ANSI/CAN/UL 12402-9:2022

JOINT CANADA-UNITED STATES NATIONAL ADOPTION

STANDARD FOR SAFETY

Personal Flotation Devices – Part 9: Test Methods

(ISO 12402-9:2011, MOD)

ANSI/UL 12402-9-2022

SCC FOREWORD

National Standard of Canada

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UL Standard for Safety for Personal Flotation Devices – Part 9: Test Methods, ANSI/CAN/UL 12402-9

First Edition, Dated December 31, 2015

Summary of Topics

This revision of ANSI/CAN/UL 12402-9 dated January 18, 2022 includes the following changes in requirements:

- ***Update to Add a Definition of Whitewater; 3.34DV***

- ***Corrections to Test Frame Dimensions; Figure 6DV***

- ***Updates to the Test Pan Dimensions; Figure 10DV***

- ***Self Righting Test Requirement Revisions, Table 6DV, 5.6.6.3ADV, and 5.6.6.3DDV.***

ANSI/CAN/UL 12402-9 is an adoption with binational deviations of ISO Standard for Personal Flotation Devices – Part 9: Test Methods, first edition of ISO 12402-9: 2006-09-01, and Amendment 1 dated 2011-04-01.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated June 11, 2021, September 3, 2021, and October 8, 2021.

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ANSI/CAN/UL 12402-9:2022

Standard for Personal Flotation Devices – Part 9: Test Methods

First Edition

December 31, 2015

This ANSI/CAN/UL 12402-9 consists of the First Edition including revisions through January 18, 2022.

The most recent designation of ANSI/UL 12402-9 as an American National Standard (ANSI) occurred on January 18, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, Preface, and SCC Foreword.

This standard has been designated as a National Standard of Canada (NSC) on January 18, 2022.

No Text on This Page

CONTENTS

Preface (UL)

This is the First Edition of the ANSI/CAN/UL 12402-9, Standard for Personal Flotation Devices – Part 9: Test Methods, which is a National Adoption of the first edition of ISO 12402-9: 2006-09-01 and Amendment 1 dated 2011-04-01.

This Standard has been developed in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization.

This ANSI/CAN/UL12402-9 Standard is under continuous maintenance, whereby each revision is approved in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization. In the event that no revisions are issued for a period of four years from the date of publication, action to revise, reaffirm, or withdraw the standard shall be initiated.

UL is accredited by the American National Standards Institute (ANSI) and the Standards Council of Canada (SCC) as a Standards Development Organization (SDO).

In Canada, there are two official languages, English and French. All safety warnings must be in French and English. Attention is drawn to the possibility that some Canadian authorities may require additional markings and/or installation instructions to be in both official languages.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at http://csds.ul.com.

To purchase UL Standards, visit the UL Standards Sales Site at http://www.shopulstandards.com/HowToOrder.aspx or call toll free 1-888-853-3503.

This Edition of the Standard has been formally approved by the UL Standards Technical Panel (STP) on Personal Flotation Devices, STP 1123.

This list represents the STP 1123 membership when the final text in this standard was balloted. Since that time, changes in the membership may have occurred.

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This Standard is intended to be used for conformity assessment.

The intended primary application of this standard is stated in its scope. It is important to note that it remains the responsibility of the user of the standard to judge its suitability for this particular application.

CETTE ADOPTION NATIONALE DU CANADA EST DISPONIBLE EN VERSIONS FRANÇAISE ET ANGLAISE

Reasons for Differences from ISO

National Differences from the ISO standard are being added in order to address regulatory and safety situations present in the US and Canada.

NATIONAL DIFFERENCES

There are six types of National Differences as noted below. The difference type is noted on the first line of the National Difference in the standard. The standard may not include all types of these National Differences. The National Differences in this standard were developed via a binational effort by the Canada / US 12402 Task Group.

DR – These are National Differences based on the **national regulatory requirements**.

D1 – These are National Differences which are based on **basic safety principles and requirements**, elimination of which would compromise safety for consumers and users of products.

D2 – These are national differences from ISO requirements based on existing **safety practices**. These requirements reflect national safety practices, where empirical substantiation (for the ISO or national requirement) is not available or the text has not been included in the ISO standard.

DC – These are National Differences based on the **component standards** and will not be deleted until a particular component standard is harmonized with the ISO component standard.

DE – These are National Differences based on **editorial comments or corrections**. Some examples of editorial comments or corrections include replacing "lifejacket" with "PFD" or vice versa and correcting paragraph references.

DT – These are National Differences that are the result of pending changes that have been tentatively agreed internationally by ISO TC188/SC1 for the next edition of the standard and therefore are expected outcomes of the second edition of ISO 12402. These changes include both clarifications and substantive changes in requirements and that will be reviewed when the next edition of ISO 12402 is published.

Each national difference contains a description of what the national difference entails. Typically one of the following words is used to explain how the text of the national difference is to be applied to the base ISO text:

Addition / Add - An addition entails adding a complete new numbered clause, subclause, table, figure, or annex. Addition is not meant to include adding select words to the base ISO text.

Modification / Modify - A modification is an altering of the existing base ISO text such as the addition, replacement or deletion of certain words or the replacement of an entire clause, subclause, table, figure, or annex of the base ISO text

Deletion / Delete - A deletion entails complete deletion of an entire numbered clause, subclause, table, figure, or annex without any replacement text.

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Foreword

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

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

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

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

ISO 12402-9 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 162, *Protective clothing including hand and arm protection and lifejackets*, in collaboration with Technical Committee ISO/TC 188, *Small craft*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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

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

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

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

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

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

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

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

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

– *Part 9: Test methods*

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

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Introduction

ISO 12402 has been prepared to give guidance on the design and application of personal flotation devices (hereafter referred to as PFDs) for persons engaged in activities, whether in relation to their work or their leisure, in or near water. PFDs manufactured, selected, and maintained to this standard should give a reasonable assurance of safety from drowning to a person who is immersed in water.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Similarly, those framing legislation regarding the use of these garments should consider carefully which class and performance levels are most appropriate for the foreseeable conditions of use, allowing for the higher risk circumstances. These higher risk circumstances should account for the highest probabilities of occurrence of accidental immersion and the expected consequences in such emergencies. More information on the selection and application is given in ISO 12402-10.

Personal flotation devices – Part 9: Test methods

1 Scope

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

1DV DR *Addition to Clause 1 as follows:*

Where references are made to ISO 12402 standards, they shall be considered to be to UL 12402 with applicable Canadian / US National Differences where UL Standards exist. Where references are made to particular requirements within a part they shall include the associated DVs contained in that standard, as applicable.

2 Normative references

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

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

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

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

ISO 12401:2004, *Small craft – Deck safety harness and safety line for use on recreational craft – Safety requirements and test methods*

2DV.1 *DT Modification of Clause 2 by replacing normative reference ISO 12401 as follows:*

ISO 12401:2009, *Small craft – Deck safety harness and safety line for use on recreational craft – Safety requirements and test methods*

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

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

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

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

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

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

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

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

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

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

International Convention for the Safety of Life of Sea (SOLAS), 1974, as amended, International Maritime Organization[1)]

2DV.2 DC *Modification of Clause 2 by adding the following normative reference:*

ANSI/UL 1191, 4th Edition, *Components for Personal Flotation Devices*

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

3 Terms and definitions

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

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

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

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

3.3DV.1 DT *Modification by deleting clause 3.3.*

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

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

3.6 **orally inflated PFD** – PFD inflated by mouth to produce buoyancy

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

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

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

3.9 **yoke-type PFD** – PFD in a style worn around the back of the neck and secured by a waist strap

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

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

3.11DV ***DT Modification by replacing the multi-chamber buoyancy system definition as follows:***

PFD with buoyancy to meet the applicable PFD performance requirement provided by multiple sources including, for example, devices with a combination of inherent buoyancy and inflatable chamber(s), or devices with two or more independent inflatable chambers that collectively provide the in-water performance conforming to the relevant part.

NOTE 1 This excludes supplemental inflation chambers.

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

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

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

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

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

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

NOTE 2 The inflatable chamber of an inflatable PFD is an example of a functional element.

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

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

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

3.19DV D1 ***Modification by adding a note to the hybrid-type PFD definition as follows:***

NOTE – An inflatable PFD with minimal inherent buoyancy to meet the uninflated buoyancy test (see UL 12402-5, 5.3.1.2) is not considered a hybrid-type PFD.

3.20DV ***DT Modification by adding bunching definition to clause 3:***

bunching – curling or folding of internal buoyant material upon itself, from its original position, within the envelope

3.21DV ***DT Modification by adding sheltered waters definition to clause 3:***

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

3.22DV ***DT Modification by adding offshore definition to clause 3:***

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

3.23DV ***DT Modification by adding primary inflation definition to clause 3:***

primary inflation – means of inflating an inflation chamber that meets the applicable PFD performance requirements and that requires the least amount of intervention by the user, generally according to the following order of precedence: automatic (easiest), manual (second), and oral (most difficult)

3.24DV ***DT Modification by adding secondary inflation definition to clause 3:***

secondary inflation – alternate method of inflation which is provided in case the primary system fails

3.25DV ***DT Modification by adding primary inflation chamber(s) definition to clause 3:***

primary inflation chamber(s) – inflation chamber(s) associated with the primary inflation system that alone meets the applicable PFD performance requirements and provides the greatest in-water performance and ease of use

3.26DV ***DT Modification by adding back-up inflation chamber definition to clause 3:***

back-up inflation chamber – inflation chamber(s) other than the primary chamber(s) that, when used alone or together, provides redundancy to float the wearer in case a primary inflation chamber fails to function

3.27DV ***DT Modification by adding supplemental inflation chamber definition to clause 3:***

supplemental inflation chamber – inflation chamber other than a primary or back-up chamber that is intended for deployment after stabilization in the water, and provides enhanced features such as splash protection, higher freeboard, improved head support, additional stability, location detection, etc.

3.28DV D2 ***Addition of definitions as follows:***

3.28.1DV somatotypes – four categories of human body types based on physical characteristics: endomorphy (En), mesomorphy (Me), ectomorphy (Ec), and central (Ce).

a) endomorph (En) – body type having a more rounded appearance with limited muscle definition, normal bone structure, higher body fat, and typically the waist and thigh areas carry a larger percentage of body mass than the upper chest area

b) mesomorph (Me) – body type having well defined muscles, large bone structure, and low body fat with broad shoulders tapering to a defined narrower waist

c) ectomorph (Ec) – lean body type with low muscle mass, light bone structure, and low body fat with a linear physique

d) central somatotype – body type having no dominant endomorph, mesomorph, or ectomorph characteristics

3.29DV D2 ***Modification by adding primary closure definition to clause 3:***

primary closure – one or more means of securing the device onto the body so that the device can be expected to function substantially in the intended manner without the use of any other means of fastening the device onto the body

3.30DV D2 ***Modification by adding secondary closure definition to clause 3:***

secondary closure – closure or closures not meeting the definition of a primary closure

3.31DV D2 ***Modification by adding structural component definition to clause 3:***

structural parts, materials, and component – parts, materials, or components that are integral to the device and that are essential for its correct function and performance

3.32DV D2 ***Modification by adding design inflation range definition to clause 3:***

design inflation range – the range of buoyancy and pressure, as specified by the manufacturer, to which a compartment may be inflated to provide the intended in-water performance

3.33DV D2 *Modification by adding user category definitions to clause 3:*

3.33DV.1 user categories – four categories of user types based on weight.

a) Adult PFD – PFD intended for users with a mass greater than 40 kg

b) Youth PFD – PFD intended for users with a mass greater than 25 kg and less than or equal to 40 kg

c) Child PFD – PFD intended for users with a mass greater than 15 kg and less than or equal to 25 kg

d) Infant PFD – PFD intended for users with a mass less than or equal to 15 kg

3.34DV D1 *Modification by adding Reference Test Device (RTD) definition to clause 3:*

Reference Test Device (RTD)

A calibrated test apparatus with known in-water performance for comparison of a candidate PFD, used in the RTD testing method.

a) Adult RTD – USCG Model 63, used in the RTD testing method for a level 100 lifejacket intended for use by persons over 40 kg

b) Child RTD – USCG Model 67, used in the RTD testing method for a level 100 lifejacket intended for use by persons between 15 and 40 kg

c) Infant RTD (Lifejacket) – SOLAS Infant RTD, used in the RTD testing for a level 100 or 150 lifejacket intended for use by persons under 15 kg

d) Infant RTD (Buoyancy Aid) – USCG Model CKS-2, used in the RTD testing for a level 70 buoyancy aid intended for use by persons under 15 kg

4 Classification of personal flotation devices

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

5 Test methods

5.1 General

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

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

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

The human subject performance tests shall be carried out under the direction of a test house's test panel that is experienced in these specific test procedures. These tests shall be observed by at least 2

experienced observers from the panel and repeated with 3 experienced observers from the panel if there is any question about the performance observed. An observer is to be qualified by having expertise in observing (or conducting under the supervision of a qualified observer) the specific test on at least 3 occasions.

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

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

5.2 Sampling and conditioning

5.2.1 Sampling

At least one sample of each size of the device to be tested shall be provided, if not specified otherwise in the part of ISO 12402.

5.2.2 Conditioning

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

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

5.2DVDV D2 ***Modification by replacing the first paragraph of clause 5.2.2 as follows :***

Conditioning prior to testing

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

5.3 Criteria for passing and failure

All required samples shall pass all tests specified in 5.5 for the entire device to meet the requirements of the relevant parts of ISO 12402. Due to the high variability between human subjects and the difficulty in assessing some subjective measures, for tests according to 5.6 a test subject may be disqualified if demonstrated not to perform in accordance with this standard when tested in a reference vest as described in Annex B, C or D. When a reference vest is used, the test report shall state the model of reference vest(s). Whenever a subject is disqualified from this test, another two subjects with similar weight, height and anatomic build shall be subjected to the same test and before the same test panel. If these additional tests are still not clearly passed in accordance with this standard and the part of ISO 12402 applicable to the performance level of device, the device shall be deemed to have failed.

5.3DV DE *Modification by deleting clause 5.3*.

5.4 Magnetic properties testing

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

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

5.5 Mechanical properties tests

5.5.1 General

The material properties tests shall be conducted in accordance with Table 1 or Table 2 on device(s) of the size that has been determined to represent the weakest construction. When different device sizes have substantially the same construction, any representative size may be tested.

Table 1
Mechanical properties tests for inherently buoyant PFDs

Applicable tests	Applicable samples					
	A[a]	B[b]	C[c]	D[d]	E[d]	F[d]
5.5.3 Rotating shock bin test method	X	X	X	X	X	X
5.5.4 Temperature cycling test	X	X	X	X	X	X
5.5.2.3.2 Horizontal load test		X[e]				
5.5.2.3.3 Vertical load test		X[e]				
5.5.2.4 Lifting loop test		X[e]				
5.5.2.5 Buddy line test		X[e]				
5.5.7 Over-pressure test						
5.5.9 Measurement of buoyancy of the whole device	X					
5.5.10 Inflation test						
5.5.11 Test of the resistance to inadvertent inflation						
5.5.12 Test of the resistance to burning	X					

[a] For each size.

[b] For adult devices, this sample may be the smallest size. For child devices, the sample may be the smallest size.

[c] For adult devices, this sample may be the largest size. For child devices, the sample may be the largest size.

[d] When substantially the same construction is used in adult and child devices, any size may be tested.

[e] An alternative sample subjected to 5.5.4 of the smallest size may be substituted for this test.

Table 1DV D2 *Modification of Table 1 by replacing with Table 1DV:*

Table 1DV
Mechanical properties tests for inherently buoyant PFDs

Applicable tests	Applicable samples		
	A[a]	B[b]	C[c]
5.5.4.3DV Resistance to temperature extremes			X
5.5.2.3.2 Horizontal load test	X[e]		
5.5.2.3.3 Vertical load test	X[e]		
5.5.2.4 Lifting loop test	X[e]		
5.5.2.5 Buddy line test	X[e]		
5.5.2.6DV Collar handles test			X[e]
5.5.2.7DV Holding down device test			X[e]
5.5.2.8DV Body strap hardware secureness test[f]			
5.5.2.9DV Secondary closure attachment-strength test[f]			
5.5.9 Measurement of buoyancy of the whole device	X		
5.5.12 Test of the resistance to burning		X	

[a] For each size.
[b] This sample shall be the smallest size.
[c] This sample shall be the largest size.
[d] When substantially the same construction is used in adult and child devices, any size may be tested.
[e] An alternate sample subjected to 5.5.4 of the same size may be substituted for this test.
[f] Not tested on a device and does not require the temperature test.

Table 2
Mechanical properties tests for inflatable PFDs

Applicable tests	Applicable samples			
	A[a]	B[b]	C[c]	D[d]
5.5.3 Rotating shock bin test method	X	X	X	X
5.5.4 Temperature cycling test	X	X	X	X
5.5.2.3.2 Horizontal load test		X[e]		
5.5.2.3.3 Vertical load test		X[e]		
5.5.2.4 Lifting loop test		X[e]		
5.5.2.5 Buddy line test		X[e]		
5.5.7 Over-pressure test			X	
5.5.9 Measurement of buoyancy of the whole device	X			
5.5.10 Inflation test		X		
5.5.11 Test of the resistance to inadvertent inflation	X			
5.5.12 Test of the resistance to burning			X	

[a] For each size.
[b] For adult devices, this sample may be the smallest size. For child devices, the sample may be the smallest size.
[c] For adult devices, this sample may be the largest size. For child devices, the sample may be the largest size.
[d] When substantially the same construction is used in adult and child devices, any size may be tested.
[e] An alternative sample subjected to 5.5.4 of the smallest size may be substituted for this test.

Table 2DV D2 *Modification of Table 2 by replacing with the following Table 2DV*

Table 2DV
Mechanical properties tests for inflatable PFDs

Applicable tests	Applicable samples				
	A[a]	B[b]	C[c]	D[d]	E[d]
5.5.3 Rotating shock bin test method	X	X	X	X	
5.5.4 Temperature cycling test	X	X	X	X	
5.5.2.3.2 Horizontal load test		X[e]			
5.5.2.3.3 Vertical load test		X[e]			
5.5.2.4 Lifting loop test		X[e]			
5.5.2.5 Buddy line test		X[e]			
5.5.2.6DV Collar handles test				X[e]	
5.5.2.7DV Holding down device test				X[e]	
5.5.2.8DV Body strap hardware secureness test[f]					
5.5.2.9DV Secondary closure attachment-strength test[f]					
5.5.2.10DV Strength of attachment test for inflatable PFDs		X[e]			
5.5.7 Over-pressure test			X		
5.5.9 Measurement of buoyancy of the whole device	X				
5.5.10 Inflation test		X[e]			
5.5.11 Test of the resistance to inadvertent inflation	X				
5.5.12 Test of the resistance to burning			X		
5.5.13DV Puncture Resistance test					X

[a] For each size.
[b] This sample shall be the smallest size.
[c] This sample shall be the largest size.
[d] When substantially the same construction is used in adult and child devices, any size may be tested.
[e] An alternate sample subjected to 5.5.3 and 5.5.4 of the same size may be substituted for this test.
[f] Not tested on a device and does not require the temperature test.

5.5.2 Horizontal and vertical load tests

5.5.2.1 Principles

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

horizontal load test wet;

vertical load test wet.

NOTE Test houses may use other test arrangements as described in 5.5.2.3, i.e. by means of a hydraulic jig, if the load maintained and the same accuracy of results can be achieved.

5.5.2.2 Apparatus

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

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

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

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

5.5.2.2DV DE *Modification by replacing paragraphs 2 through 4 of clause 5.5.2.2 as follows:*

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

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

For the vertical load tests shown in Figure 3DV and Figure 5DV, the apparatus shall have the dimensions as indicated in Figure 6DV.

The dummy or test form may be modified to prevent the device from slipping off of the neck projection, if needed for a valid test.

For all load tests, any load from the test fixtures applied to the device shall be included in the test load.

5.5.2.3 Procedure

5.5.2.3.1 General

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

A different sample is acceptable to test each configuration. Except for hardware closures on buoyancy aids, the tests shall be repeated on each closure independently. For buoyancy aids, all closures shall be fastened and adjusted to the mid-range to approximate even loading.

5.5.2.3.1DV D1 ***Modification by adding a paragraph to clause 5.5.2.3.1 as follows:***

For buoyancy aids that are configured with both body straps with front closures and a zipper, the tests shall be repeated with the body straps with the front closures adjusted to their maximum length with the zipper completely engaged.

5.5.2.3.2 Horizontal load test

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

5.5.2.3.2DV DE ***Modification by replacing the first paragraph of clause 5.5.2.3.2 as follows:***

The PFD shall be fitted to the upper test cylinder in the manner shown in Figure 2 for yoke types or Figure 4 for vest types. If inflatable, it shall be tested both when uninflated and when inflated by its primary means of inflation or by air to the maximum pressure of the design inflation range (30 ± 5) min prior the test. The PFD shall be attached to the cylinders such that all adjustment devices are tested. When testing jacket-style PFDs, the sleeves are to be removed or strategically cut to allow the test apparatus to pass through.

The lower test cylinder shall be fixed in the appropriate positions shown in Figure 2 and Figure 4. The specified pre-load shall be added and the test arrangement shall be adjusted such that the axes A1-A2 and B1-B2 of the upper and lower test cylinders are substantially parallel and horizontal.

The additional test load shall be applied steadily until the PFD is hanging freely. The load shall be maintained for 30 min, if not specified otherwise. For buoyancy aids (level 50), the load is maintained for 5 min only, see ISO 12402-5:2006, 5.3.3.2.

5.5.2.3.2DV.2 D2 ***Modification by replacing the third paragraph of clause 5.5.2.3.2 as follows:***

The additional test load shall be applied steadily until the PFD is hanging freely, and then maintained for the time specified in the relevant parts of UL 12402.

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

5.5.2.3.2DV.3 D2 ***Modification by adding a sentence to the last paragraph of clause 5.5.2.3.2:***

Measure and record any adjustment device slippage.

5.5.2.3.3 Vertical load test

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

means of inflation. When testing jacket-style PFDs, the sleeves are to be removed or strategically cut to allow the test apparatus to pass through.

5.5.2.3.3DV *DT Modification by replacing first sentence in the first paragraph of clause 5.5.2.3.3 as follows:*

The PFD shall be fitted to the upper test cylinder, in the manner shown in Figure 3DV for yoke types or Figure 5DV for vest types. When testing jacket-style PFDs, the sleeves are to be removed or strategically cut to allow the test apparatus to pass through.

5.5.2.3.3DV.0 D1 *Modification by modifying second sentence in the first paragraph of clause 5.5.2.3.3 as follows:*

If inflatable, it shall be tested both when uninflated and when inflated by its primary means of inflation or by air to the maximum pressure of the design inflation range.

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

5.5.2.3.3DV.1 DE *Modification of clause 5.5.2.3.3 by replacing second paragraph with the following:*

Adjust the device to fit the test form according to Figure 6DV.

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

5.5.2.3.3DV.2 DE *DT Modification by replacing first sentence in the third paragraph of clause 5.5.2.3.3 as follows:*

Attach the load suspension cord to the test frame in the appropriate positions shown in Figure 3DV and Figure 5DV.

5.5.2.4 Lifting loop test

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

5.5.2.4DV D2 *Modification by deleting the first sentence and replacing the second and third sentence in the first paragraph of clause 5.5.2.4 as follows:*

The PFD shall be fitted to the appropriately sized dummy such as that shown in ISO 12401, 5.2.2.1 or the appropriately sized test form (see Figure 6DV) according to the manufacturer's donning and adjustment instructions. If inflatable, the lifejacket shall be

inflated by its primary means of inflation or by air to the maximum pressure of the design inflation range prior to load application.

