejackets is likely to be difficult. Furthermore attempting to specify buoyancy protection in isolation is always likely to be a problem when integrated assemblies are used until it is possible for the entire assembly can be specified.

One of the most significant factors in making a lifejacket or buoyancy aid an effective piece of PPE is in keeping costs low and in ensuring maximum comfort during use.

Another overriding consideration is that of any occupational use, such as welding. There is no protective value in a lifejacket if it has become damaged in normal use so that it no longer functions as required. Those workers whose lifejackets may be subject to increased abrasion, molten metal splash etc. should have specified for them those items described in the additional items Standards, as well as protective covers, and possibly also multi-chamber buoyancy. Almost all workers can come into contact with some corrosive or noxious chemicals and it may be necessary to use the additional requirements of appropriate European Standards for chemical resistance. Specifying such industrial PPE can be a very elaborate process, in which no two applications are quite the same; however the additional items provided for in the standards are designed to cover most common hazards. PPE manufacturers have to be advised on specialist industrial items when specifying such equipment.

Another fundamental decision which must influence all requirements for lifejackets and buoyancy aids is whether the item will be worn all of the time that immersion is a possiblility. The aim is to ensure that no one enters the water without having donned a lifejacket or buoyancy aid. 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 wearer and certainly must 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 a cover specified an additional item to reduce snagging hazards. They will also not be able to use inherently buoyant devices and automatically inflatable lifejackets shall be required. Considerations shall be given first to use safety harnesses or other technical means to prevent accidental immersion altogether.

Flotation devices must be simple to don and to doff. Although the standards each include timed tests for donning, it may be necessary in certain circumstances to consider additional requirements beyond those required by the Standards; for example to ensure rapid and reliable donning in complete darkness or in confined spaces or wearing gloves or mittens. Donning is also effected by the compatibility of the lifejacket with other equipment.

The physical circumstances of intended use are also of importance in determining the specification required of a lifejacket or buoyancy aid. If inflatable lifejackets are stored or worn in temperature below 0 °C, carbon dioxide, the tradional inflations gas, may be adversely affected and result in only partial inflation. Other components such as nylon poppers may become rigid and difficult to open. The Standards are intended to provide a reasonable performance for all lifejackets and buoyancy aids from the tropics to cold temperate climes, but do not require all devices to meet the more severe cold conditions likely to be encountered in polar regions. Temperatures have a considerable influence on the performance of the inflation mechanism. This occurs not just by slowing of carbon-dioxide inflation but also by the increasing activation times of the firing heads. It is very important to specify the lowest performance temperature for firing-tests, if the lifejacket is to be exposed to temperatures much below 0 °C. Another feature of the environment of higher latitudes in winter is short day length, and all those who are at all likely to use their lifejackets during the hours of darkness should also use lights which comply with the additional items Standard.

The EU-Directive for Occupational Health and Safety requires 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 personal protection equipment.

It is become popular belief that most immersion deaths result form hypothermia after some time in water, but in fact recent research has demonstrated that it is often the first few minutes which are most critical. Effective lifejackets and buoyancy aids must therefore be fully functional immediately on entry into the water.

The most obvious factor which needs careful consideration is the mode of inflation, as it is this which determines how rapidly and effectively the lifejacket can perform. In foreseeable conditions of use in which the wearer can enter cold water suddenly, or in a disabled or unconscious condition, then the lifejacket must be of an automatically operated type. Thus once it has been donned, it requires no further action by the wearer.

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

- by waves and water-splash entering the air-ways and

- by waves inverting the wearer.

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

The design of the lifejacket and the orientation of the wearer with respect to waves are also very important.

A lifejacket 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 conditons in which a sprayhood is required are very seldom encountered in inland waters unless they are very large; but 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 its breathing is rapid and uncontrollable – as occours 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 lifejackets is a key in most standards. Self-righting is of importance if an unconscious or disabled person is capsized by a wave. An unconscious person with the buoyancy of a lifejacket may surface inverted following initial entry into the water if air has been trapped in their clothing. The reason for self-righting tests being included in the European Standards is thus to try to provide for this event and because experience has shown that if an otherwise well-designed lifejacket performs well in this test, it is generally good in its overall performance in water in the sense of having good stability. The Standards call for such tests to be undertaken on subjects wearing bathing costumes in order to ensure a degree of test replicability although it is recognised that self-righting is usually a much greater problem when wearing clothing.

There is a commendable recent trend towards the wearing of garments which slow the cooling of the body.

There are of two types:

- constant wear suits (prEN 1913-1);

- abandonment suits (prEN 1913-2).

All pose problem however because such garments frequently trap air within them with the result that the wearer may in reality have effective buoyancy which may negate the righting properties of the lifejacket. The net result may be an assembly of immersion suit and lifejacket which is actually stable in the inverted position.

The 275 N Standard lifejacket is intended to give reasonable assurance that righting will be achieved with any well designed immersion protective clothing.

Finally, to repeat the vital principle:

- the aim of all recommandations and rules must be to ensure that lifejackets and buoyancy aids are comfortable to wear and attractive in use.