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

5.5.2.4DV.1 D2 *Modification by replacing second paragraph of clause 5.5.2.4 as follows:*

The device shall be loaded with F_1 or F_2, which will include the weight of the dummy (see Figure 1) or test form. Lift the assembly without jerking by means of a cylinder (50 ±5) mm in diameter, which is put through the loop until it is suspended freely.

Maintain the load for (1 ± 0,1) min.

See also 5.5 in the relevant parts of ISO 12402.

5.5.2.4DV.2 D2 *Modification by replacing the second and third paragraphs of clause 5.5.2.4 as follows:*

The additional test load shall be applied steadily until the PFD is hanging freely, and then maintained for the time specified in the relevant parts of UL 12402.

5.5.2.5 Buddy line test

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

5.5.2.5DV *DT Modification by replacing first paragraph of clause 5.5.2.5 as follows:*

If a buddy line is attached to a PFD, the load specified in the relevant parts of UL 12402, which includes the weight of the dummy or test form, shall be applied for the specified time perpendicular to the PFD, whilst the PFD is fitted to an appropriately sized dummy such as that shown in ISO 12401:2009, 5.2.2.1 or the appropriately sized test form (see Figure 6DV of this Part). Record if damage occurs to the buddy line or to the PFD. The buddy line shall then be pulled until torn from the device. Record the force at which the buddy line separates from the PFD and whether the separation of the buddy line from the device adversely affects the integrity of the device.

5.5.2DV D2 *Modification of adding 5.5.2.6DV – 5.5.2.10DV to Clause 5.5.2:*

5.5.2.6DV Collar handles test

The PFD shall be fitted to an appropriate test form to suspend the PFD vertically in the inverted position. A 50 ±10 mm wide strap and a having 6 ±2 mm thick foam covering shall be looped through the collar handle strap and the vertical test load specified. The test load shall be applied slowly until supported by the collar handle strap. Maintain the load for the

time specified in the relevant parts of UL 12402. Examine PFD for any damage that might endanger the function of the PFD.

5.5.2.7DV Holding down device test

The PFD shall be fitted to an appropriate test form to suspend the PFD vertically in the upright position. The holding down device, such as crotch strap, shall be laced or fastened and adjusted to mid-range. The holding down device shall be connected to the vertical test load specified using a looped strap 50 ±10 mm wide strap and having 6 ±2 mm thick foam covering. The test load shall be applied slowly until supported by the holding down device. Maintain the load for the time specified in the relevant parts of UL 12402. Measure webbing slippage and examine PFD for any damage that might endanger the function of the PFD.

5.5.2.8DV Body strap hardware secureness test

5.5.2.8.1DV Principle

Hardware that is not mechanically secured to the device, webbing, or lacing and is necessary for the performance of the device shall be adequately secured to that it will not be inadvertently lost.

5.5.2.8.2DV Procedure

5.5.2.8.2.1DV With the retention means on webbing or lacing located as close as possible to the adjustable hardware, the force specified in Figure 7DV shall be slowly applied to the end of the webbing without the retention means, with the adjustable hardware rigidly mounted perpendicular to the direction of the force applied, as shown in Figure 7DV.

NOTE The hardware shall be tested at an angle different than perpendicular to the force if it is determined that it will produce more slippage through the hardware.

5.5.2.8.2.2DV If a t-tab construction is used, the tab shall be placed against the webbing to allow for a greater possibility of unthreading, as shown in Figure 7DV.

5.5.2.8.2.3DV Results

Report if the free end completely separates from the hardware.

5.5.2.9DV Secondary closure attachment-strength test

5.5.2.9.1DV Six samples of the closure/fabric combination that represent the weakest combination of components that can be documented, three with the attachment sewn parallel to the direction of greater thread count and three in the direction of lesser thread count, are to be prepared. The closure shall be attached, centered, using the intended securing means, such as a box X or bar tack stitch, on fabric cut (100 ±5) mm wide and of sufficient length to be clamped for testing.

5.5.2.9.2DV Each sample is to be placed, in turn, in a tensile test machine by clamping the closure in the fixed jaws, aligning the cover fabric centered parallel with the direction of closure, and then securing the cover fabric portion in the moving jaws (50 ±5) mm from the attachment point. The moving jaw shall be at least as wide as the width of the closure attachment to the cover fabric. The jaws are to be separated at a constant rate of (300 ±10) mm per minute. Record the breaking force for each sample.

5.5.2.10DV Strength of attachment test for inflatable PFDs

5.5.2.10.1DV Principle

This test is to evaluate the potential for attachments to be torn from an inflation chamber or damaged which could result in deflation.

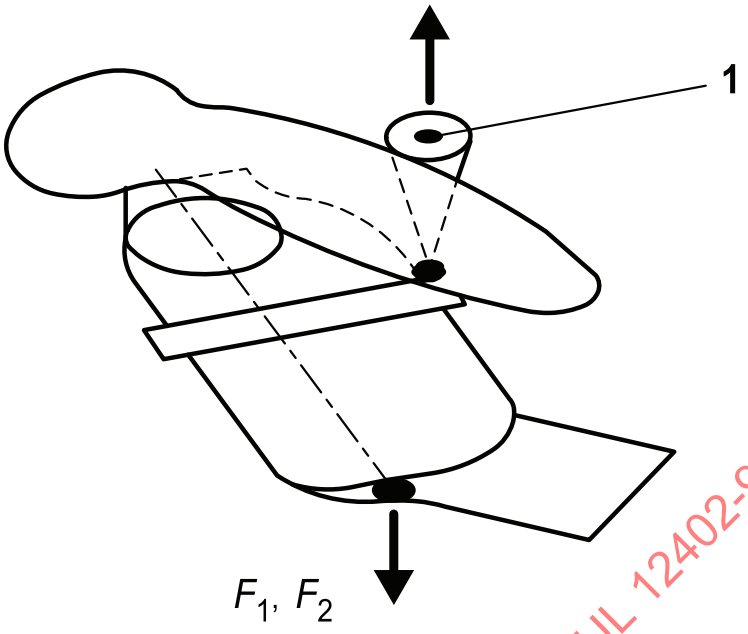
5.5.2.10.2DV The sample is to be mounted on the test form illustrated in Figure 6DV in the uninflated condition. Each compartment is to be inflated to the maximum pressure of the design inflation range. A supported load of 220 ±5 N is to be attached to each inflation system, in turn, by means of a clamp, lacing, or the like as close as possible to the point of attachment to the device. The test form is to be freely supported from the top, and is then to be slowly applied until the inflation system completely supports the load, and is to be maintained in this position for the time specified in the relevant parts of UL 12402.

5.5.2.10.3DV For an inflation system having an additional joint or coupling other than at the connection to the compartment, this procedure is to be repeated with the weight attached at a point beyond the joint or coupling. Any tubes or hoses are to be evaluated by adjusting the point of attachment to the location(s) most critical for the specific design being evaluated.

5.5.2.10.4DV For an inflatable device having other identifiable attachments to the gas holding portion of the inflatable chamber, such as loop for accessories (for example a personal marker light), the procedure detailed above is to be repeated using a load of 135 ±5 N applied to the attachment points.

5.5.2.10.5DV The same device tested above is to be deflated and the tests are to be repeated with a supported load of 135 ±5 N.

5.5.2.10.6DV For each attachment, record whether the load was supported and what the chamber pressure is at the end of the test.



su1048

Key

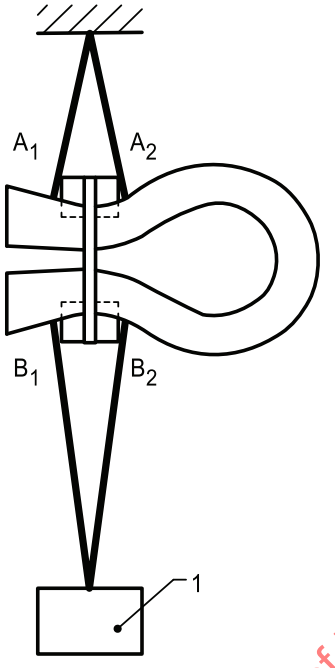
F_1 load for adult size (according to 5.5 in the relevant part of ISO 12402, mass of the dummy included)

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

1 test load

Figure 1

Test dummy

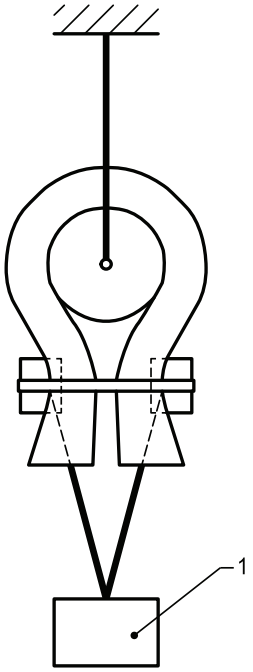


Key

1 test load

Figure 2

Horizontal load test of yoke-type PFD



Key

1 test load

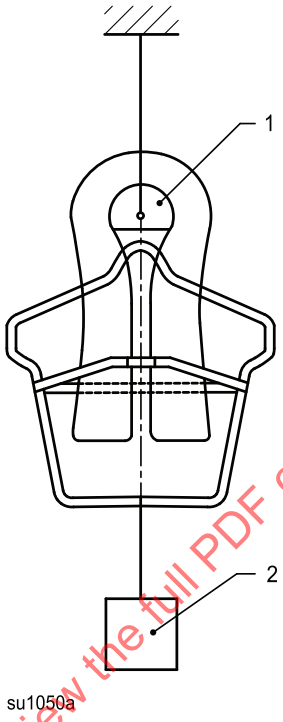
Figure 3

Vertical load test of yoke-type PFD

Figure 3DV ***DT Modification of Figure 3 by replacing with the following:***

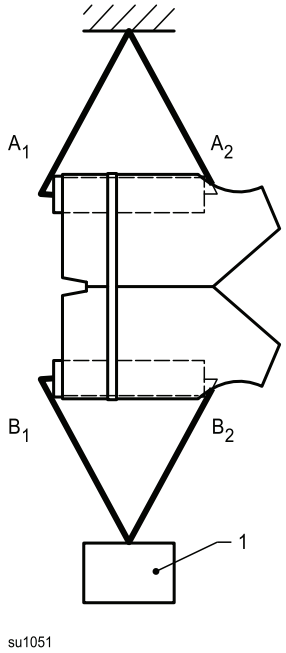
Figure 3DV

Vertical load test of yoke-type PFD



Key

1 test load



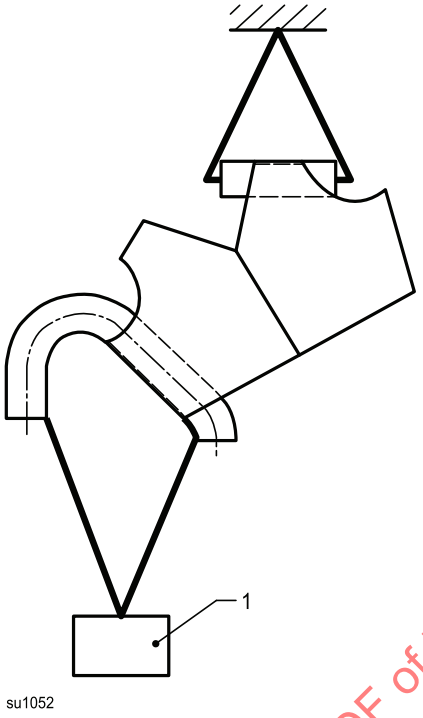
Key

1 upper test cylinder

1 test load

Figure 4

Horizontal load test of vest-type PFD



Key

1 test load

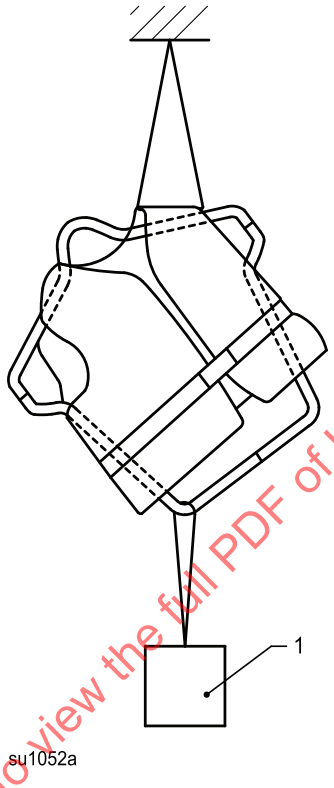
Figure 5

Vertical test of vest-type PFD

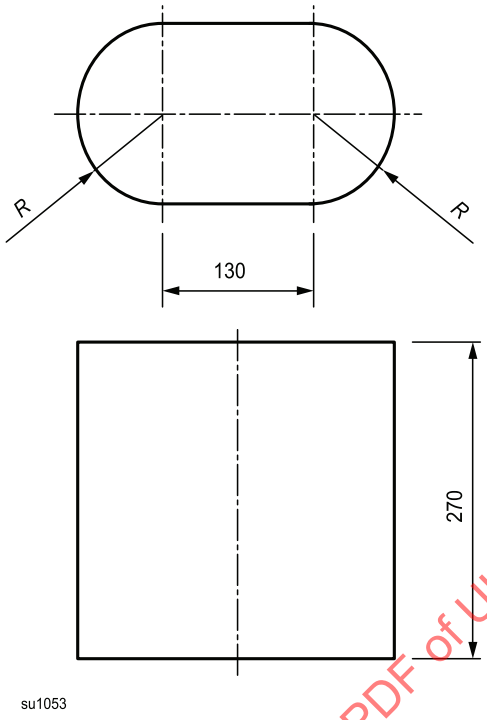
Figure 5DV ***DT Modification by replacing Figure 5 with new Figure 5DV.***

Figure 5DV

Vertical load test of vest-type PFD



Dimensions in millimetres



Key

R = 155 mm

Figure 6

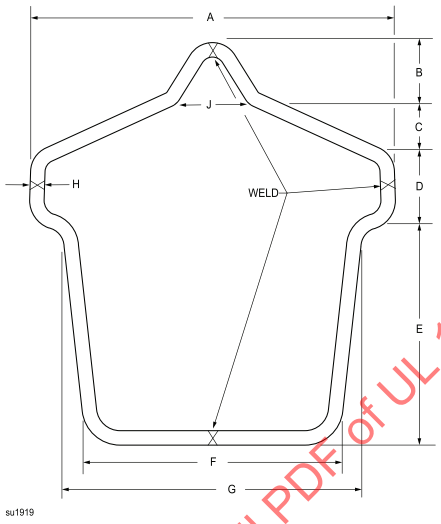
Body for vertical load test (general tolerances ISO 2768-1, v)

Figure 6DV ***DT Modification by replacing Figure 6 with new Figure 6DV:***

Figure 6DV

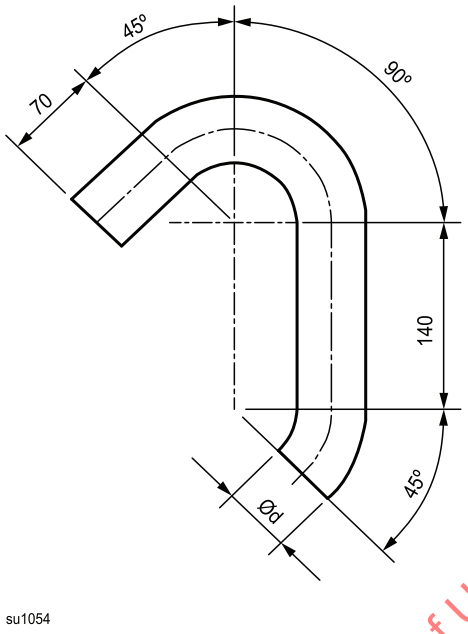
Test form for vertical load test, lifting loop and buddy lines

(general tolerances ISO 2768-1, v)



Size	A	B	C	D	E	F	G	H	J
Adult	610	114	76,2	127	381	432	508	25,4	178
Youth	508	102	76,2	102	279	330	406	22,2	152
Child	330	76,2	50,8	76,2	229	254	292	19,1	102
Infant	305	63,5	38,1	63,5	191	203	241	19,1	76,2

Dimensions in millimetres



Key

Ø = (125 ± 10) mm for adult size

Ø = (50 ± 10) mm for child size

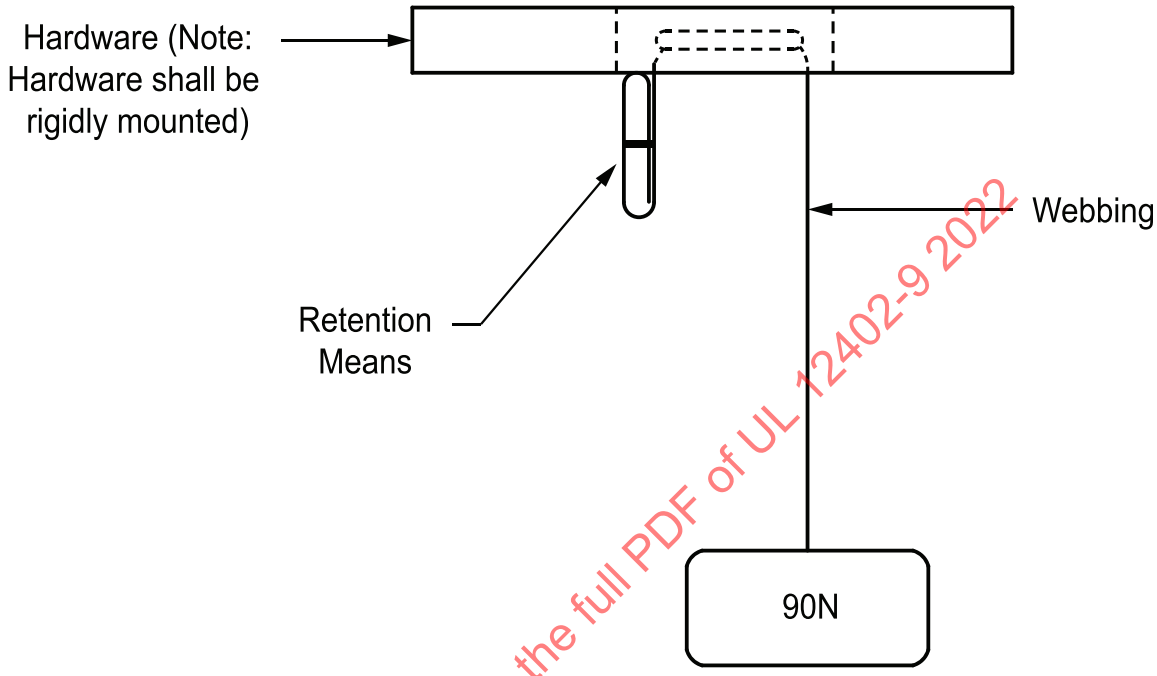
Figure 7

Bent tube for vertical load test (general tolerances ISO 2768-1, v)

Figure 7DV ***DT Modification by replacing Figure 7 with Figure 7DV.***

Figure 7DV

Hardware secureness test configuration



su1576

5.5.3 Rotating shock bin test method

5.5.3DV D2 Modification by replacing the title of 5.5.3 as follows: "5.5.3 Rotating shock bin test method for inflatable PFDs"

5.5.3.1 Principle

The PFD shall provide a minimum resistance against wear and tear.

5.5.3.2 Apparatus

The equipment used shall be that shown in Figure 8, and consists of a box 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 center of its mass, as shown in Figure 8, and permit the bin to be rotated freely.

5.5.3.3 Procedure

The PFD shall be exposed to this test in the condition "ready for use", i.e. unpacked and un-inflated, if inflatable, buckles closed but not tightened or wrapped around.

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 rev/min.

On completion of the rotations, the specimen shall be removed. The device, if inflatable, shall be inflated for (5,0 ± 0,1) min then examined for damage and checked for leaks under water. Perform the functional test according to the relevant performance level if damage is detected.

5.5.3.3DV D2 ***Modification by replacing the third paragraph as follows:***

On completion of the rotations, the specimen shall be removed. The device shall be inflated by its primary means of inflation or by air to the maximum pressure of the design inflation range and set aside for (5,0 ±0,1) min, then examined for damage and checked for leaks under water. Perform the functional test according to the relevant performance level if damage is detected.

5.5.3.4DV DE ***Modification by adding a clause to 5.5.3 as follows:***

5.5.3.4DV Results

Report whether damage and/or leakage was observed.

Dimensions in millimetres

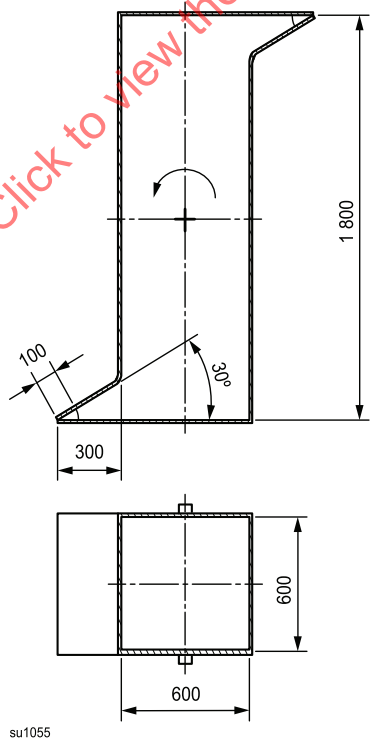


Figure 8

Design of rotating shock bin apparatus

5.5.4 Temperature cycling test

5.5.4.1 For inherently buoyant PFDs, six samples shall be alternately subjected for 8 h to surrounding temperatures of (– 30 ± 2) °C and (+ 60 ± 2) °C. These alternating cycles need not follow immediately after each other and the following procedure, repeated for 10 cycles, is acceptable.

An 8 h cycle at (+ 60 ± 2) °C is to be completed in one day. The samples are to be removed from the warm chamber that same day and left exposed under ordinary room conditions until the next day.

An 8 h cycle at (– 30 ± 2) °C is to be completed the next day. The samples are to be removed from the cold chamber that same day and left exposed under ordinary room conditions until the next day.

Two of the samples shall be cut open and shall not show any sign of internal change of structure.

Four of the samples shall be used for the water absorption test according to 5.5.5. Two of these samples shall be so tested after they have also been subjected to the oil and water resistance tests (5.5.4).

5.5.4.1DV D2 *Modification by replacing entire clause 5.5.4.1 as follows:*

5.5.4.1DV.1 Inflatable PFDs shall be alternately subjected for 8 h to surrounding temperatures of (+60 ±2)°C and (-30 ±2)°C for 2 complete cycles. One complete cycle shall consist of the following:

a) An 8 h cycle at (+60 ±2)°C is to be completed in one day. The samples are to be removed from the warm chamber that same day and left exposed at (21 ±2)°C and (65 ±5) percent relative humidity until the next day.

b) An 8 h cycle at (-30 ±2)°C is to be completed the next day. The samples are to be removed from the cold chamber that same day and left exposed at (+21 ±2)°C and (65 ±5) percent relative humidity until the next day.

5.5.4.1DV.2 Inflatable PFDs, shall be subjected to the temperature cycling test in the packed and armed (but with an empty cylinder) condition with closures secured loosely. On completion of the high temperature exposure on the second cycle, a device shall be inflated by its primary means of inflation no more than 1 min after being removed from the temperature exposure. In addition, on completion of the cold temperature exposure on the second cycle, a device shall be inflated by its primary means of inflation no more than 1 min after being removed from the temperature exposure. Each PFD shall be examined for damage and checked for leaks under water at a temperature of (20 ±1)°C after being inflated for (5.0 ±0.1) min.

5.5.4.2 If inflatable, two PFDs shall be subjected to the temperature cycling test in the uninflated condition and shall then be externally examined. The inflatable PFDs shall show no sign of damage such as shrinking, cracking, swelling, dissolution or change of mechanical qualities. The automatic and manual inflation systems shall each be tested immediately after each temperature cycling test as follows.

a) After the high temperature cycle at (+ 60 ± 2) °C, the two inflatable PFDs are removed from the warm chamber. One shall be activated using the automatic inflation system by placing it in sea water at a temperature of (+ 30 ± 2) °C and the other shall be activated using the manual inflation system.

b) After the low temperature cycle at (– 30 ± 2) °C, the two inflatable PFDs are removed from the cold chamber. One shall be activated using the automatic inflation system by placing it in sea water at a temperature of – 1 °C and the other shall be activated using the manual inflation system.

5.5.4.2DV D2 *Modification by replacing entire clause to 5.5.4.2 as follows:*

5.5.4.2DV.1 Results

Report whether the inflatable PFDs show any sign of damage such as shrinking, cracking, swelling, change of mechanical properties, or report whether leakage occurred.

5.5.4.3DV *DT Modification by adding new clause to 5.5:*

5.5.4.3DV Resistance to temperature extremes

For inherently buoyant PFDs, one sample shall be tested as follows:

a) After the PFD is stabilized at a temperature of (+60 ±2)°C for no less than 24 hours, the device is to be fully opened to simulate donning within 30 seconds after removal from the chamber. The PFD shall be examined for functional damage.

b) After the PFD is stabilized at a temperature of (−18 ±2)°C for no less than 24 hours, the device is to be fully opened to simulate donning within 30 seconds after removal from the chamber. The PFD shall be examined for functional damage.

5.5.5 Oil and water resistance tests

5.5.5.1 General

The PFD (if inflatable, in the un-inflated condition) shall be immersed completely in oil and artificial sea water. Between immersions, the PFD shall be cleaned and left to dry for (17,0 ± 0,1) h according to the instructions given in the information supplied by the manufacturer.

If the PFD is automatically inflated, the mechanism producing automatic activation shall be disabled prior to this test, and it shall be inflated using the manual mechanism on completion.

5.5.5.2 Sea water resistance test

The PFD shall be immersed in a tank of artificial sea water (4,5 % NaCl) horizontally (300 ± 30) mm below the surface for a period of 72 h at normal room temperature.

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

5.5.5.3 Oil resistance test

A sample of the device, with any automatic inflation means disabled, is to be subject to a series of three separate 5 min immersion periods of total submergence in fuel B according to ASTM D471-98:1999, with a 30 min drying period between submersions. After the last submergence period, the sample is to be removed from the liquid and the excess liquid allowed to run off for 5 min. The sample, if inflatable, is to be inflated by the primary means of inflation in accordance with the design inflation range.

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

5.5.5DV ***DT Modification by deleting entire clause 5.5.5.***

5.5.6 Water absorption test

The test is applicable to devices with inherently buoyant material, insofar as material samples have not been exposed when tested according to ISO 12402-7.

A set of two samples of the PFD as delivered, two samples having been exposed to the temperature cycling test according to 5.5.3 and two samples having been exposed according to 5.5.3 and 5.5.4 shall be placed in a tank of fresh water at a depth of 1 250 mm for seven days. Changes of dimensions shall be reported. The minimum buoyancy shall be not less than required in 5.3.4.2 of ISO 12402-2:2006 to ISO 12402-5:2006.

The changes of buoyancy after one day and seven days shall be reported.

5.5.6DV ***DT Modification by deleting entire clause 5.5.6.***

5.5.7 Over-pressure test

The inflatable buoyancy chambers shall be capable of withstanding an internal over-pressure at ambient temperature. All chambers of a PFD shall be inflated to 4,0 kPa using the oral method of inflation. After inflation the relief valves shall be disabled and a fully charged gas cylinder (but not multiple cylinders as would be present on SOLAS dual-chamber PFDs) according to manufacturer's instructions shall be fitted to the same inflation device and the device actuated. The device shall be set aside for 10 min. The pressure shall be measured and then that pressure shall be increased by 20 % in all chambers through the oral inflation tube. All fully charged gas cylinders used in this test shall be sized according to the markings on the PFD. Chamber integrity and leakage shall be checked after 5 min by functional tests.

5.5.7DV D2 ***Modification by adding new paragraph between first and last paragraph of clause 5.5.7:***

When a relief valve is provided, the over-pressure test for that chamber shall be conducted, with the valve blocked, at two times the relief valve setting or 55,0 kPa, whichever is greater.

If the PFD is of multi-chamber design, the test procedure shall continue. With one buoyancy chamber inflated (at 4,0 kPa), the operating head on the opposite buoyancy chamber shall be fired manually, using a fully charged gas cylinder according to the manufacturer's instructions. The operation of the relief valves shall be noted to ensure that the excess pressure is relieved. Chamber integrity and leakage shall be checked after 5 min by functional tests.

5.5.8 Colour

The colour of the exposed portions (excluding components such as webbing, zippers and other fittings) of the lifejacket when deployed in the normal flotation position shall be in accordance with ISO 12402-7:2006, 4.3.3.

5.5.8DV ***DT Modification by deleting entire clause 5.5.8.***

5.5.9 Measurement of buoyancy of the whole device

5.5.9.1 Principle

The buoyancy of the device shall be measured using Archimedes' principle of weighing the device in air and water, as specified below.

The two inflatable PFDs subjected to the temperature cycling test according to 5.5.3.2 shall be used for the buoyancy test.

5.5.9.1DV ***DT Modification by deleting second paragraph of clause 5.5.9.1:***

For inherently buoyant PFDs, the buoyancy of the PFD shall be measured upon initial stabilisation (buoyancy without entrapped air) and after 24 h complete submersion.

5.5.9.1DV.1 ***DT Modification by replacing third paragraph of clause 5.5.9.1:***

The buoyancy of the PFD shall be measured and recorded upon initial stabilisation (buoyancy without entrapped air) and after 24 h complete submersion. The buoyancy distribution (front and back) of the PFD shall be measured after the 24 h complete submersion.

For inflatable and multi-chamber devices, the test shall be repeated according to the number of inflatable chambers and inflatable systems under deflated condition 5.7 of ISO 12402-8:2006. Every possible combination of chambers and inflation systems shall be tested with one of the chambers in the deflated condition.

The chamber shall be fitted with the correct gas cylinder.

See also ISO 12402-8:2006, 5.7.

5.5.9.2 Apparatus

The standard equipment required consists of a weighted cage, whose submerged weight is greater than 1,1 times the expected buoyancy value.

Weighing takes place in a tank of water, deep enough to accommodate the device horizontally with its upper surface at a depth of 100 mm to 150 mm below the water surface without contacting the sides of the tank or the bottom, and with a calibrated load cell or balance supporting it.

5.5.9.2DV D2 ***Modification by replacing clause 5.5.9.2:***

The standard equipment required consists of a weighted cage, whose submerged weight is greater than 1,1 times the expected buoyancy value and a tank of fresh water, deep enough to accommodate the device horizontally with its upper surface at a depth of 50 mm to 150 mm below the water surface without contacting the sides of the tank or the bottom and with a calibrated load cell or balance supporting it.

5.5.9.3 Procedure

If the PFD contains inflatable buoyancy, it shall be inflated through the oral inflation tube to the pressure reached by the primary means of inflation (or 1,4 kPa ± 0,1 kPa, if orally inflated). The PFD shall then be enclosed in the cage attached to the weight.

5.5.9.3DV D2 *Modification by replacing first paragraph of clause 5.5.9.3 as follows:*

If the PFD contains inflatable buoyancy, it shall be inflated with air through the oral inflation tube to the pressure reached by the primary means of inflation or (4,0 ±0,1) kPa whichever is less. The PFD shall then be enclosed in the weighted cage.

The cage shall be suspended in fresh water at a temperature of (20 ± 5) °C from the load cell so that the upper surface of the horizontally positioned PFD is submerged at 100 mm to 150 mm below the surface. The immersed weight shall be recorded as A.

5.5.9.3DV.1 D2 *Modification by replacing first sentence in the second paragraph of clause 5.5.9.3 as follows:*

The cage shall be suspended in fresh water at a temperature of (20 ±5) °C from the load cell so that the upper surface of the horizontally positioned PFD is submerged at 50 mm to 150 mm below the surface.

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

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

5.5.9.3DV.2 *DT Modification by adding a paragraph to clause 5.5.9.3:*

The water temperature, air temperature, and atmospheric pressure shall be recorded at the start of each test and then after completion of each test.

5.5.9.3DV.3 D2 *Modification by adding a paragraph to clause 5.5.9.3:*

The above test procedure shall be repeated with the PFD inflated with CO_2 but a (6 ±0,2) h immersion period.

5.5.9.4 Results

5.5.9.4DV.1 *DT Modification by adding a new first paragraph to clause 5.5.9.4:*

The buoyancy values shall be corrected to a temperature of 20°C and pressure of 1 atmosphere (101.325 kPa) and recorded.

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.

The water temperature, air temperature and atmospheric pressure shall be recorded at the start of each test and then after 24 h on completion of each test and the buoyancies shall be corrected to the values of standard temperature and pressure conditions.

5.5.9.4DV.2 ***DT Modification by deleting the last paragraph of clause 5.5.9.4.***

5.5.10 Inflation test

5.5.10.1 General

The inflation can be carried out using normal air.

5.5.10.1DV D2 ***Modification by replacing clause 5.5.10.1 with the following:***

These tests shall be conducted to ensure that the PFD achieves the required buoyancy within the required time and that the inflator fires within the required load range.

5.5.10.2 Inflated PFDs

5.5.10.2.1 The inflation test shall be carried out twice: once at (– 5 ± 1) °C and once at (+ 30 ± 1) °C.

5.5.10.2.1DV D2 ***Modification by replacing clause 5.5.10.2.1:***

The apparatus consists of the appropriately sized test form (see Figure 8).

5.5.10.2.2 Inflated PFDs shall achieve sufficient buoyancy to conform to the relevant part of ISO 12402, including correct distribution through the chambers, within the time required in the relevant part of ISO 12402 after firing the inflation mechanism.

5.5.10.2.2DV D2 ***Modification by replacing clause 5.5.10.2.2 with the following:***

5.5.10.2.2DV.1 Principle

This test is conducted to ensure that the PFD achieves the required buoyancy and distribution through the chamber within the required time and that the inflator fires within the required load range

5.5.10.2.3 The PFD shall be placed securely on a test frame. A force shall be applied to the pull toggle in the correct direction to fire the operating head. The head shall not fire below 13 N and shall fire between 13 N and 67 N.

5.5.10.2.3DV D2 ***Modification by replacing clause 5.5.10.2.3 as follows:***

5.5.10.2.3DV.1 ***National Difference Deleted***

For automatic and manual PFD's the inflation tests shall be carried out twice; once following conditioning at (+30 ± 1) and once following conditioning at (–5 ± 1) °C in accordance with a) and b) below.

a) Two inflatable PFDs in the packed and armed condition shall be mounted on test frames described in Figure [8] to approximate the intended position on a wearer. Each test frame shall have an in-water weight equal to the minimum buoyancy required by UL 12402-5 or 50% of the minimum buoyancy required by the relevant part of UL 12402, whichever is greater. The PFDs shall be conditioned by exposing them for (5,0 ± 0,1) h at a temperature of (-5 ± 1) °C. The two inflatable PFDs shall then be inflated as follows:

i) The PFD in manual mode shall be rapidly submerged in a tank of salt water at a temperature of (–1 ± 2) °C until the operating head is at a minimum depth of 500mm and shall be activated using the manual inflation system. The time required for the assembly to begin to rise to the surface shall be recorded.

ii) The PFD in automatic mode shall be rapidly submerged in a tank of salt water at a temperature of (–1 ± 2) °C until the operating head activates and the time required for the assembly to begin to rise to the surface shall be recorded.

b) The test in paragraph a) above shall then be repeated but with the two PFDs conditioned by exposing them for (5,0 ± 0,1) h at a temperature of (+30 ± 1) °C and with each test frame having an in-water weight equal to the minimum buoyancy required by the relevant part of UL 12402.

c) In addition, one automatically inflated PFD shall be conditioned by exposing it for (5,0 ± 0,1) h to an air temperature of (0 ± 1) °C. The sample shall then be activated using the automatic inflation system by placing it in fresh water at a temperature of (0 ± 2) °C.

d) One inflatable PFD shall be placed securely on a test form. A force starting at 13 N shall be applied to the pull toggle in the correct direction to activate the inflation mechanism. The force shall be increased steadily until the inflation mechanism activates or 120 N is reached.

5.5.10.2.4 Automatically inflated PFDs shall first be conditioned by exposing them for (5,0 ± 0,1) h to an air temperature of (0 ± 1) °C. Then they shall be submersed rapidly until the operating head is at a depth of (300 ± 50) mm beneath the surface of fresh water at a temperature of 0 °C.

5.5.10.2.4DV D2 ***Modification by deleting entire clause 5.5.10.2.4.***

5.5.10.2.5DV D2 ***Modification by adding new clause 5.5.10.2.5 as follows:***

5.5.10.2.5DV.1 ***Deleted***

5.5.10.2.5DV.2 Results

For a), b) and c): After firing the inflation mechanism observe and record whether the inflated PFDs achieve the required buoyancy within the time required in the relevant part of UL 12402. The time from immersion until initiation of inflation in automatic mode shall also be reported.

For d): When manually fired, record whether the inflation mechanism activates between 13 N and 120 N pulling force.

5.5.11 Test of the resistance to inadvertent inflation

5.5.11.1 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.

After the test, it is necessary to examine whether the automatic device works.

5.5.11.2 Apparatus

The PFD shall be fitted correctly to a free-standing rotating manikin or equivalent type of test form of adult size, with a minimum shoulder height of 1 500 mm. The PFD shall be deployed in the mode in which it is used ready for use, but not deployed as used in the water (i.e. if it is equipped with a cover which is normally used closed, then the cover shall be closed for the test). See Figure 9.

Two spray nozzles shall be installed so as to spray fresh water onto the PFD, as shown in Figure 9. One shall be positioned 500 mm above the highest point of the PFD, be oriented at an angle of 15° from the vertical centerline of the manikin and be centered on the inflation system. The other nozzle shall be installed horizontally at a distance of 500 mm, be centered on the inflation system, and oriented 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 flow of 600 l/h, and a temperature of (19 ± 1) °C.

5.5.11.2DV D2 *National Difference Deleted*

5.5.11.3 Procedure

The sprays shall be turned on, and the PFD exposed to the following series of spray exposures by turning the test apparatus according to Figure 9:

a) 10 min with high spray on the front;

b) 10 min with high spray on the left side;

c) 10 min with high spray on the back;

d) 10 min with high spray on the right side.

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.

5.5.11.3DV ***DT Modification by adding a sentence to 5.5.11.3 and new clause 5.5.11.4 as follows:***

At the conclusion of the exposure, submerge the PFD in water to determine if the auto inflation mechanism activates within the required time.

5.5.11.4DV ***DT Results***

Report whether the device activates during the exposure and whether it activates when submerged following the exposure.

Dimensions in millimetres

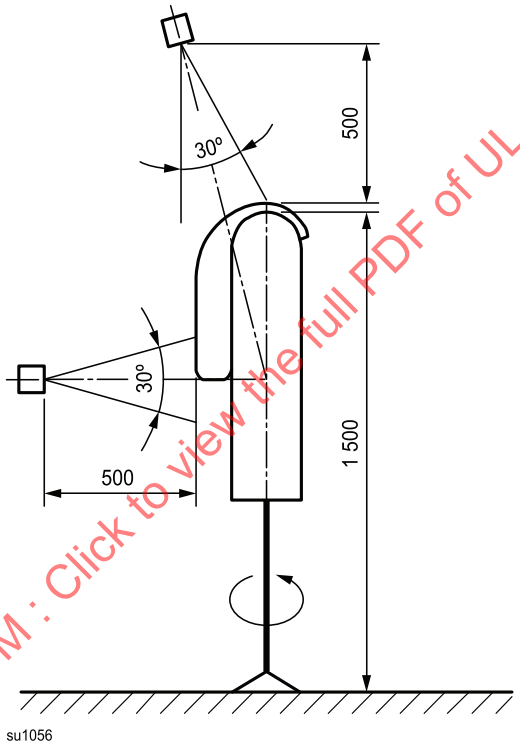


Figure 9

Test apparatus for automatic inflation devices

5.5.12 Test of the resistance to burning

5.5.12.1 Principle

This test is to demonstrate that the PFD does not create a greater hazard to the user when exposed to flame than if the user were not wearing any PFD. The premise is that a person will sustain injury if subjected to a fire as specified herein for more than 2 s, and a PFD shall not add fuel to or intensify such an exposure and shall remain useful after the exposure.

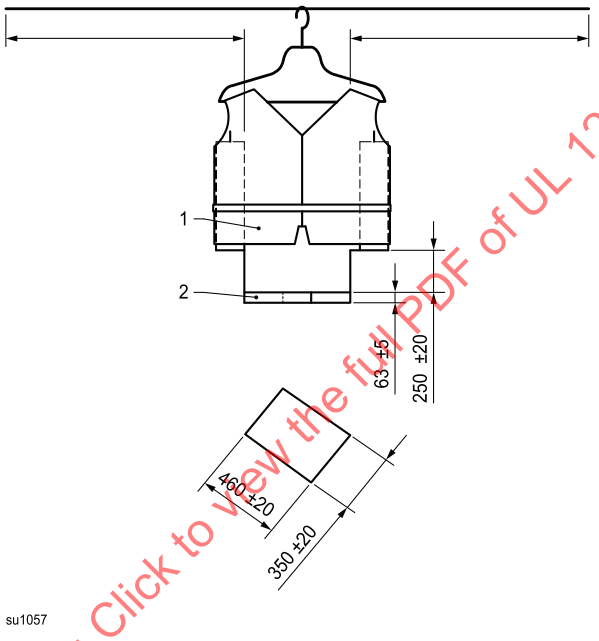
5.5.12.2 Apparatus

The test pan shall be (460 ± 20) mm × (350 ± 20) mm × (63 ± 5) mm. See Figure 10. The test shall be conducted in a large, essentially draft-free enclosed area.

5.5.12.2DV *DT Modification by replacing first paragraph of clause 5.5.12.2 as follows:*

The test pan shall be (300 ±20) mm × (350 ±20) mm × (60 ±5) mm. The PFD shall be suspended above the pan as in Figure 10DV. The test shall be conducted in a large, essentially draft-free enclosed area.

Dimensions in millimetres



Key

1 PFD

2 test pan

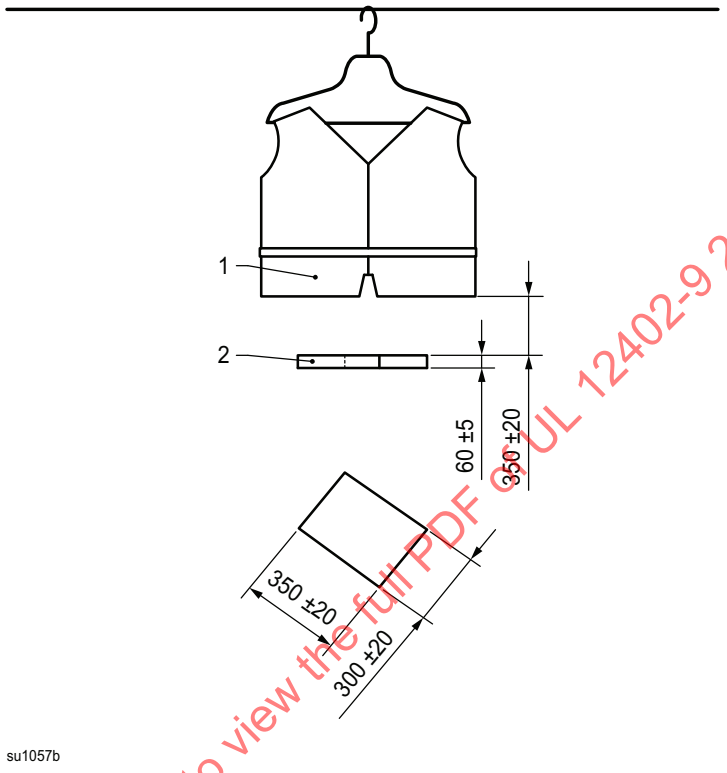
Figure 10

Test arrangement

Figure 10DV D2 *Modification by replacing Figure 10 with new Figure 10DV.*

Figure 10DV

Test arrangement



5.5.12.3 Procedure

10 mm of water is to be put in the bottom of the test pan, followed by enough petrol to make a minimum total depth of 40 mm. The petrol or n-heptane is to be ignited and allowed to burn freely for 30 s before the device is inserted.

5.5.12.3DV D2 *Modification by replacing first paragraph of clause 5.5.12.3 as follows:*

10 mm of water is to be put in the bottom of the test pan, followed by enough n-heptane to make a minimum total depth of 40 mm. The n-heptane is to be ignited and allowed to burn freely for 30 s before the device is inserted.

The upright device is to be passed through the flames in a forward, vertical, free-hanging position, with the bottom of the device (250 ± 20) mm above the top edge of the test pan. Loose parts, e.g. crotch straps, are to be secured above the lower edge of the bottom of the device. The sample is to be exposed to the flame for 2 s, starting as soon as the leading edge of the sample is touched by the flames and stopping as the trailing edge leaves the flames.

Except for lifejackets according to ISO 12402-1, if the device is burning upon emergence from the flames, 6 s shall elapse before extinguishing the flames. For lifejackets according to ISO 12402-1, if the device is burning upon emergence from the flames, the time until the device stops burning shall be recorded.

Gas cylinders shall be removed from inflatable PFDs for the duration of this test.

5.5.12.3DV.1 D1 *Modification by replacing fourth paragraph of clause 5.5.12.3 as follows:*

If inflatable, the device shall be exposed in its inflated condition by discharging the CO_2 cylinder (the primary charge if multi chambered). Any remaining charged gas cylinders shall be removed from inflatable PFDs for the duration of this test.

Following exposure to the flames, the device shall be subjected to the horizontal load test called for by the performance level of PFD being tested, except that the test loads shall be 75 % of those specified.

5.5.12.3DV.2 *DT Modification by deleting last paragraph of clause 5.5.12.3:*

5.5.12.4 Results

At the conclusion of the burning test, the device shall be subjected to the water entry test, and either the self-righting or flotation stability test, as appropriate to the performance level of the PFD being tested, utilizing one test participant having the maximum chest size or weight, as appropriate, for which the device is intended.

5.5.12.4DV D2 *Modification by replacing first paragraph of clause 5.5.12.4 as follows:*

Record whether or not the device continued to burn after removal from the flame and how long the device continued to burn if applicable. Examine the device for physical damage and record observations. If damage that would reduce buoyancy is noted, the buoyancy shall be measured in accordance with 5.5.9 of this part and recorded (10 ±1) minutes after removing trapped air.

5.5.13DV D1 *Modification by adding new clause to 5.5:*

Puncture resistance test

5.5.13.1DV Principle

For an inflatable PFD to provide adequate durability while in use, the minimum resistance to puncture is evaluated by being subjected to a probe representing a medium pen point.

5.5.13.2DV Procedure

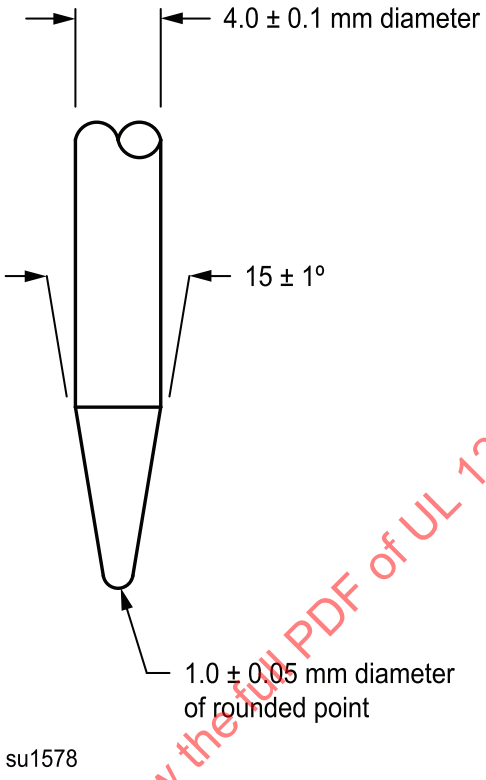
Each compartment is to be inflated separately to the maximum pressure of the design inflation range as stated by the manufacturer and placed on a smooth, flat surface. The steel test point, Figure 10.1DV, is to be pressed against each compartment at three different locations (such as each front side and the collar), at a point of maximum wall separation for the compartment, perpendicular to the wall, and with a uniform speed of 2,5 – 3,5 mm/s until a force (30 ±1 N) is attained.

5.5.13.3DV Results

Report whether the test point punctures the chamber. See Figure 10.1DV.

Figure 10.1DV

Puncture resistance test point



5.5.14DV D2 *Modification by adding new clause to 5.5 as follows:*

Uninflated buoyancy test

5.5.14.1DV Principle

Inflatable PFD's are evaluated for the ability of the device to remain afloat when dropped in water in uninflated condition.

5.5.14.2DV Procedure

An inflatable PFD in its packed and unarmed condition with full gas cylinder (or equivalent in-water weight) and closures secured loosely, shall be released from a height of (2000 ±100 mm) into water at a temperature of (+20 ±5)°C such that the inflator is closest to the water. If equipped with auto inflation, it shall be disabled prior to the test.

5.5.14.3DV Results

After 15 minutes observe and record whether the device floats at the surface of the water.

5.5.15DV D1 *Modification by adding new clause to 5.5 as follows:*

Loss distribution test

5.5.15.1DV Principle

To demonstrate that a PFD constructed with various V-factor foams will provide acceptable buoyancy distribution after a period of use, a sample to represent its used distribution is tested for in-water human subject performance tests.

5.5.15.2DV Procedure

The manufacturer shall alter a sample of the PFD. Each foam insert of the sample is to have an amount of the foam removed by skiving the surface of greatest area, or the equivalent, so that the buoyancy of each insert is as follows:

$$B = B_o\left[\left(\frac{3V}{100}\right) - 2\right]$$

in which:

B is the buoyancy of the altered insert (tolerance for front inserts: plus 0, minus 15 percent; and for back inserts: plus 15, minus 0 percent);

B_o is the buoyancy of the insert as provided in the as-received device; and

V is the V-factor of the foam from which the insert is formed, determined in accordance with ANSI/UL 1191, 24.3.

The sample then is to be reassembled in a manner that represents the construction of the complete device, to account for buoyancy loss from sewing and the like. After reassembly the sample is tested in accordance with the in-water human subject performance tests in 5.6.6 of this part.

5.5.15.3DV Results

Record the results in accordance with 5.6.6 of this part.

5.5.16DV D2 *Modification by adding clause 5.5.16DV as follows:*

5.5.16DV Gas exchange test

5.5.16DV.1 General

Gas exchange can be measured as oxygen decrease or carbon dioxide increase.

The values shall be measured under the sprayhood either on the right or left side of the face between nose and mouth and at a distance from the face center line of (10 0/-3) cm.

Two test persons between 20 years and 30 years of age and free from all know impairments to pulmonary function, shall be equipped with the lifejacket and activated sprayhood. They shall be positioned relaxed in quiet water.

The CO_2 and O_2 values are related as follows:

% CO_2 = 21 % – % O_2.

5.5.16DV.2 Procedure

5.5.16DV.2.1 Measurement of the absolute values with continuously working electronic equipment

The measurement shall be started 1 min after adjusting the sprayhood. Measurement duration shall be 5 min. The sprayhood fails if 5 % CO_2 is exceeded or O_2 falls below 16 % once.

5.5.16DV.2.2 Measurement of the average values with chemical reaction tubes or equivalent devices

The reaction tube shall be fixed directly at the measuring point without dead volume. The measurement shall be started 1 min. after adjusting the sprayhood. The duration of the measurement depends on the tube type.

The sprayhood fails if the measured CO_2 average value of 2,5 % is exceeded or the measured O_2 average value is below 18,5 %.

5.5.16DV.2.3 Results

The amount of carbon dioxide level shall be recorded.

5.5.17DV D1 ***Modification by adding new clause to 5.5 as follows:***

5.5.17DV Placard Strength of Attachment Test

5.5.17DV.1 Principle

To demonstrate the strength of both the placard material and its attachment means to the PFD.

5.5.17DV.2 Procedure

One complete sample of a placard t and its attachment means shall not break or separate from a PFD. Each different attachment means and method of attaching the placard to a PFD is to be tested.

A complete PFD is to be suspended above the floor by any convenient fixed means. The fastener used to attach the placard is to be attached to a PFD by its intended method. A total weight of 1.80 kg is to be attached by a clamping mechanism approximately 25.4 mm from the bottom middle portion of the placard. The complete assembly, consisting of the PFD, the placard, the attachment means, and the weight, is to be suspended for 1 minute so that the complete assembly does not touch the floor for the duration of the test.

5.5.17DV.3 Results

Record if the placard is detached from the PFD.

5.6 Human subject performance tests

5.6.1 Test subjects

5.6.1.1 General

The PFD according to the relevant part of ISO 12402 shall be tested using subjects in front of the test panel described in 5.1. Tests shall be conducted in a swimming pool containing fresh water, treated as necessary for hygienic purposes.

Donning of PFDs shall be tested on various sizes of adult, wearing both ordinary and heavy clothing. A PFD designed to be worn inside-out shall be tested in all configurations.

Ordinary clothing is defined as follows:

– underwear (short sleeved, short legged);

– shirt (long sleeved);

– trousers (not woollen);

– athletics shoes, if the device is required to be donned over the foot and leg.

Heavy clothing is defined as ordinary clothing with the addition of a woollen sweater and woollen overcoat.

5.6.1.1DV.2 DE *Modification by deleting the second, third and fourth paragraphs of clause 5.6.1.1.*

Test subjects shall be generally informed of the methods and intent of the in-water performance tests, but should have no knowledge of the specific PFD being tested. The subjects shall be in suitable health to physically perform the tests. The principles of the Declaration of Helsinki as amended shall be considered in so far as applicable. The test shall have been passed if all results of the human subject performance tests are positive.

The tests may be modified for child test subjects under 12 years of age who are not water adapted, so as to ensure their safety and co-operation. When assessing such children's sizes, the panel can make greater use of subjective indicators, as self-righting and jumping can be hazardous and more subjective when applied to small children. The position in the water and support afforded can be useful indicators.

Reference testing with child manikins shall be done according to 5.6.9.

The tests shall be carried out in the order 5.6.4, 5.6.7, 5.6.5, 5.6.6, 5.6.8, 5.6.2, 5.6.3 and 5.6.9.

5.6.1.1DV.3 *DT Modification by deleting the last paragraph of clause 5.6.1.1.*

5.6.1.2 Subject requirements for adults

PFDs shall be tested using at least eight subjects if the device is sized to accommodate a range of chest sizes in excess of 400 mm or a body mass range greater than 30 kg. If the manufacturer offers different sizes, five subjects for lifejackets and special purpose devices and three subjects for buoyancy aids shall

be used to test each size range which does not exceed 150 mm chest circumference or 20 kg body mass. PFD designs having size ranges between these limits shall be tested on a proportionate number of subjects.

The test shall be carried out with able-bodied persons according to Table 3. The marked mass and/or height and chest size, if stated, on the PFD shall be taken into account when selecting test subjects.

Table 3
Adult test subjects

Height category mm	Body mass kg							
	40 to 42	> 42 to 60	> 60 to 70	> 70 to 80	> 80 to 100	> 100 to 110	> 110 to 120	> 120
< 1 500	1	X	X	X	–	–	–	–
1 500 to 1 600	X	1	1	X	X	–	–	–
>1 600 to 1 700	–	X	X	1	X	X	–	–
>1 700 to 1 800	–	–	X	X	1	X	X	X
>1 800 to 1 900	–	–	X	X	X	1	1	X
>1 900	–	–	–	–	X	X	X	1

The following applies:

a) Between one third and one half of test subjects shall be females, including at least one per height category but excluding the highest height.

b) At least one male and one female shall be from the lowest and highest mass groups appropriate to the PFD.

c) At least one subject shall be selected per cell that is appropriate to the PFD and marked with a “1”.

d) Enough additional subjects shall be selected from cells marked “X” to total the required number of test subjects for the size range of PFD, with no more than one subject per cell. A uniform distribution across mass groups shall be maintained.

e) The test subject size selection shall be adjusted for the lowest mass group to test at least one subject within 2 kg of the lowest size for which the PFD is to be certified. Subjects of less than 40 kg may be shorter than 1 400 mm if required. One subject shall be tested for each 4 kg below 40 kg.

Table 3DV D1 ***Modification by deleting Table 3.***

Each test subject shall be made familiar with each of the tests, particularly the requirements regarding relaxing and exhaling in the face-down position.

Only good swimmers shall be used, since the ability to relax in the water is rarely otherwise obtained.

To verify that the test subjects used represent a valid cross-section of the adult population for testing a lifejacket according to ISO 12402-1, the average face-up righting time for the group of test subjects shall be at least 2,2 s when tested using the reference vest specified in Annex B and the leg release method according to 5.6.6.3 a).

5.6.1.2DV D1 ***Modification by replacing entire clause 5.6.1.2 with 5.6.1.2DV as follows:***

5.6.1.2DV Subject requirements for adults

5.6.1.2DV.1 Subject requirements for Buoyancy Aids

Buoyancy aids shall be tested using at least 12 subjects if the device is sized to accommodate a range of chest sizes in excess of 400 mm. At least 6 subjects shall be used to test each size range which does not exceed 200 mm chest circumference. Buoyancy aid designs having size ranges between these limits shall be tested on at least a proportionate number of subjects, rounding up to the nearest whole number.

Within a series of marked sized devices (for example, S, M, L, etc.) where each adjacent size utilizes the same inflation chamber or buoyancy element(s) with only cover and closure materials that differ proportionally over the chest size range, multiple sizes may be considered as a single size range for determining the minimum number of test subjects.

5.6.1.2DV.2 Subject requirements for Lifejackets

Non-Reference Test Device Method

Lifejackets shall be tested using at least 18 subjects if the device is sized to accommodate a range of chest sizes in excess of 400 mm. At least 12 subjects shall be used to test each size range of 200 to 400 mm chest circumference. At least 6 subjects shall be used to test each size range less than 200 mm chest circumference.

Reference Test Device Method:

Lifejackets shall be tested using at least 12 subjects if the device is sized to accommodate a range of chest sizes in excess of 400 mm. At least 6 subjects shall be used to test each size range which does not exceed 200 mm chest circumference. Lifejacket designs having size ranges between these limits shall be tested on at least a proportionate number of subjects, rounding up to the nearest whole number.

Within a series of marked sized devices (for example, S, M, L, etc.) where each adjacent size utilizes the same inflation chamber or buoyancy element(s) with only cover and closure materials that differ proportionally over the chest size range, multiple sizes may be considered as a single size range for determining the minimum number of test subjects.

The following shall be used when selecting test subjects:

a) The marked mass, chest size and/or height, and/or waist size on the PFD;

b) Between one third and one half of test subjects shall be females;

c) For a device or group of devices with a chest size range in excess of 400 mm, subjects must represent at least one of each mesomorphic, endomorphic, ectomorphic somatotypes;

NOTE: Refer to Annex FDV to determine a subject's somatotype when there is difficulty determining it visually.

d) For a device with a marked mass without a defined range (eg. >40 kg), at least one subject shall have a mass within ± 1 kg of the minimum marked mass. For a device with a marked mass with a defined range (eg. >40 – 60 kg), at least one subject shall have a mass within ± 1 kg of the minimum marked mass and at least one subject shall have a mass within ± 1 kg of the maximum marked mass.

e) At least one subject shall have a chest size 25 mm (±13 mm) below the minimum marked chest size and one subject 25 mm (±13 mm) above the maximum marked chest size;

f) At least one subject shall be of a height 25 mm (±13 mm) below the minimum marked height and one subject 25 mm (±13 mm) above the maximum marked height. If no maximum height is marked on an adult device, one test subject shall be at least 1.8 m in height.

g) For inflatable belt pack devices, or devices designed to be worn around the waist, at least one subject shall have a waist size 25 mm (±13 mm) below the minimum marked waist size and one subject 25 mm (±13 mm) above the maximum marked waist size;

h) Subjects shall be sized as to represent the device's entire size adjustment range, or each adjacent size, proportionately; and

i) For lifejackets, subjects meeting the in-water weight criteria in clause 5.6.1.4.3DV of this part shall be included in each group of subjects.

j) For Level 50 buoyancy aids, at least one subject shall have an in-water weight meeting the criteria in clause 5.6.1.4.4DV of this part.

5.6.1.3 Subject requirements for children

Test subjects shall be selected to fully represent the range of sizes for which the device is to be approved. Devices for smaller children shall be tested on children as small as approximately 760 mm tall and 9 kg mass. At least six test subjects shall be used for each 380 mm and 16 kg of size range according to Table 4.

Water tests using children shall avoid causing distress or risk to the child. Consideration shall be taken of their age and ability.

Table 4
Child test subjects

Height category cm	Body mass kg											
	9 to 12	> 12 to 14	> 14 to 17	> 17 to 20	> 20 to 22	> 22 to 25	> 25 to 28	> 28 to 30	> 30 to 33	> 33 to 36	> 36 to 38	> 38 to 41
76 to 83	1	X	–	–	–	–	–	–	–	–	–	–
79 to 105	X	1	X	X	X	–	–	–	–	–	–	–
90 to 118	–	–	X	X	1	X	–	–	–	–	–	–
102 to 130	–	–	–	–	X	X	X	X	–	–	–	–
112 to 135	–	–	–	–	–	–	X	X	X	–	–	–
122 to 150	–	–	–	–	–	–	–	–	1	1	X	X
145 to 165	–	–	–	–	–	–	–	–	–	–	X	1

The following applies:

a) At least 40 % of the subjects shall be male and at least 40 % female.

b) At least one subject shall be selected per cell which is appropriate to the PFD and marked with a “1”.

c) Enough additional subjects shall be selected from cells marked “X” to total the required number of test subjects for the size range of PFD. A uniform distribution across mass groups shall be maintained.

Table 4DV D1 ***Modification by deleting entire Table 4.***

When conducting water performance tests, child-size PFDs shall meet the requirements for their minimum buoyancy. The range of sizes for child-size PFDs shall be considered based on the test results. Devices shall be sized by height or by height and body mass.

5.6.1.3DV D1 ***Modification by replacing entire clause 5.6.1.3 as follows:***

5.6.1.3DV Subject requirements for children and infants

5.6.1.3DV.1 Subject requirements for Buoyancy Aids

Test subjects shall be selected to fully represent the range of sizes for which the device is to be approved. At least six test subjects shall be used for each size range.

5.6.1.3DV.2 Subject requirements for Lifejackets

Non-Reference Device Method

Test subjects shall be selected to fully represent the range of sizes for which the device is to be approved. At least six test subjects shall be used for each size range.

Reference Device Method

Test subjects shall be selected to fully represent the range of sizes for which the device is to be approved. At least six test subjects shall be used for each 380 mm and 16 kg of size range, rounding up to the nearest whole number. Infant, child, youth should be four subjects for each size range. If the device covers two size ranges the number of subjects should cover both ranges.

The following shall be used when selecting test subjects:

a) The marked mass and/or height, and/or waist size, and/or chest size on the PFD;

b) For devices marked with a height size range, at least one subject shall have a height 25 mm (±13 mm) below the minimum marked height size and one subject 25 mm (±13 mm) above the maximum marked height size;

c) For devices marked with a chest size range, at least one subject shall have a chest size 25 mm (±13 mm) below the minimum marked chest size and one subject 25 mm (±13 mm) above the maximum marked chest size;

d) At least one subject shall have at least a mass 0.5 kg (±0.25 kg) below the minimum marked weight range and one subject at least 0.5 kg (±0.25 kg) above the maximum marked weight range;

e) For inflatable belt pack devices, at least one subject shall have a waist size 25 mm (±13 mm) below the minimum marked waist size and one subject 25 mm (±13 mm) above the maximum marked waist size;

f) For lifejackets, the selected subjects shall have an in-water weight according to 5.6.1.4.3DV; and

g) For Level 50 buoyancy aids, one subject shall have an in-water weight according to 5.6.1.4.4DV.

In-water tests using children shall avoid causing distress or risk to the child. Consideration shall be taken of their age and ability.

5.6.1.4 In-water weight

This test is only to be carried out on subjects for adult's lifejackets.

The in-water weight of each test subject is to be measured to ensure an adequate minimum acceptable range of representative subjects. The in-water weight of each test subject of 40 kg or more is taken with the tip of the chin and bottom of the ear lobes touching the water at the bottom of the normal breathing cycle. The in-water weight is the highest repeated value out of 10 readings or the third highest value if none is repeated.

5.6.1.4DV D1 ***Modification by replacing entire clause 5.6.1.4 as follows:***

5.6.1.4DV In-water weight

5.6.1.4.1DV Principle

The in-water weight of test subjects is measured to ensure an adequate minimum acceptable range of representative subjects.

5.6.1.4.2DV Procedure

The in-water weight of a test subject is taken with the tip of the chin and bottom of the ear lobes touching the water at the bottom of the normal breathing cycle (See Figure 10.2DV). The in-water weight is the highest repeated value out of 10 readings or the third highest value if none is repeated. Additional weight may be secured to the ankle(s) to maintain the subject in a vertical position provided that the additional weight is subtracted from the total in-water weight.

5.6.1.4.3DV In-water weight of test subjects for lifejackets

For a group of test subjects to have an acceptable range of in-water weights, at least one subject shall exceed the upper in-water weight and at least one subject shall not exceed the lower in-water weight as specified in Table 5DV.1 according to the mass range of the PFD being tested. Where a PFD is intended for more than one mass range, the upper in-water weight value of the highest mass range and the lower in-water weight value of the lowest mass range of the PFD design shall be used. For subjects less than or equal to 40 kg the in-water weight is optional if subjects cannot perform as instructed.

Table 5DV.1
Range of test subject in-water weights for lifejackets

Parameter	User						
	Infant	Child		Adult			
User mass range, m (kg)	m ≤ 15	15 < m ≤ 30	30 < m ≤ 40	40 < m ≤ 50	50 < m ≤ 60	60 < m ≤ 70	m ≥ 70
Upper in-water weight (N)	–	–	28	34	40	49	55
Lower in-water weight (N)	–	–	22	22	22	24	26

5.6.1.4.4DV In-water weight for testing Level 50 buoyancy aids

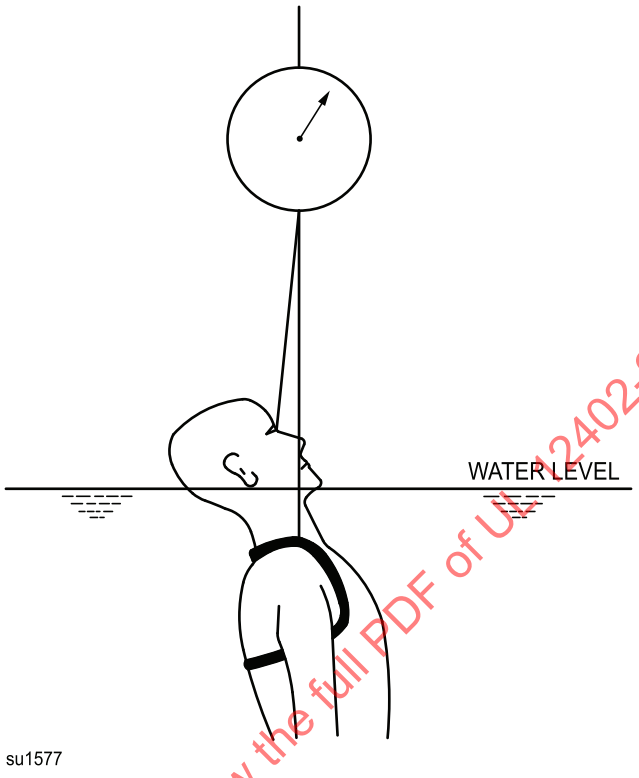
For Level 50 buoyancy aids, one subject shall have an in-water weight as described in Table 5DV.2. For a device with more than one mass range, the higher in-water weight shall be used.

Table 5DV.2
Range of test subject in-water weights for Level 50 buoyancy aids

Parameter	User						
	Infant	Child		Adult			
User mass range, m (kg)	m ≤ 15	15 < m ≤ 30	30 < m ≤ 40	40 < m ≤ 50	50 < m ≤ 60	60 < m ≤ 70	m ≥ 70
In-Water weight range (N)	–	–	28 – 35	34 – 43	40 – 50	49 – 62	55 – 69

Figure 10.2DV

In-water weight test arrangement



5.6.1.5 Sex and dress

Subjects shall include both males and females and no more than two thirds of one sex. See also Table 3. All test subjects shall use only bathing costumes during height, weight, and in-water measurements and for all in-water tests. After being weighed and measured, the subject shall be dressed in ordinary clothing (see 5.6.1.1) to conduct the donning test before becoming familiar with the PFD being tested.

5.6.1.5DV DE *Modification by deleting first two sentences of clause 5.6.1.5*

5.6.1.6DV *DT Modification by adding new clause to 5.6.1:*

In-water human subject performance tests sequence

5.6.1.6.1DV The human subject performance tests shall be carried out in the order described in Table 6DV, Table 7DV, and Table 8DV, as applicable to the type of buoyancy and methods of inflation.

Table 6DV
In-water performance tests sequence for inherently buoyant PFDs

Tests		Clause / Paragraph number
1	Donning	5.6.4
2	Water Entry – 1000 mm	5.6.5, 5.6.5.2.4DV
3	In-Water Stability Test (if applicable)	5.6.8
4	Self-Righting and Stability	5.6.6
5	Retroreflective Material Visibility (if applicable)	5.6.10DV
6	Ride-Up	5.6.11DV
7	Water Entry – 3000 mm (if applicable)	5.6.5.2.2DV, 5.6.5.2.4DV
8	Water Entry – 4500 mm [1](if applicable)	5.6.5.2.3DV
9	Pocket Flotation Stability Test (if applicable)[2]	5.6.13DV
10	Ergonomics[2]	5.6.7
11	Boarding[2]	5.6.3
Note 1 – For ISO 12402-1 devices only.		
Note 2 – This test may be performed any time after the freeboard test.		

Table 7DV
In-water performance tests sequence for automatic inflatable PFDs

Tests		Clause / Paragraph number
1	Donning	5.6.4
2	Water Entry – 1000 mm[1]	5.6.5
3	In-Water Stability Test (for lifejackets only)	5.6.8
4	Water Entry – 1000 mm[1]	5.6.5
5	Self-Righting and Stability	5.6.6
6	Retroreflective Material Visibility (if applicable)	5.6.10DV
7	Ride-Up	5.6.11DV
8	Water Entry – 1000 mm[1]	5.6.5
9	Water Entry – 3000 mm[1]	5.6.5
10	Water Entry – 4500 mm [2]	5.6.5
11	Pocket Flotation Stability Test (if applicable)[3]	5.6.13DV
12	Ergonomics[3]	5.6.7
13	Boarding[3]	5.6.3
Note 1 – Refer to Water Entry Test, 5.6.5 of this part for the appropriate configuration for inflatable PFDs.		
Note 2 – For ISO 12402-1 lifejackets only.		
Note 3 – This test may be performed any time after the freeboard test.		

Table 8DV
In-water performance tests sequence for manual only inflatable PFDs

Tests		Clause / Paragraph number
1	Donning	5.6.4
2	Water Entry – 1000 mm[1]	5.6.5
3	In-Water Stability Test (for lifejackets only)	5.6.8
4	Water Entry – 1000 mm[1]	5.6.5
5	Self-Righting and Stability	5.6.6
6	Retroreflective Material Visibility (if applicable)	5.6.10DV
7	Ride-Up	5.6.11DV
8	Water Entry – 3000 mm[1]	5.6.5
9	Water Entry – 4500 mm [2]	5.6.5
10	Pocket Flotation Stability Test (if applicable)[3]	5.6.13DV
11	Ergonomics[3]	5.6.7
12	Boarding[3]	5.6.3
Note 1 – Refer to Water Entry Test, 5.6.5 of this part for the appropriate configuration for inflatable PFDs.		
Note 2 – For ISO 12402-1 lifejackets only.		
Note 3 – This test may be performed any time after the freeboard test.		

5.6.2 Measurement of freeboard

5.6.2.1 Principle

The freeboard shall be measured as the vertical difference between the water surface and the lowest corner of the mouth.

5.6.2.2 Apparatus

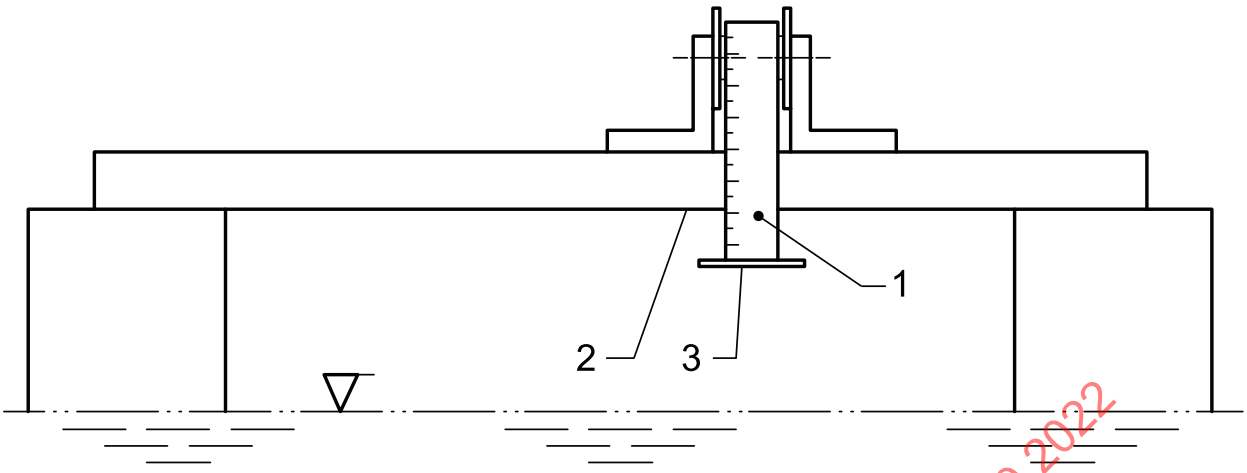
A suitable measuring device is shown in Figure 11. It consists of two floats made of closed-cell foam, connected by a rigid bridge at such a height that a test subject using a PFD in the water has approximately 100 mm clearance between the top of his head and the bridge. On the bridge, one third of the way along from one end, a steel measuring tape roll or drum is to 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 maintain a fixed tape protrusion length. At the free end of the tape, a plastic disk of (100 ± 5) mm diameter is fixed in a perpendicular position. There is also a measuring mark made along the bottom edge of the bridge.

5.6.2.3 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 subject is to be instructed to relax during measurement of the freeboard. The distance between the measuring line and the lowest point of respiration, typically the corner of the mouth, of the subject shall then be measured.

5.6.2.4 Results

The individual freeboard for each subject shall be recorded.



su1058

Key

1 tape

2 measuring mark

3 plastic disk

Figure 11

Device for measuring freeboard

5.6.3 Boarding test

The test shall prove and limit the encumbrance of a PFD on the ability of the wearer to climb out of water under adverse conditions.

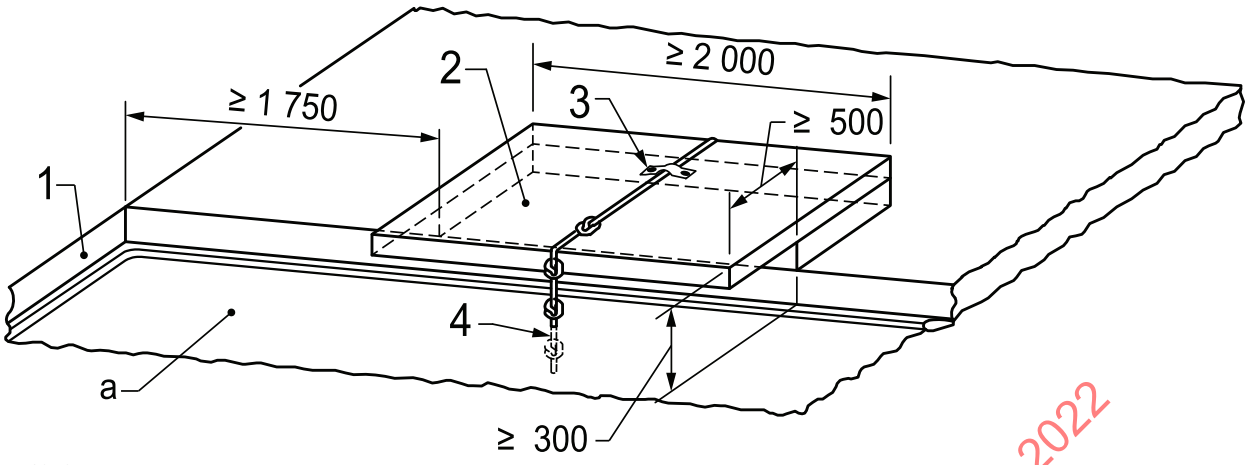
All test subjects, without using the PFD, shall attempt to swim 25 m and board a SOLAS liferaft or rigid platform as shown in Figure 12 with its surface 300 mm above the water surface. Each test subject who successfully completes this task shall perform it again while wearing the PFD. At least two thirds of these subjects shall complete the task wearing the PFD. If two thirds of the subjects do not qualify without wearing the PFD, additional subjects may be used until the required number of subjects qualify.

5.6.3DV.D2 *Modification by replacing second paragraph of clause 5.6.3 as follows:*

The test subject, while wearing the PFD, shall attempt to swim 25 m and board a SOLAS liferaft or rigid platform as shown in Figure 12 with its surface 300 mm above the water surface. Each test subject who is unable to complete this task shall attempt it again without wearing the PFD. A test subject who is able to complete the task, with or without the PFD, shall be considered qualified. If two thirds of the subjects do not qualify, an additional group of subjects shall be selected for qualification. Two thirds of the total number of 12 subjects tested must be qualified.

NOTE If necessary, each test subject is allowed to rest prior to conducting the Boarding Test.

Report the type of apparatus used, the number of test subjects who attempted the boarding test, and the number test subjects who were disqualified, and the number who successfully completed the boarding while wearing the PFD.



su1059

Key

1 pool side

2 platform

3 rope fixing point

4 rope

[a] Water level.

Figure 12

Boarding platform

5.6.4 Donning test

5.6.4.1 Principle

PFDs are evaluated for ease of donning to assess their usefulness in an emergency. 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. Inflatable PFDs shall be tested inflated and uninflated.

5.6.4.1DV ***DT Modification by adding the following to the end of clause 5.6.4.1:***

Where it is required to test while wearing ordinary clothing, such clothing is defined as follows:

– underwear (short sleeved, short legged);

– shirt (long sleeved);

– trousers (not woollen);

– athletics shoes, if the device is required to be donned over the foot and leg.

Heavy clothing is defined as ordinary clothing with the addition of a hooded winter insulated parka.

5.6.4.2 Procedure

Using ordinary clothing, subjects who are completely unfamiliar with the PFD shall attempt to don the PFD to a snug fit. If the attire customary to the designated purpose of the PFD can have an adverse effect on the test results, the tests shall be repeated with at least one subject wearing such attire. Each subject may have two attempts as follows.

5.6.4.2DV ***DT Modification by replacing the first paragraph of clause 5.6.4.2 as follows:***

For PFDs according to ISO 12402-3 to ISO 12402-4 and UL 12402-5:2012, wearing either a bathing costume or ordinary clothing, subjects who are completely unfamiliar with the PFD shall attempt to don the PFD to a snug fit. If the attire customary to the designated purpose of the PFD or ordinary clothing can have an adverse effect on the test results, the tests shall be repeated with at least one subject wearing such attire. For lifejackets according to ISO 12402-1 and ISO 12402-2 the test shall be run wearing ordinary clothing. Each subject may have two attempts as follows.

a) For all PFDs, the first attempt shall be with no assistance, guidance or prior demonstration. The PFD, with closures undone and adjusted to fit a mid-sized subject, shall be placed on the deck, face up, in front of the test subject. The instruction provided shall be identical for each subject and shall be equivalent to the following: “PLEASE DON THIS DEVICE QUICKLY AND SECURELY SO YOU CAN ABANDON SHIP.” The attempt shall be timed. Donning is considered complete when the subject has donned and securely adjusted all methods of securing the PFD to the extent needed to meet the in-water performance requirements for the performance level of PFD, including inflation, if needed.

5.6.4.2ADV D1 ***Modification by adding the new fourth sentence to clause 5.6.4.2a as follows:***

The instruction shall include the requirement to inflate an inflatable PFD.

b) For PFDs according to ISO 12402-2 to ISO 12402-6, the second attempt, if necessary, shall be after the test subject has read the instructions printed on the PFD.

5.6.4.2BDV ***DT Modification by replacing 5.6.4.2b as follows:***

b) When a subject does not follow the donning instructions on the second attempt, the subject shall be replaced, provided that no other subject dons the device in the same improper manner.

NOTE For the purposes of testing, a facsimile of the instructions may be provided separately.

c) For lifejackets according to ISO 12402-1, if necessary, the second attempt shall be after the subjects have viewed a demonstration of proper donning of the lifejacket.

For lifejackets according to ISO 12402-1, each subject shall make one additional donning attempt using the procedures specified in a) while using heavy-weather clothing consisting of an arctic parka with hood and warm cotton gloves.

5.6.4.2DV.1 ***DT Modification by replacing the last paragraph of clause 5.6.4.2 as follows:***

If specified in the relevant parts of ISO 12402, each subject shall make one additional donning attempt using the procedures specified in a) while using heavy weather clothing.

5.6.4.2DV.2 ***DT Modification by adding the following paragraphs to clause 5.6.4.2 as follows:***

In addition, inflatable PFD's shall be donned with the PFD fully inflated. The second attempt, if necessary, should allow the test subjects to be instructed that partial deflation is acceptable to successfully don the PFD in the inflated condition. Donning is considered complete when the subject has donned and securely adjusted the PFD to the extent needed to meet the in-water performance requirements of the performance level of PFD, including full re-inflation of the inflatable chamber via the oral inflation tube.

For devices requiring additional action by the user, such as oral inflation or other activities in the way of secondary donning, this test is to be repeated in the water.

5.6.4.3 Results

All PFDs shall be capable of being completely donned by at least 75 % of persons using ordinary clothing and who are completely unfamiliar with the PFD within a period of 1 min without assistance, guidance or prior demonstration. If less than 75 % of the first group of test subjects are able to don the lifejacket within the 1 min period on the first attempt, a second and third set of test subjects may be used to cumulatively demonstrate meeting the 75 % criterion. If used, the second and third sets of subjects shall meet the same criteria as the first set of subjects.

5.6.4.3DV.1 DE ***Modification by replacing the second sentence of the first paragraph of clause 5.6.4.3 as follows:***

If less than 75 % of the first group of test subjects are able to don the PFD within the 1 min period on the first attempt, a second and third set of test subjects may be used to cumulatively demonstrate meeting the criterion specified.

For PFDs according to ISO 12402-2 to ISO 12402-6, after the subjects have read the instructions printed on the PFD, the PFD shall be capable of being completely donned by all persons without assistance within a period of 1 min.

For lifejackets according to ISO 12402-1, after the subjects have viewed a demonstration of proper donning of the lifejacket, the PFD shall be capable of being completely donned by all persons without assistance within a period of 1 min.

For lifejackets according to ISO 12402-1, using heavy weather clothing, all persons shall be able to correctly don it within a period of 1 min without assistance.

5.6.4.4 Secondary donning

All devices requiring additional action by the user, such as oral inflation or other activities in the way of secondary donning, shall be tested on each subject to demonstrate that they can be accomplished within

the prescribed time. The subjects shall prove that the necessary action for secondary donning and inflation can be performed in water and on land within the prescribed time.

5.6.5 Water entry test

5.6.5.1 Principle

PFDs shall be evaluated for their ability to stay on a user when falling or jumping into the water, and to remain in a usable position. The evaluation is intended to cover most unfavourable attitudes of water entry.

The PFD shall withstand any damage when the user jumps from height. The PFD shall be tested according to the designated design. The test shall prove all service conditions, i.e. for a PFD being inflated both automatically and manually, or if of multi-chamber design also with one of the compartments uninflated. The tests shall be repeated as many times as necessary to verify all service conditions.

The subject shall be familiar with jumping from such height.

Without readjusting the PFD, the test subject shall jump vertically into the water, feet first. The test subject shall be allowed to hold on to the PFD or brace arms during water entry according to 5.6.5.2.2 and 5.6.5.2.3 to avoid possible injury.

5.6.5.1DV *DT Modification by deleting the fourth paragraph of clause 5.6.5.1:*

The test subject shall come to rest with the mouth clear of the water by at least the required freeboard.

5.6.5.1DV.1 D1 *Modification by replacing the fifth paragraph of clause 5.6.5.1 with the following:*

The ability of an automatic inflation system to bring the subject to the surface of the water shall is evaluated for both activation function and time to surface.

Any elastic parts used to improve the fit of the garment shall be cut prior to the test.

5.6.5.2 Procedure

5.6.5.2.1 An inflatable PFD shall be donned and inflated by the primary means of inflation. Non-inflatable PFDs shall be donned. The test subject, initially with arms held vertically over the head, shall fall or step into the water, feet first, from a height of (1 000 $^{0}_{+500}$) mm. Upon going into the water, the test subject shall relax to simulate a state of utter exhaustion. Water entry in other orientations such as a dive or a feet-first step with arms at sides shall be performed if they are more likely to produce adverse results.

5.6.5.2.1DV.1 D1 *Modification by replacing clause 5.6.5.2.1 as follows:*

All PFD's shall be donned in accordance with the manufacturer's instruction for use prior to water entry. For an inflatable PFD, the subject shall enter the water in the device configuration and order of jumps defined in Table 9DV. For all PFD's, the test subject, initially with arms held vertically over the head, shall fall or step into the water, feet first, from a height of (1000 ±100) mm. Water entry in other orientations such as a dive or a feet-first step with arms at sides shall be performed if they are more likely to produce adverse results.

Table 9DV
Water entry configurations for inflatable PFDs

Order of Jumps	Jump Height (mm)[1]	Conditions of Device Before Jump
1	1000	Fully inflated after donning[2]
2	1000	Deflated with automatic inflation system armed
3	1000	Deflated with manual inflation armed but with automatic inflation system disarmed
4	3000	Fully Inflated[2,3]
5	4500	Fully Inflated[4]

Note 1 – All jump heights have a tolerance of ± 100 mm

Note 2 – Secondary donning shall be completed prior to jump

Note 3 – For ISO 12402-2 thru 12402-4 and UL 12402-5:2012 devices only

Note 4 – For ISO 12402-1 devices only

For manual CO_2-inflated PFDs the test shall be repeated after evacuating the inflation chamber and re-inflating it manually once in the water with the appropriate size CO_2-filled cylinder. For automatic CO_2-inflatable PFDs the test shall be repeated on the uninflated device, with the system armed, after evacuating the inflation chamber.

5.6.5.2.1DV.3 D1 ***Modification by adding a third paragraph for clause 5.6.5.2.1 as follows:***

In addition to the water entry configurations in Table 9DV, for a device that incorporates automatic and manual-auto inflation systems, jump sequence 2 shall be repeated by at least three subjects, however the subjects shall enter the water in a dive position. Upon going into the water, the subjects shall relax to simulate a state of utter exhaustion.

5.6.5.2.2 When testing PFDs according to ISO 12402-2 to ISO 12402-5, the feet-first water entry tests shall be repeated with the subject entering the water from a height of (3 000 $^{0}_{+500}$) mm.

5.6.5.2.2DV D1 ***Modification by replacing entire clause 5.6.5.2.2 as follows:***

When testing lifejackets according to ISO 12402-2, ISO 12402-3, or ISO 12402-4 and inflatable buoyancy aids according to UL 12402-5:2012, the feet-first water entry tests shall be repeated with the subject entering the water from a height of (3 000 $^{0}_{+500}$) mm. Subjects shall be instructed to hold onto the device during this water entry.

5.6.5.2.3 For PFDs according to ISO 12402-1, the test subject shall additionally perform this test by jumping vertically into the water, feet first, from a height of (4 500 $^{0}_{+500}$) mm.

5.6.5.2.3DV ***DT Modification by adding the following sentence to the end of clause 5.6.5.2.3:***

Subjects shall be instructed to hold onto the device during this water entry.

5.6.5.2.4DV *DT Modification by adding a new clause to 5.6.5:*

When testing child PFDs according to 5.6.5.2.1DV.1, subjects unwilling or unable to enter the water from an elevated height shall be given the option to jump from the side of the pool with arms held vertically over the head.

When testing child PFDs, the water entry tests according to 5.6.5.2.2DV and 5.6.5.2.3 shall not be conducted.

When testing infant PFDs, the water entry tests according to 5.6.5.2 shall not be conducted.

5.6.5.3 Results

Record the individual and average of all subjects' trunk angles from vertical. Record the individual and average of all subjects' face plane (head) angles from horizontal.

The panel shall examine the PFD and note any damage.

The panel shall observe that the PFD is not dislodged, does not harm the wearer, has not been damaged to endanger its in-water performance, and brings the wearer to the surface in the attitude specified in the applicable part of ISO 12402. When not required to bring the subject to a face-up position, the panel shall observe that the PFD 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.

5.6.5.3DV D1 *Modification by replacing entire clause 5.6.5.3 as follows:*

5.6.5.3.1DV After each water entry record the freeboard:

a) For buoyancy aids, record if the individual freeboards are positive according to UL 12402-5.

b) For lifejackets, record the individual freeboards according to ISO 12402-1 to ISO 12402-4.

In addition, after each water entry, the panel shall:

a) Observe that the PFD is not dislodged;

b) Observe that the PFD does not harm the wearer;

c) Observe whether the PFD brings the wearer to the surface in the attitude specified in the applicable part of ISO 12402 and UL 12402-5:2012 and provides adequate face-up stability,

d) Observe whether an inflatable PFD completely opens and is located on the subject as intended by the manufacturer.

5.6.5.3.2DV When not required to bring the subject to a face-up position, the panel shall observe whether the PFD 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.

5.6.5.3.3DV For inflatables, after each sequence of water entry testing, the device shall be examined for incorrect distribution through the inflation chambers such as an unopened cover, twisted shoulder, or the like. In addition, for automatic and manual-auto devices, the times to bring the subjects to the surface of the water shall be recorded.

5.6.5.3.4DV After each water entry described above, each PFD shall be examined and any damage noted. The PFD may be removed from the subject for examination.

5.6.6 Self-righting and stability test

5.6.6.1 Principle

5.6.6.1.1 The tests according to 5.6.6.3 shall demonstrate that a PFD (see ISO 12402-2:2006, 5.6, to ISO 12402-4:2006, 5.6) being evaluated provides,

a) for lifejackets and buoyancy aids, an adequate face-up stability, and associated resistance to being turned face down by waves or other forces, and

5.6.6.1.1DV.1 D1 *Modification of replacing the first sentence and item "a" of clause 5.6.6.1.1 as follows:*

The tests according to 5.6.6.3a) are to evaluate whether a lifejacket (see ISO 12402-1:2006, 5.6 to ISO 12402-4:2006, 5.6) being evaluated provides,

a) an adequate face-up stability, and associated resistance to being turned face down, and

b) for buoyancy aids, the intended potential for bringing the user face up in the unlikely event that the user either enters the water face down and unconscious, or becomes unconscious in the water.

5.6.6.1.1DV.2 *DT Modification by replacing the item "b" paragraph of clause 5.6.6.1.1 as follows:*

b) the intended potential for bringing the user face up in the unlikely event that the user either enters the water face down and unconscious, or becomes unconscious in the water.

These test procedures recognize that different body types present differing resistance to the face-up turning capacity of a PFD, and therefore are intended to evaluate a wide range of the population with as few test subjects as possible.

An inflatable PFD shall be tested inflated by its primary means of inflation. Chambers provided with only oral inflation capability shall be tested inflated to 4 kPa.

Because a tense subject is not representative nor simulates a state of utter exhaustion, the starting time for all righting tests shall not begin until the subject is noted to be in a relaxed position. A relaxed position should be achieved by having the subject relax his or her body with arms placed perpendicular to the body (as in mid-position of a breaststroke) and head going into the water at the same time. If turning starts before the subject has relaxed, the test is invalid and the test is to be repeated. If the PFD is so buoyant that the subject cannot get his/her face down into the water before being righted, the turn is to be counted.

NOTE The amount of air in test subjects' lungs has a profound influence on the test results, and subjects should be instructed accordingly. For a 'normal breath' or 'half breath' the lungs should be near the top of 'tidal volume' only. A person in repose, breathing normally, will be at the top of tidal volume when their lungs are at their highest, or largest, during such a breathing cycle. When the procedure requires the subject to 'exhale' or exhale in the water, the subject relaxes completely while allowing air to gradually flow out of the lungs, not forcing it out, until they reach 'functional residual capacity' (FRC) and no less. A person in repose, breathing normally, will be at FRC when their lungs are at their lowest, or smallest, during such a breathing cycle.

5.6.6.1.2 The test according to 5.6.6.3 b) is to demonstrate that a buoyancy aid according to ISO 12402-5, that is not designed to self right the wearer provides adequate face-up stability, and associated resistance to being turned face down by waves or other forces.

5.6.6.2 Apparatus

For testing PFDs according to ISO 12402-1 to ISO 12402-5, the reference vest used shall be constructed in accordance with Annex B, C or D according to the size of the PFD being tested.

5.6.6.2DV D2 *Modification by replacing clause 5.6.6.2:*

For testing PFDs according to ISO 12402-1 the reference vest used shall be constructed in accordance with Annex B, C, or D according to the size of PFD being tested.

5.6.6.3 Procedures

During testing the panel shall observe whether any closure fails to remain secure.

Unless otherwise specified, for each of the following procedures, as the subject places the face in the water the lungs shall be near the top of tidal volume by instructing the subject to take a normal breath or half breath.

For lifejackets according to ISO 12402-1, the tests shall be repeated with each test subject in the reference vest.

The PFD shall be tested on each test subject by carrying out the following tests as called for by its intended performance level, in the relevant part of ISO 12402 applicable to its intended classification.

a) Leg release righting test

Facing away from the test assistant, the subject shall attain a face-down horizontal position in the water, but with mouth held out of the water. The feet shall be supported, shoulder-width apart with the heels at the surface of the water, by a test assistant. The subject shall be instructed in the following sequence:

– straighten the legs;

– put the arms along the sides;

– allow the arms, shoulders, and body to completely relax;

– lower the face into the water while breathing out normally; and

– relax the neck.

During the relaxation phase, the test assistant shall maintain the subject in a stable position. Immediately after the subject has relaxed with the face in the water, the test assistant shall release the subject's feet. The subject shall remain limp while the turning time is measured. The turning

time is determined from the release of the feet until the subject's mouth is clear of the water, to the nearest 0,1 s. The test shall be conducted six times, discarding the highest and lowest turning times and averaging the remaining four times.

NOTE Child subjects not able to relax the arms are instructed to straighten the arms along the sides.

5.6.6.3DV D2 *Modification by replacing the 3rd paragraph of clause 5.6.6.3 as follows:*

When performing these tests when using the RTD method, the tests described in 5.6.3.3 a), b), c), e), and f) shall be repeated with the same subject wearing the appropriate RTD.

5.6.6.3ADV *Modification by replacing item "a" of clause 5.6.6.3 as follows:*

a) Leg release righting test

Facing away from the test assistant, the subject shall attain a face-down horizontal position in the water, but with mouth held out of the water. The feet shall be supported, shoulder-width apart with the heels at the surface of the water, by a test assistant. After assuming a starting position with the legs straight and arms along the sides, the subject shall be instructed in the following sequence to allow the body to gradually and completely relax:

– allow the arms, and shoulders to relax;

– allow the legs to relax, and then the spine; and

– relax the neck, allowing the face to fall into the water while breathing out normally.

During the relaxation phase, the test assistant shall maintain the subject in a stable position. Immediately after the subject has relaxed with the face in the water, if possible, simulating a state of utter exhaustion, the test assistant shall release the subject's feet. The subject shall remain limp while the turning time is measured. The turning time is determined from the release of the feet until the subject's mouth is clear of the water, to the nearest 0,1 s. The test shall be conducted six times, discarding the highest and lowest turning times and averaging the remaining four times.

NOTE Child subjects not able to relax the arms may be instructed to straighten the arms along the sides.

b) Vertical stability test

During the test, the panel shall observe whether any closure fails to remain secure.

For determination of the floating position of buoyancy aid, each subject shall don the device and enter the water. The subject shall then assume an upright, slightly behind vertical position in the water, keeping the head, torso, and legs in the same plane, while holding the arms at the sides. A straight rod with an inclinometer attached may be used to establish the starting position is 5° ± 2° degrees behind vertical. The subject shall maintain this position until the device induces motion (forward or backward of vertical). Then, the subject shall allow the arms, legs, torso, and head to assume their naturally relaxed positions so that the head falls in the direction of induced motion. If motion is not induced, the subject shall allow the head to fall backwards and then allow the arms, legs, and torso to assume their naturally relaxed positions. After the subject has attained an attitude of relaxed static balance, the freeboard of the subject shall be measured while the subject is at the lowest level attained during the normal breathing cycle.

c) Flotation attitude test

To assess floating attitude for lifejackets, the angle of the trunk and head shall be measured. Measure the angle of the face in relation to the horizontal, using an imaginary line from the chin to the forehead. Measure the angle of the body trunk in relation to vertical, using an imaginary line from the shoulder to the hip. The angle of the trunk shall be measured underwater to reduce any effect due to the refraction properties of water.

5.6.6.3CDV DE *Modification by replacing last sentence of item "c" of clause 5.6.6.3 as follows:*

The angle of the trunk shall be measured in such a way to reduce any effect due to the refraction properties of water.

5.6.6.3DDV D2 *Modification by adding items "d", "e", and "f" to clause 5.6.6.3:*

Flotation test for buoyancy aid

d) For a buoyancy aid, each subject shall don the device and enter the water. The subject shall then attain a face-down position in the water. On the command "Go" the subject shall attempt to turn to a stable face up position in which respiration is not impeded. The time from the command "Go" until a stable face up position is achieved shall be recorded.

Alternate self-righting test for child devices (when applicable)

e) For a child device, the following method may be used as an alternative to the 5.6.6.3ADV leg release test. The device is to be fastened in the intended manner on the subject. The subject is to gently push-off from the side of the pool, take a single breaststroke, and then face down in the water, relax and exhale slowly. The turning time is to be recorded. The test then is to be repeated two additional times. As an alternative, the device is to be fastened in the intended manner on the subject, who then is to be placed in a face down (mouth above the water) position in the water and released. The turning time is to be recorded. The subject then is to repeat the test two additional times.

Self-righting test for infant devices

f) For an infant device, the device is to be fastened in the intended manner on the subject, who then is to be placed in a face down (mouth above the water) position in the water and released. To prevent the test subject from inhaling water during the test it is permissible to gently blow air into the infant's face immediately prior to the release. The turning time is to be recorded. The test is to be repeated two additional times.

5.6.6.4 Results

5.6.6.4.1 Report whether any closure securing the PFD to the body does not remain secure during the tests.

5.6.6.4.2 For lifejackets according to ISO 12402-1 to ISO 12402-4, report the average time to bring each test subject's mouth clear of the water without him/her having to carry out any voluntary movement.

5.6.6.4.2DV D2 *Modification of clause 5.6.6.4.2:*

For lifejackets according to ISO 12402-1 to ISO 12402-4, report the average time to bring each test subject's mouth clear of the water without him/her having to carry out any voluntary movement with both the candidate device and RTD, as applicable.

5.6.6.4.3 For buoyancy aids according to ISO 12402-5, report whether

a) any subject's respiration is impeded in an attitude of relaxed static balance at any time,

b) there is any tendency to turn a subject face down from the position of relaxed static balance in the water,

c) there is any negative freeboard.

If any one of these conditions is reported, the device is considered to have failed.

5.6.6.4.3DV D2 *Modification by replacing entire clause 5.6.6.4.3 as follows:*

For buoyancy aids according to UL 12402-5, report:

a) Whether any subject's respiration is impeded in an attitude of relaxed static balance at any time,

b) Whether there is any tendency to turn a subject face down from the position of relaxed static balance in the water,

c) Whether there is any negative freeboard for level 50 devices, and

d) The individual and average freeboard for level 70 devices.

5.6.6.4.4 Floating attitude

For both, lifejackets and buoyancy aids, report the measured trunk and face angles.

5.6.6.4.4DV *DT Modification by replacing the text of clause 5.6.6.4.4 as follows:*

For lifejackets, report the measured trunk and head angles.

5.6.6.4.4DV.1 D2 *Modification by replacing the text of clause 5.6.6.4.4 as follows:*

For lifejackets, report the measured trunk and head angles with both the candidate device and RTD, as applicable.

5.6.7 Ergonomics

5.6.7.1 Principle

While being observed by the test panel, the test subjects shall assess comfort and interference with motion when using the PFD to determine whether the PFD is fit for the intended and emergency use.

5.6.7.2 Procedure

5.6.7.2.1 General

The test panel shall observe ease of movement and elicit comments from the subjects relating to comfort or interference with desirable behaviour or movements during all the human subject tests. The panel shall pay particular attention to

a) head and limb movement, and their potential to interfere with emergency use or the subject desiring to remove the PFD due to discomfort, and

b) any interference with vision, hearing or breathing.

Assessments shall be made both out of and in the water, and with the PFD both inflated and uninflated, if applicable.

The panel shall assess donning/secondary-donning actions, swimming and encumbrance.

5.6.7.2.2 Inflation

An inflatable PFD shall permit the user to top up the inflation by mouth while in or out of the water using either hand independently.

5.6.7.2.2DV D2 *Modification by replacing entire clause 5.6.7.2.2 as follows:*

During the human subject performance tests and use tests of an inflatable PFD each test subject shall demonstrate whether the PFD allows him or her to manually inflate and to top up the inflation by mouth while in or out of the water using either hand independently.

5.6.7.2.3 Oral inflation

With each test subject in the water, the PFD shall permit secondary donning and oral inflation sufficient to provide the test subject with positive freeboard within 45 s for any PFD up to 150 N buoyancy. For PFDs over 150 N buoyancy, an additional 15 s is allowed for each additional 50 N buoyancy.

5.6.7.2.3DV D1 *Modification by replacing entire clause 5.6.7.2.3 as follows:*

5.6.7.2.3.1DV D1 *Principle*

The purpose of this test is to evaluate the ease of inflation via oral inflation using either hand.

5.6.7.2.3.2DV *Procedure*

With the unarmed device donned on deck as intended prior to inflation, each test subject shall access the oral inflation mechanism and bring to the mouth ready to inflate using the right hand only, then repeat using the left hand only.

With the unarmed device restored to its normally worn deflated condition, each test subject who is not breathing impaired shall enter and tread water without contacting the bottom or side. Upon the command "Go", the test subject shall do what is necessary to float as quickly as possible using oral inflation. After 45 s, plus an additional 15 s for each additional 50 N buoyancy greater than 150 N, the subject shall stop, relax, and breathe normally. Record if freeboard is positive or negative. If positive, the test subject shall then complete oral inflation using the right hand only, then deflate slightly and re-inflate using the left hand only.

5.6.7.2.3.3DV *Results*

Report if the oral inflation mechanism is accessible by either hand both in and out of the water and if positive freeboard is achieved in the required time. If applicable, report if secondary donning was completed in the required time.

5.6.7.2.4 Encumbrance assessment

The test panel shall observe ease of movement and elicit comments from the subjects during the following activities:

a) sitting in a liferaft simulating awaiting rescue;

b) climbing a distance of 2 500 mm up and down a vertical ladder;

c) drinking from a cup;

d) touching toes;

e) accessing and using any additional items provided on or with the PFD, such as whistle, buddy line, light;

f) tightening and loosening of all essential adjustments.

These assessments shall be made out of the water, and both inflated and uninflated, if applicable. These assessments are not required for PFDs under 100 N buoyancy.

Additionally, the panel shall consider comfort and encumbrance

a) during and after donning,

b) during water entry and swimming tests, and

c) during the boarding test.

5.6.8 In-water stability test

5.6.8DV *DT Modification by replacing title of clause 5.6.8 as follows:*

In-water stability test for lifejackets

5.6.8.1 Principle

This test is to assess the ability of a PFD to safely support the user.

5.6.8.2 Procedure

The test subject shall attain a relaxed face up position of static balance in the water with shoulders and back toward the test conductor. The subject shall be instructed to place elbows against his/her sides, hands on stomach, under the PFD if possible, and bring the knees up as close to the chest as possible while keeping them together. The test conductor shall grasp the subject's shoulders and rotate the subject clockwise around the longitudinal axis of the torso so that the subject attains a (55 ± 5)° list. The subject shall then be released. It shall be observed whether the subject returns to a stable face-up position. This test shall be repeated, but the subject is rotated counter-clockwise.

5.6.8.2DV D2 *Modification by adding second paragraph to clause 5.6.8.2:*

When performing this test when using the RTD method, the test described above shall be repeated with the same subject wearing the appropriate RTD.

5.6.8.3 Results

Report whether the candidate device did or did not return the subject to a stable face-up position according to 5.6.6.3. If applicable, report whether the reference vest did or did not return the subject to a face-up position. See also 5.3.

5.6.8.3DV D2 *Modification by replacing the text of clause 5.6.8.3 as follows:*

Report whether the device did or did not return the subject to a stable face-up position with both the candidate device and RTD, as applicable.

5.6.9 Tests using child manikins

5.6.9.1 General

The test can be used as a supplementary tool to assess PFDs in accordance with 5.6.3.1 of ISO 12402-2:2006, ISO 12402-3:2006, and ISO 12402-4:2006, designed for children of less than 20 kg, using manikins. An example of a relevant manikin is described in Annex E.

The manikin shall be dressed in a close-fitting non-buoyant bathing suit. The manikin harness shall be fitted and the PFD shall then be donned on the manikin, over the harness, following the manufacturer's instructions.

All tests shall be carried out in an indoor pool, in calm water.

NOTE A study on infant and baby manikins for lifejackets in Japan is available at Japan Marine Standards Association, Sumitorno Fudosan Bldg. 4, 7th, 7-12-14, Ueno, Taito-ku, Tokyo, 110-0005 Japan.

5.6.9.2 Test order

The tests shall be carried out in one sequence and in the order given in 5.6.9.2.1 to 5.6.9.2.3.

5.6.9.2.1 Series 1:

a) fall from sitting position on pool-side, 500 mm above water surface (face-forward);

b) mouth freeboard;

c) fall from sitting position on pool-side, 500 mm above water surface (face-forward);

d) mouth freeboard;

e) fall from sitting position on pool-side, 500 mm above water surface (face-forward);

f) mouth freeboard;

g) body angles;

h) self-righting;

i) mouth freeboard (conscious, central head position).

Remove from water and inspect for damage.

5.6.9.2.2 Series 2:

a) fall from 1 000 mm (forward-bent);

b) mouth freeboard;

c) fall from 1 000 mm (forward-bent);

d) mouth freeboard;

e) fall from 1 000 mm (forward-bent);

f) mouth freeboard.

Remove from water and inspect for damage.

5.6.9.2.3 Series 3:

a) fall from 3 000 mm (forward-bent);

b) mouth freeboard;

c) fall from 3 000 mm (forward-bent);

d) mouth freeboard;

e) fall from 3 000 mm (forward-bent);

f) mouth freeboard.

Remove from water and inspect for damage.

5.6.9.3 Fall from a height

5.6.9.3.1 Principle

The principle is to assess the performance of a PFD when the manikin is dropped into the water from a height of (500 ± 50) mm, (1 000 ± 50) mm or (3 000 ± 50) mm.

5.6.9.3.2 Procedure

The PFD shall bring the manikin to the surface within 5 s of impact. The manikin shall then float in a face-up posture with the mouth clear of the water. There shall be no functional damage to the PFD.

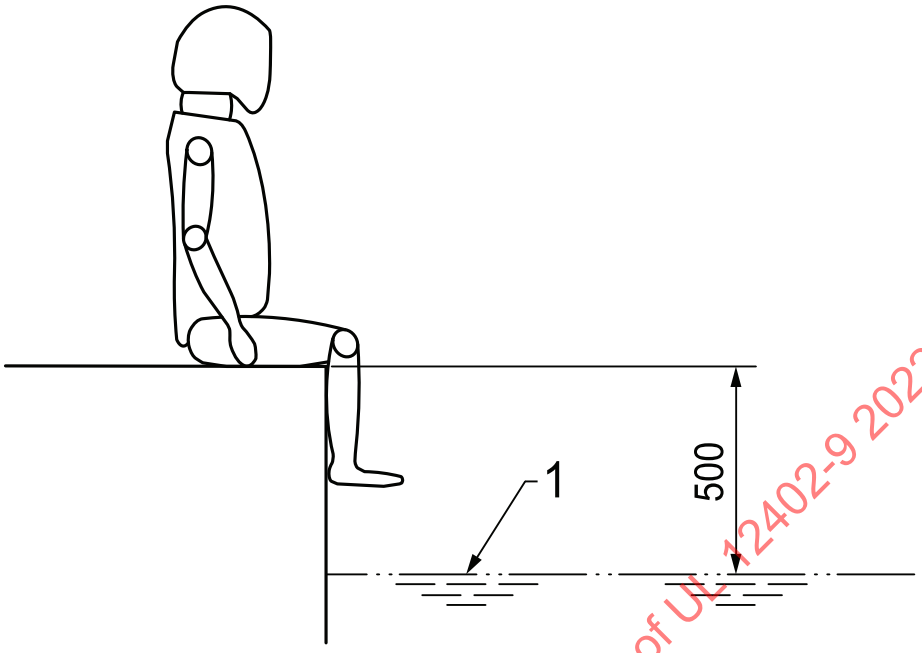
For the drop from the pool-side, the manikin shall be seated at a height of 500 mm above the water surface. Slight even pressure shall be placed on the back of the shoulders, pushing the manikin forwards into the water. See Figure 13.

For the drops from 1 000 mm and 3 000 mm, the quick-release system and line shall be attached to the harness using the D-ring at the back of the neck. Ensure that the PFD is not hindered in any way by the release system. The manikin shall be suspended in a forward-bent position, with the bottom of the feet 1 000 mm or 3 000 mm above the water surface for the drops from 1 000 mm and 3 000 mm, respectively. See Figure 14.

The manikin shall be released, and submersion time recorded as the time from the manikin hitting the water to the time when the mouth markers are seen above the water surface.

Three tests shall be performed at each height. The PFD shall be inspected for displacement after each test and then adjusted. After the third drop, the PFD shall be inspected for damage.

Dimensions in millimetres



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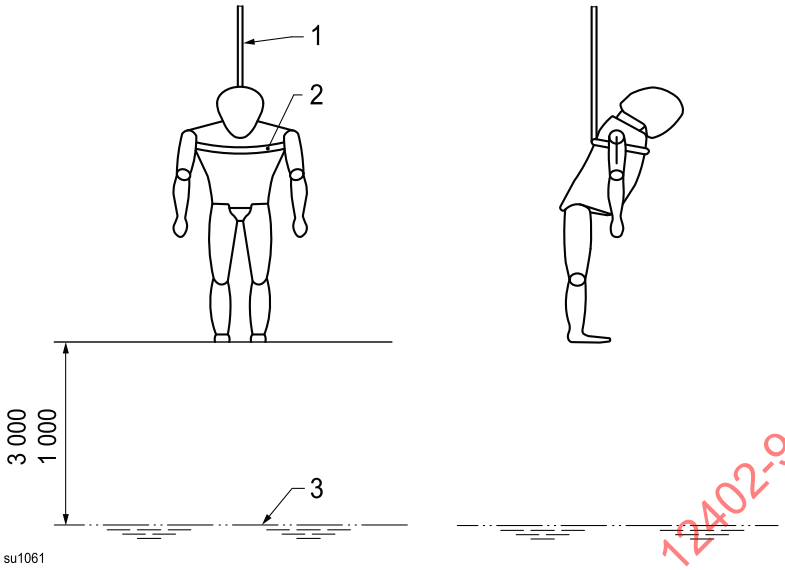
Key

1 water surface

Figure 13

500 mm fall from pool-side

Dimensions in millimetres



Key

1 line

2 harness with quick-release system at back of neck

3 water surface

Figure 14

Forward-bent drop

5.6.9.4 Mouth freeboard

5.6.9.4.1 Principle

The principle is to ensure that the lower corner of the mouth is held at a sufficient height above the water surface.

The risk of water washing over the face of the child is to be reduced.

5.6.9.4.2 Procedure

For a device for measuring freeboard, see 5.6.2. The plastic disc at the free end of the measuring tape shall be reduced to a diameter of (20 ± 5) mm.

The tape shall be lowered to the marker at the lower corner of the mouth.

Following a drop test, mouth freeboard shall be measured without adjustment to the position of the head (the unconscious position). Three measurements of mouth freeboard shall be made at each drop height. To pass the test, two out of the three measurements shall meet the requirement.

Following the self-righting test, a single measurement of mouth freeboard shall be made with the head adjusted to a central (conscious) position in line with the body without adjusting the position of the PFD on the manikin.

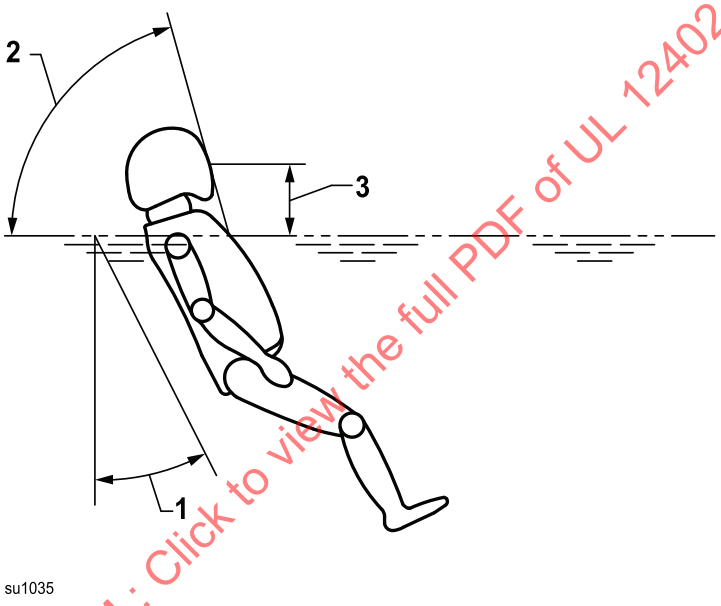
To assess the angle of the body in relation to the water surface following a fall into water, the body shall float in a face-up position. See Figure 15. The head shall be bent slightly forward relative to the torso, with the nose above the mouth.

NOTE If the head of an unconscious child was horizontal, the child could choke due to the tongue blocking the respiratory tract.

Measure the angle of the face in relation to the horizontal, using an imaginary line from the chin to the forehead.

Measure the angle of the body trunk in relation to the horizontal, using an imaginary line from the shoulder to the hip.

The angle of the trunk shall be measured underwater, to reduce any effect due to the refraction properties of water. The angle shall be measured from the side and not over the chest.



Key

1 trunk angle.

2 face-place angle

3 mouth freeboard

Figure 15

Mouth freeboard and flotation attitude

5.6.9.5 Stability and self-righting

5.6.9.5.1 Principle

The principle is to measure the time taken for a PFD to turn the manikin from a face-down to a face-up position with the mouth clear of the water surface. Many children, particularly those who cannot swim, will panic if they fall into the water. Therefore the PFD shall turn a child onto its back with ease, and only be stable in that position.

5.6.9.5.2 Procedure

With the manikin starting in a face-up floating position, one shoulder of the manikin shall be pushed under-water, through an angle of 90°. It shall be assessed whether the manikin returns to the face-up position. Repeat, pushing down the opposite shoulder.

To assess self-righting, turn the manikin onto its front in the face-down floating position, with arms and legs in-line with the body. Hold the manikin by the shoulders, in this horizontal position, without applying any significant downward force. Once in the correct position, release.

Time self-righting from the point when the manikin is released to the point when the marked mouth of the manikin is clear of the water surface.

The self-righting test shall be repeated a further two times. All three tests shall meet the requirement for the PFD to pass.

5.6.10DV D1 *Modification by adding new clause 5.6.10DV to 5.6:*

Retroreflective material visibility test

5.6.10.1DV Principle

When retroreflective material is required to be provided, the device shall be evaluated for visibility of the material from the water and air.

5.6.10.2DV Procedure

5.6.10.2DV.1 Each subject shall be floating in a relaxed, face up position. Measure the area of retroreflective material visible above the water.

5.6.10.2DV.2 Each subject shall be positioned in the water in a relaxed, face up position, in front of the test panel located 3000 ±500 mm away. With the line of sight for the test panel being at a height of 1000 ±300 mm, the panel shall determine if retroreflective material is visible above water with the subject positioned to be observed from each of the following orientations:

a) Front,

b) Left side,

c) Back,

d) Right side.

In addition to the above orientations, the test panel shall observe that retroreflective material is visible from a height of at least 1000 mm when the subject is directly below the test panel.

5.6.10.2DV.3 Results

The total amount of retroreflective material above water shall be recorded. Report whether retroreflective material is visible from each orientation.

5.6.11DV D1 *Modification by adding new clause 5.6.11DV to 5.6:*

5.6.11.1DV Placement Security evaluations

5.6.11.1.1DV Principle

A ride-up test is conducted to evaluate the placement security characteristics of the PFD. Poor placement security could impair the overall performance of a PFD since the ridden up PFD may interfere with the wearer's breathing, vision, mobility, and cause the wearer distress while expending energy to overcome these interferences. Additionally, a ridden up PFD may result in less of the PFD's buoyancy being in the water and therefore not be as effective in protecting from drowning.

5.6.11.1.2DV Procedure

Except for wetsuit style or full-sleeved float coat style PFDs, the subjects are to perform 3 plunging motions in the water while in a vertical position to induce ride-up. Prior to the plunging motions and while in the water, the subjects are to be instructed to readjust the device to a comfortably snug fit. Immature, young subjects with limited manual dexterity may be assisted when readjusting the device.

The plunging motions are then to be generated by stretching the arms straight out from the sides at the water's surface with the palms facing downward. The legs are to be spread. Starting from this position, the subjects are to push down on the water with their hands in an open, flat orientation and bring the legs together. While pushing down on the water, the subjects are to fully inhale as they rise in the water. After reaching the upward peak, the subjects are to bring their hands together over the head, spread the legs, and fully exhale while sinking into the water. The head must go under the water's surface to be counted, unless it is determined that the buoyancy of the device is preventing the subject from completely submerging the head. This plunging motion must be performed total of three times.

Immediately following the plunging motions, the Vertical Stability Test, 5.6.6.3b of this part shall be conducted.

5.6.11.1.3DV Results

Record the freeboard following the plunging motions and whether the device in the ridden-up condition has a tendency to turn a subject face-down from the position of relaxed static balance in the water. Record whether the device shifted upward on the wearer so as to impede respiration or forward vision.

5.6.11.2DV Placement security test

5.6.11.2.1DV Principle

The measurement of PFD displacement on the body as a result of the ride up test is a way to quantify placement security as one factor in making equivalency determinations between PFD performance characteristics.

5.6.11.2.2DV Procedure for measurement of displacement

If required by the applicable part, prior to the three plunging motions described in the ride up test above and after readjusting the device to a comfortably snug fit, while vertical, either the shoulder gap is measured or the location of the PFD is marked relative to a prominent anatomical land mark, such as the ear, the jaw, the suprasternal notch, etc. Immediately following the last plunging motion, while vertical, either the shoulder gap is to be measured at the same shoulder that was measured prior to the plunging motions or the vertical distance is measured from the anatomical landmark used to mark the relative location of the PFD prior to the plunging motions.

5.6.11.2.3DV Results

The change in shoulder gap measurement or vertical change in location is recorded. Also, record whether the subject is a pear shaped person.

5.6.12DV D1 *Modification by adding new clause 5.6.12DV to 5.6:*

Rearming / repacking test

5.6.12.1DV Principle

To evaluate the ease of returning an inflatable PFD to its armed and packed condition by untrained persons, test subjects are used to demonstrate whether the device can be properly rearmed and repacked in accordance with the manufacturer's instructions.

5.6.12.2DV Procedure

Each test subject in 5.6.1.2DV and 5.6.1.3DV shall perform the rearming/repacking evaluation.

A test subject who admits or demonstrates a significant lack of mechanical aptitude shall be disqualified. If a subject is disqualified, a subject may be substituted to only perform the rearming/repacking evaluation if all other applicable tests in 5.6 were conducted.

Proper repacking includes, but is not limited to, the proper stowing of inflation system and lanyards, and refolding and securement of inflation chambers and cover, if applicable.

Prior to the evaluation, the test subjects are to be instructed that they will be given two rearming kits with instructions, and that they are free to test one of the kits if they need to do so in order to satisfy themselves that they can perform the rearming procedure properly.

The subjects are to be instructed that the rearming portion of the trial is complete when they present what they believe to be a properly rearmed device (which they have not actuated).

Each test subject is then given the manufacturer's rearming and repacking instructions to be provided with each device (written, pictogram, video, etc.), two rearming kits, and access to the manufacturer's toll-free telephone number and/or website when provided. The test subject is then to be instructed to proceed with the rearming and repacking evaluation.

When the test subject indicates that rearming and repacking is complete, the device is to be given to the test participant with the instruction. "Please put this on as quickly as possible, adjust to fit snugly, and inflate."

5.6.12.3DV Results

Record whether each subject rearmed and repacked the device in accordance with the manufacturer's instructions. Record whether each subject donned and inflated the device.

5.6.13DV D1 *Modification by adding new clause 5.6.13DV to 5.6:*

Pocket flotation stability test

5.6.13.1DV Principles

PFD's shall be evaluated for their ability to maintain freeboard, maintain relaxed static balance, for lifejackets, and not prohibit the turning action of the device when pockets are loaded with buoyant and non-buoyant material.

5.6.13.2DV Procedure

This test shall be conducted with one test subject. The in-water weight of the test subject shall meet the upper in-water weight value required by Table 5DV.1 and Table 5DV.2 of this part but shall not exceed the upper limit by more than 15 percent.

5.6.13.2.1DV Lifejackets

Lifejackets with front pockets shall be filled with non-buoyant material with a density no less than 1350 kg/m^3.

Lifejackets with rear pockets shall be filled with buoyant material with a density no more than 64 kg/m^3.

5.6.13.2.2DV Buoyancy aids

Buoyancy aids with rear pockets shall be filled with buoyant material with a density no more than 64 kg/m^3.

5.6.13.2.3DV Pocket Capacity Measurement

To determine the maximum capacity of each front pocket, rigid rectangular prisms below are to be placed in the pockets and each pocket is to be filled with as many of the prisms as it is able to hold. Based on the size and shape of the pocket, combinations of each prism size may be used.

a) (114 mm x 76 mm x 25) ± 5 mm and is to have an in-water weight of 250 ± 5 grams, and

b) (32 x 38 x 64) ± 5 mm and is to have an in-water weight of 140 ± 5 grams.

To determine the maximum capacity of each rear pocket, rigid rectangular prisms are to be placed in the pockets. The prisms are to measure (114 x 76 x 25) ± 5 mm, and each pocket

is to be filled with as many prisms as it is able to hold. Closed cell foam buoyant material with a density of no more than 64.1 kg/m^3 and a volume equal to the rigid prisms are then to be used.

Conduct the righting, stability, and freeboard tests in accordance with 5.6.6.3ADV and 5.6.2 respectively of this part.

5.6.13.3DV Results

Record the time for the lifejacket to bring the test subject's mouth clear of the water without him/her having to carry out any voluntary movement. Record if the PFD maintains a relaxed static balance. Record the test subject's freeboard.

Annex A
(informative)

Classification of personal flotation devices

A.1 Classification

A.1.1 Classes

A.1.1.1 Lifejackets

These devices provide face-up flotation with levels of support sufficient for various open and rough water uses. Lifejackets have a buoyancy distribution sufficient to turn most users, when tested on users wearing swimming costumes according to ISO 12402, to a position where the mouth has a defined freeboard above the water's surface, even when the user is unconscious.

A.1.1.2 Buoyancy aids

These devices should be comfortable for continuous wear and provide lift, without significant face-up turning ability, to float the conscious user with the level of support marked on the device. Buoyancy aids shall at least be suitable for sheltered waters, but at higher performance levels may be suitable for some users in other waters.

A.1.1.3 Special purpose lifejackets and buoyancy aids

These devices perform as in A.1.1.1 and A.1.1.2 with different levels of support, but have modifications related to special applications for use. These applications shall not relate to essential requirements such as in-water performance, stability and safety in use. The specific conditions for use shall be stated on their label to maintain essential requirements.

A.1DV ***DT Modification by replacing entire clause A.1 as follows:***

A.1.1.1DV Buoyancy aids

A buoyancy aid is a garment or device that, when worn correctly, will provide support without significant face up turning ability and therefore may require action by the user to position the face clear of the water.

A buoyancy aid provides suitable performance in sheltered waters, and at higher levels of support, may be suitable for use in other waters.

A.1.1.2DV Lifejackets

A lifejacket is a garment or device that, when worn correctly, will maintain the user in a face-up flotation position, without additional action, with various levels of performance suitable for sheltered and unsheltered waters.

When tested to the relevant part of this standard, a lifejacket has a buoyancy distribution sufficient to turn most users, wearing swimming costume, to a position where the mouth is clear of the water even when exhausted.

A.1.1.3DV Special purpose devices

A special purpose device has performance equivalent to a lifejacket or buoyancy aid, but has modifications related to specific applications for use. These modifications may require additional action by the user, or may only be suitable for certain activities or user groups.

A.1.2 Performance levels

A.1.2.1 Level 275

This level is intended primarily for offshore use under extreme conditions. It is also of value to those who are wearing clothing which traps air and which may adversely affect the self-righting capacity of the lifejacket. It is designed to ensure that the user is floating in the correct position with his mouth and nose clear of the surface.

See ISO 12402-2.

A.1.2.2 Level 150

This level is intended for general application or for use with foul weather clothing. It will turn an unconscious person into a safe position and requires no subsequent action by the user to maintain this position.

See ISO 12402-3.

A.1.2.3 Level 100

This level is intended for those who may have to wait for rescue, but are likely to do so in sheltered water. The device should not be used in rough conditions.

See ISO 12402-4.

A.1.2.4 Level 275

This level is intended for use by those who are competent swimmers and who are near to bank or shore, or who have help and a means of rescue close at hand. These garments have minimal bulk, but they are of limited use in disturbed water, and cannot be expected to keep the user safe for a long period of time. They do not have sufficient buoyancy to protect people who are unable to help themselves. They require active participation by the user.

See ISO 12402-5.

A.1.2DV *DT Modification by replacing entire clause A.2 as follows:*

Performance levels

A.1.2.1DV Level 50

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

A.1.2.2DV Level 100

This level is intended for use in sheltered or calm water, where users may have to wait for rescue. As tested in swimming costume (when fully inflated, if inflatable) the device has some turning ability to bring the user into a position with the mouth and nose clear of the water. It is intended to maintain a fully clothed user in this position without active participation.

A.1.2.3DV Level 150

This level is intended for general, offshore, and rough water use. As tested in swimming costume (when fully inflated, if inflatable) the device will turn an unconscious user into a position with the mouth and nose clear of the water. It is intended to maintain a fully clothed user in this position without active participation.

A.1.2.4DV Level 275

This level is intended primarily for offshore use under severe weather or sea conditions. It is of value to those who are wearing clothing which traps air and adversely affects the self-righting capacity of the lifejacket. It is also intended for a user who requires a high level of buoyancy, for example when carrying heavy objects. As tested in swimming costume, (when fully inflated, if inflatable) it will turn an unconscious user into a position with the mouth and nose clear of the water. It is intended to maintain a fully clothed user in this position without active participation.

A.1.2.5DV DR *Modification by adding Level 70 to clause A.2 as follows:*

A.1.2.5 Level 70

This level is intended for use by those who have help or a means of rescue close at hand, or who are near to bank or shore. These devices have minimal bulk, but cannot be expected to keep the user safe for a long period of time in disturbed water.

Annex B
(normative)

Adult reference vest for test-subject disqualification and test-subject group validation

B.1 General

This annex specifies the design and construction of the adult lifejacket used to disqualify individual test subjects and to verify that the group of test subjects used represents a valid cross-section of the adult population when testing lifejackets according to ISO 12402-1 to ISO 12402-6.

B.2 Description

The reference vest is made with two types of buoyant foam in a vest style using a heavy nylon cover fabric shell secured to the body with 25 mm webbing, closures, and adjustments. The shell is made with slide fasteners (zippers) in place of closing seams to hold the foam within, in order that the foam inserts can be easily removed to check their buoyancy and renew or supplement them if they are out of tolerance. Hook and loop fasteners are used on the interior foam retainers to position and prevent shifting of the foam panels. The vest is designed to fit persons of a chest size from 700 mm to 1 350 mm and to be comfortable to use as a non-reversible device such that it would be obvious to the user as to which is the inside and outside of the device, even under reduced lighting conditions.

B.3 Materials

B.3.1 General

All materials used shall comply with ISO 12402-7.

B.3.2 Foam requirements

B.3.2.1 General

The performance of the reference vest is dependent on having the proper foam stiffness and shapes.

B.3.2.2 Stiffness

Two foams of different stiffness are used: one is a soft foam and the other is a stiff foam. A bridge deflection test is provided to determine acceptability for the intended application. Figure B.1 provides the set-up details and Table B.1 provides the specific measured values. For selecting the type of foam for the specific insert, see Table B.2 and Table B.3. To measure the center deflection of a foam panel of the specified cross-section ($a \times b$) and 110 mm wide, place the foam panel centered across the two equal height, parallel, horizontal surfaces separated by the specified distance (c), and then load with a mass of the specified width. Note the length of the load shall be at least 110 mm, such that when placed on the foam panel it will extend the full width of the foam panel. The load may extend beyond the width of the foam panel provided that it is centered over the panel with equal amounts extending over the sides of the foam panel. Measure the deflection at the bottom center location of the foam panel 30 s after placing the load on the panel.

B.3.2.3 Shape

The shape of each foam insert is specified in Figure B.8 to Figure B.11. For dimensions, see Table B.2 and Table B.4.

B.3.2.4 Buoyancy

The total design buoyancy of the inserts is 149 N. Table B.3 specifies, for each insert, the buoyancy and buoyancy tolerances. These values apply to both new and used inserts. Table B.3 also specifies the buoyancy distribution between the front and back inserts and the tolerance.

B.3.3 Other component requirements

See Table B.2.

B.4 Construction

B.4.1 The construction and assembly of the device shall be in accordance with Table B.2 to Table B.5 and Figure B.2 to Figure B.17.

B.4.2 The seam allowances are 13 mm, unless otherwise specified.

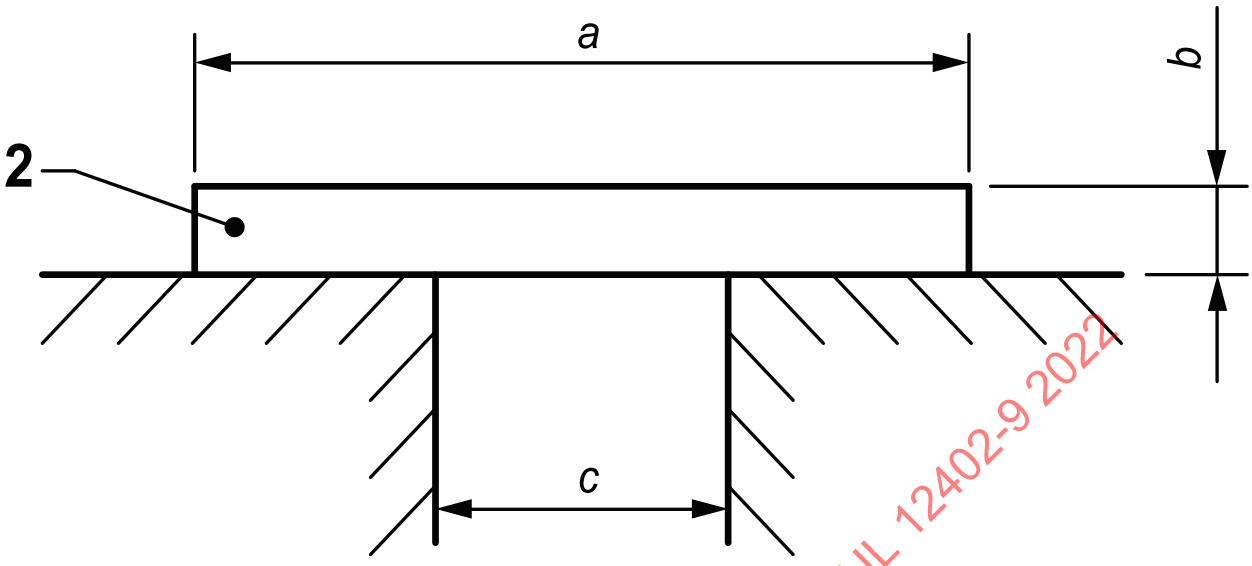
B.4.3 All structural seams use a lock-type stitch so that the seam will not unravel when a force is applied in the direction of the seam on any of the threads forming the stitch. Stitching should have a density of 7 stitches to 12 stitches per 25 mm of stitch length. The box-x stitching on the webbing is 15 mm × 18 mm, unless otherwise specified. The bar-tack stitching on the webbing is 15 mm × 2 mm.

B.4.4 On the closing seam of the back section of the outer and inside covers, the cut ends of the fabric are turned under and stitched so that the fabric will not ravel. The cut ends of webbing should be heat-sealed.

B.4.5 A tab on the ends of the waist belt is formed by turning under 40 mm of material twice and stitching 19 mm from the end of the folds with box-x or bar-tack stitching.

B.4.6 A tolerance of ± 6 mm is used throughout for fabric cutting and stitching assembly. A tolerance of ± 6 mm is also used for foam cutting; however, the buoyancy requirements of Table B.3 shall be met.

a) Initial set-up



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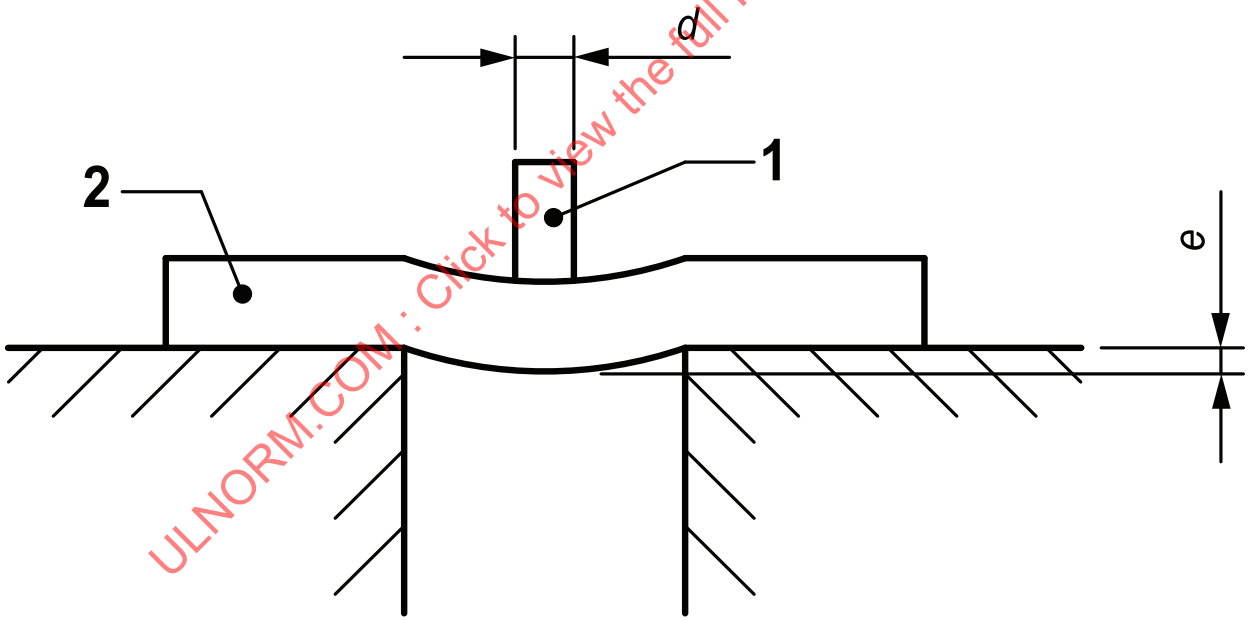
b) Bridge deflection after 30 s



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Key

1 load, centered over gap *c*

2 foam

Figure B.1

Foam bridge deflection test

Table B.1
Specifications for the foam bridge deflection test

Foam type	Dimension shown in Figure B.1 mm						Load mass
	a (length)	(Not shown) (width)	*b* (thickness)	*c* (span)	*d* (load width)	*e* (deflection)	kg
Stiff	394	110	83	300	120	< 20	8,6
Soft	394	110	45	150	30	W 25	0,75

Table B.2
Parts, quantity and assembly

Component	Description	Quantity	See Figure	Construction notes
1 Cover fabric	420 denier nylon, with ravel-resistant coating, orange			
1.1 Front outer cover		1	Figure B.2	
1.2 Back outer cover		1	Figure B.2	
1.3 Inside cover		1	Figure B.3	
1.4 Center gusset		2	Figure B.4	
1.5 Collar, outer and inside cover		2	Figure B.5	
1.6 Fabric reinforcement		4	Figure B.6 Figure B.14	Attach to inside of collar cover, as attachment 1, for reinforcement at webbing attachment (see Figure B.14).
1.7 Interior fabric retainers for foam inserts 1		2	Figure B.7 Figure B.13	Attach to inside of front cover, as attachment 3, stitch to cover at each side to form a foam retainer for inside front foam insert components 2.2.1 and 2.2.2 (see Figure B.13).
1.8 Interior fabric retainers for foam inserts 2		2	Figure B.7 Figure B.14	Attach hoop and loop fasteners to the ends and stitch at center to the inside of front cover, as attachment 4, to form a foam retainer for front foam insert components 2.1.1 and 2.1.2 (see Figure B.13).
2 Foam				
2.1 Stiff	See Table B.1 and Table B.3			
2.1.1 Front foam insert, right side	81 mm thick	1	Figure B.8	
2.1.2 Front foam insert, left side	81 mm thick	1	Figure B.8	
2.1.3 Collar foam insert	56 mm thick	1	Figure B.10	
2.2 Soft	See Table B.1 and Table B.3			
2.2.1 Inside front foam insert, right side	46 mm thick	1	Figure B.9	
2.2.2 Inside front foam insert, left side	46 mm thick	1	Figure B.9	
2.2.3 Back foam insert	32 mm thick	1	Figure B.11	
3 Webbing	25 mm, polypropylene, with easy adjustment and no			

Table B.2 Continued on Next Page

Table B.2 Continued

Component	Description	Quantity	See Figure	Construction notes
	significant slippage when used with the specified hardware.			
3.1 Chest strap	127 mm, black	2	Figure B.12	On left side of front cover, attach webbing with male buckle. On right side of front cover, attach webbing with female buckle. The free ends of the chest strap are folded under the yellow webbing (collar attachment webbing), with reinforcing fabric (see Figure B.6) on inside of cover fabric. A box-x stitch is used to attach the chest strap to the front cover.
3.2 Waist belt	203 mm, black	2	Figure B.12	On left side, attach waist belt with slide and buckle clip waist belt. On right side, attach bottom belt with D-ring and slide.
3.3 Waist belt	1 867 mm, black	1	Figure B.12 Figure B.13	Form 40 mm tab on each end. Attach to back cover using three box-x stitches (after front and back covers are assembled).
3.4 Belt loop on front cover	76 mm, black	2	Figure B.12	Attach webbing to front outer cover and form a belt loop (one on each side) by two sets of double bar tack stitches.
3.5 Belt loop on inside cover	89 mm, black	2	Figure B.13	Attach webbing to inside cover and form a belt loop (one on each side) by two box-x stitches.
3.6 Collar attachment	1 384 mm, yellow	1	Figure B.14 Figure B.6 Figure B.12	Attach webbing to collar and reinforcing fabric, in two places using box-x stitch.
4 Hook and loop fastener	50 mm × 70 mm, black generic	2	Figure B.13 Figure B.7	Hook and loop fasteners are attached to the ends of interior fabric retainer for foam insert.
5 Thread	Generic synthetic	AR		
6 Hardware				
6.1 Buckle	Male and female 25 mm, plastic, 890 N single-end strength	1		Chest strap
6.2 Slide	Adjuster 25 mm, plastic, 1 600 N single-end strength	2		Waist belt
6.3 Snap hook	25 mm, stainless steel, 1 600 N single-end strength	1		Waist belt
6.4 D-ring	25 mm, stainless steel, 1 600 N single-end strength	2		Waist belt
6.5 Zipper	280 mm, plastic (zipper chain and pulls)	1	Figure B.14	Foam access for collar cover
6.6 Zipper	370 mm, plastic (zipper chain and pulls)	1	Figure B.12	Foam access for back cover
6.7 Zipper	440 mm, plastic (zipper chain and pulls)	2	Figure B.12 Figure B.13	Foam access for front cover

Table B.3
Foam insert buoyancy specifications

Values in newtons

Insert	Front right	Front left	Inside front right	Inside front left	Back	Collar
Foam type[a]	Stiff	Stiff	Soft	Soft	Soft	Stiff
Buoyancy[b]	34 ± 1,2	34 ± 1,2	17,5 ± 0,65	17,5 ± 0,65	18 ± 0,7	28 ± 0,8

[a] The buoyancy of most foams will change over time with the greatest change occurring in the first several months after manufacture. The exact kind of foam selected will need to be evaluated to determine the amount of additional buoyancy needed at the time of manufacture to maintain the values specified.

[b] Buoyancy distribution: 69 % front ± 1,5 %.

Table B.4
List of dimensions shown in Figure B.2 to Figure B.14

Dimensions in millimetres

Dimension	Figure											
	Figure B.2	Figure B.3	Figure B.4	Figure B.5	Figure B.6, Figure B.7	Figure B.8	Figure B.9	Figure B.10	Figure B.11	Figure B.12	Figure B.13	Figure B.14
a	66	298	23	308	73	198	76	20	188	120	138	19
b	298	100	497	75	73	46	46	56	274	18	18	155
c	427	1 106	586	10	130	76	394	51	414	35	35	53
d	430	199	102	288	205	84	38	216	343	5	295	25
e	423	398		342	72	76	51	229	147	95	55	45
f	141	597		396	470	157	165	259	223	320		
g	100	1 124		65		394		45		90		
R								70				
h	705	141				46				40		
I	199					8				55		
j	398					20				225		
k	197					20				80		
l	723					76						
m						46						
n						38						
o						165						
p						25						

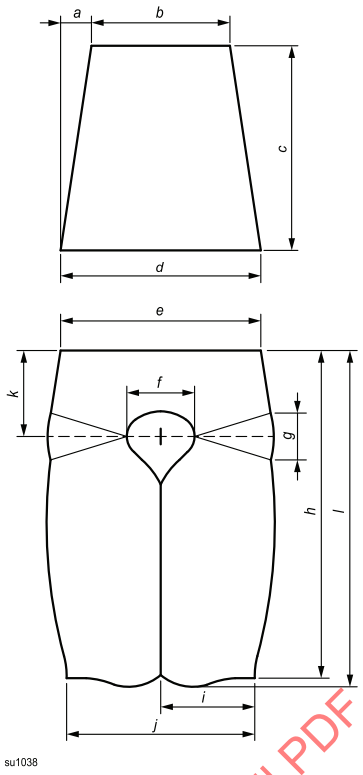


Figure B.2

Outer cover, front and back sections

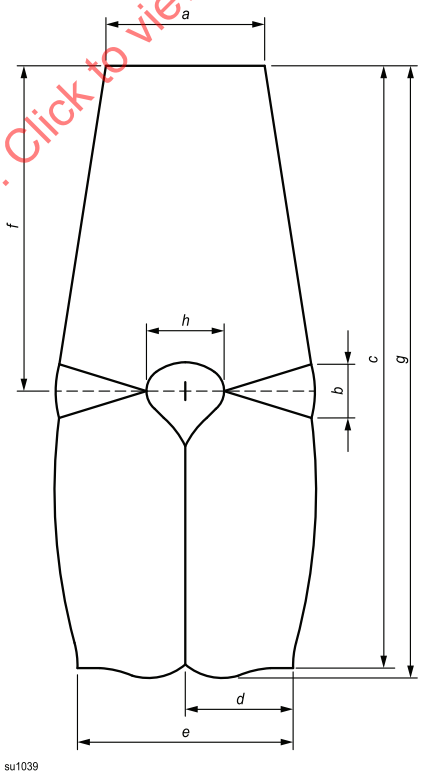


Figure B.3

Inside cover

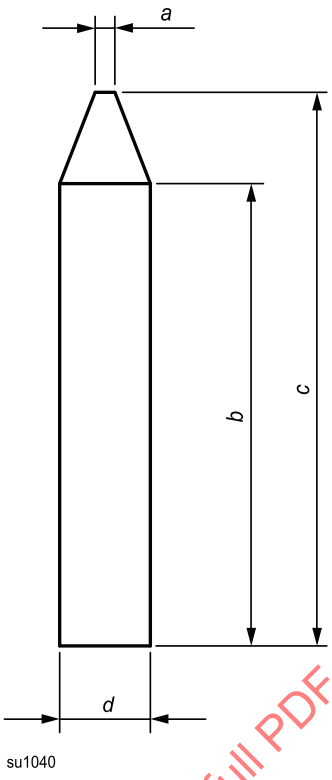


Figure B.4

Center gusset

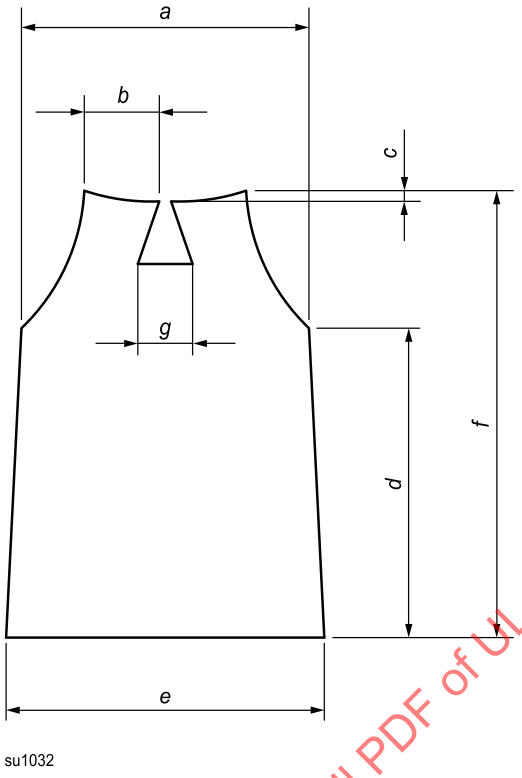


Figure B.5

Outer and inside cover, collar

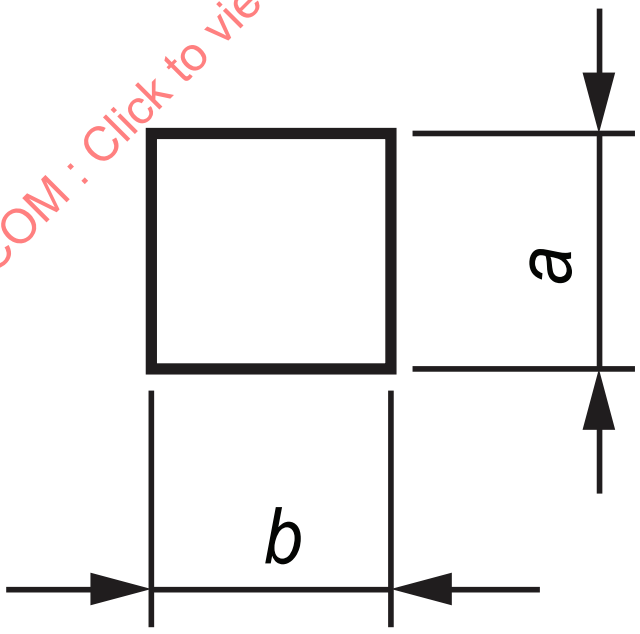
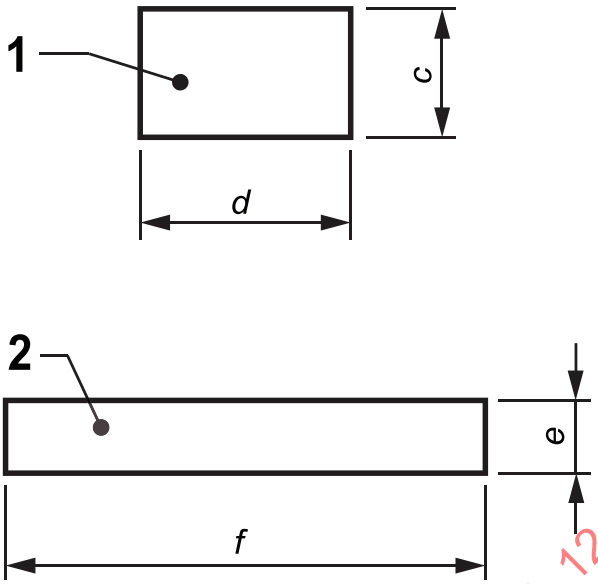


Figure B.6

Fabric reinforcement



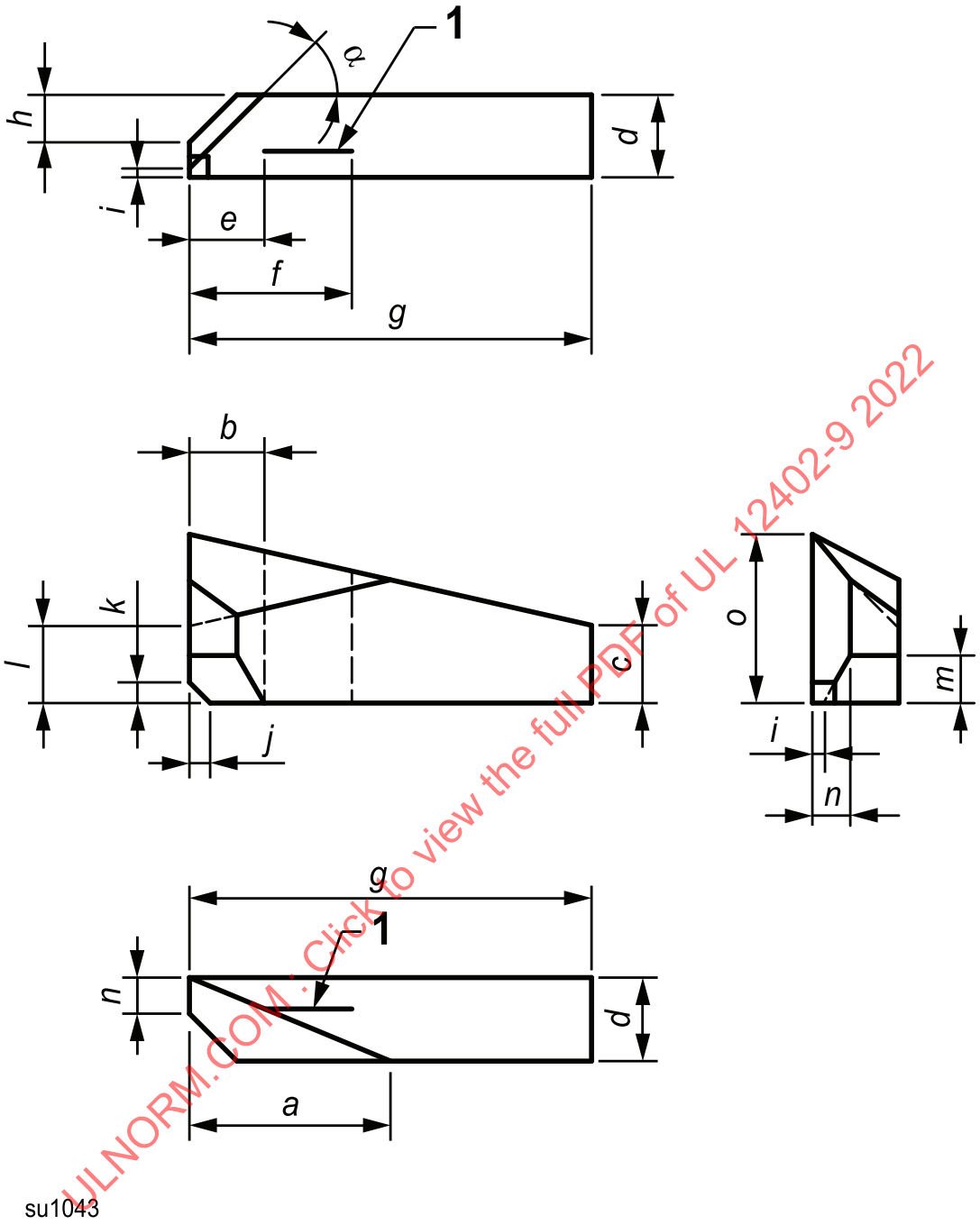
Key

1 interior fabric retainers for foam inserts 1

2 interior fabric retainers for foam inserts 2

Figure B.7

Interior foam retainer



Key

1 slot

a 45°

Figure B.8

Front foam insert

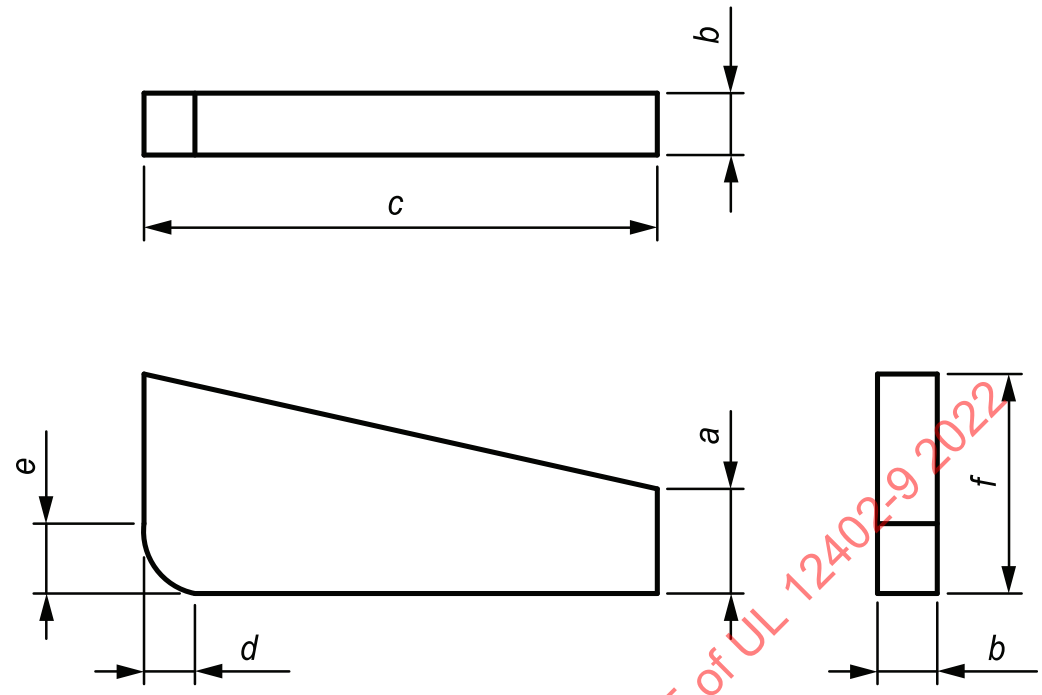
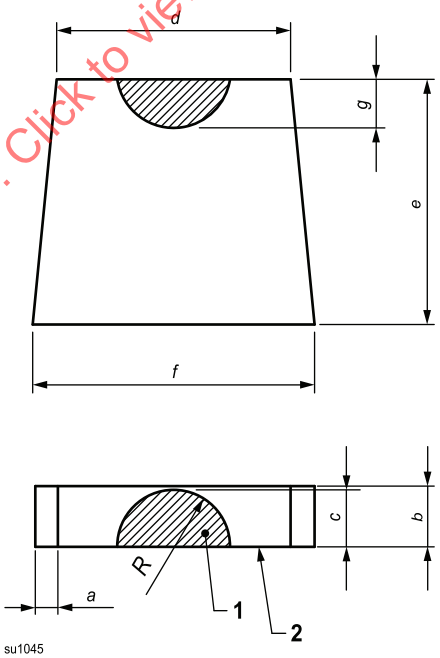


Figure B.9

Inside front foam insert



Key

1 skive

2 side towards body

Figure B.10

Collar foam insert

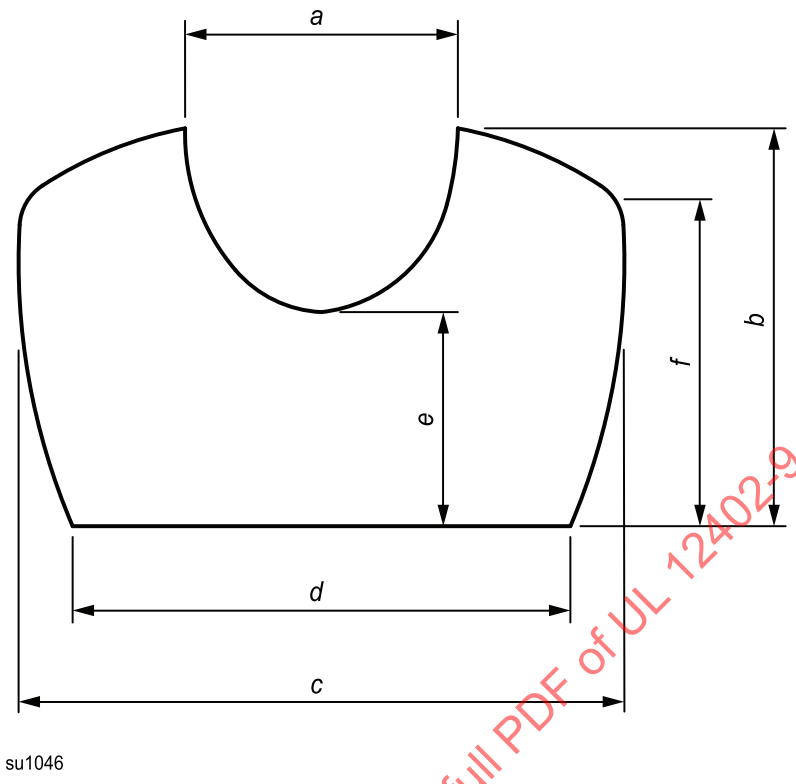
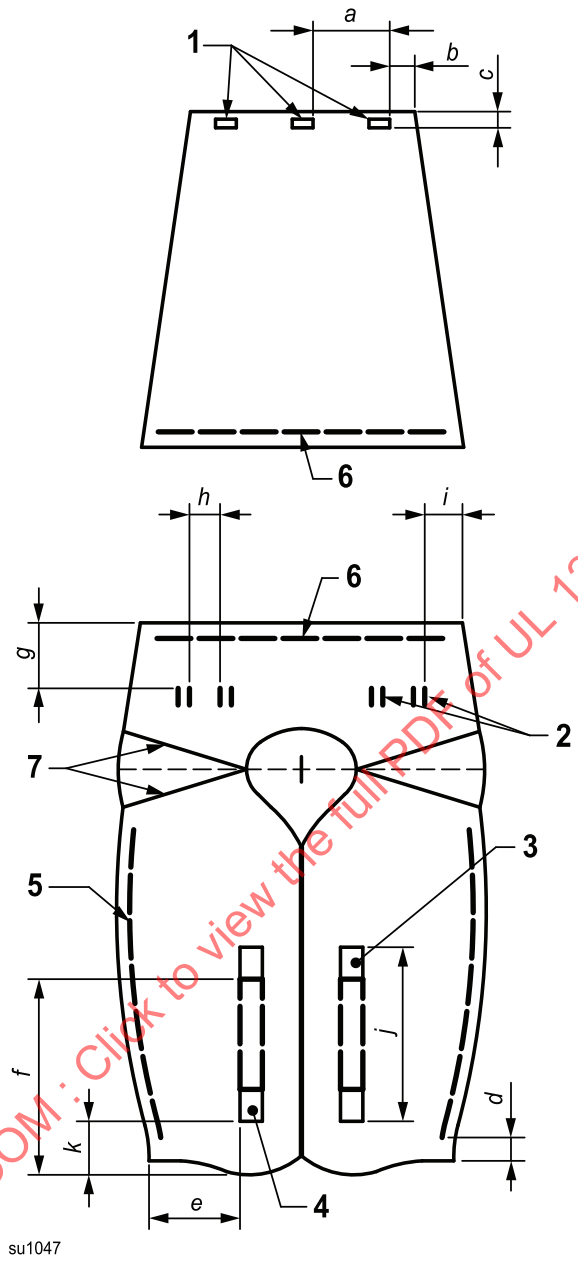


Figure B.11

Back foam insert (thickness = 25 mm)



Key

1 waist belt (1 867 mm) attachment to outside of back cover

2 belt loop webbing (76 mm) attachment to outside of front cover

3 chest strap webbing (127 mm) attachment to outside of front cover

4 waist belt (203 mm) attachment to outside of front cover

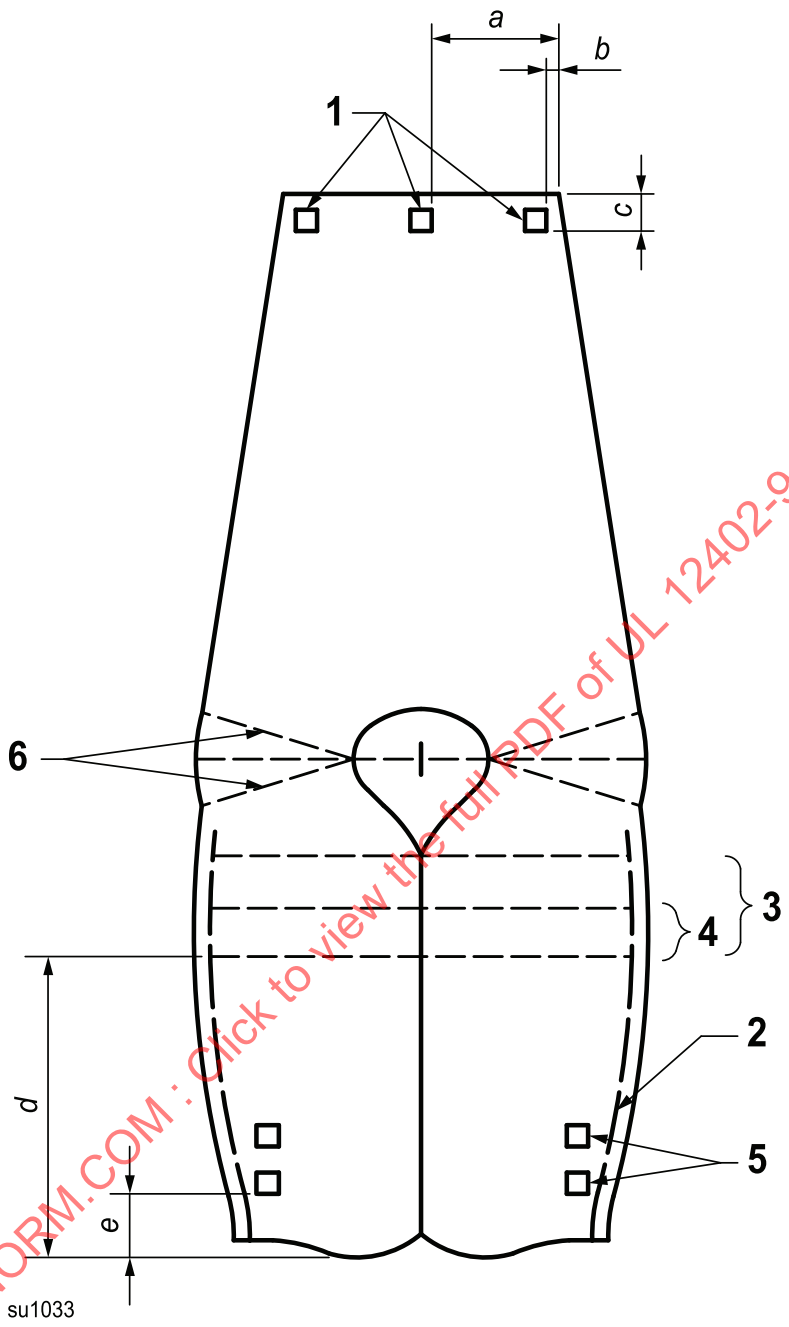
5 zipper (440 mm) attachment to front

6 zipper (370 mm) attachment to front and back covers

7 dart

Figure B.12

Attachments to front and back cover (dimensions on pattern, before sewing)



Key

1 waist belt (1 867 mm) attachment to outside of back cover and inside cover (see Figure B.12)

2 zipper (440 mm) attachment

3 interior fabric retainer attachment to centre and outer edge of inside front cover

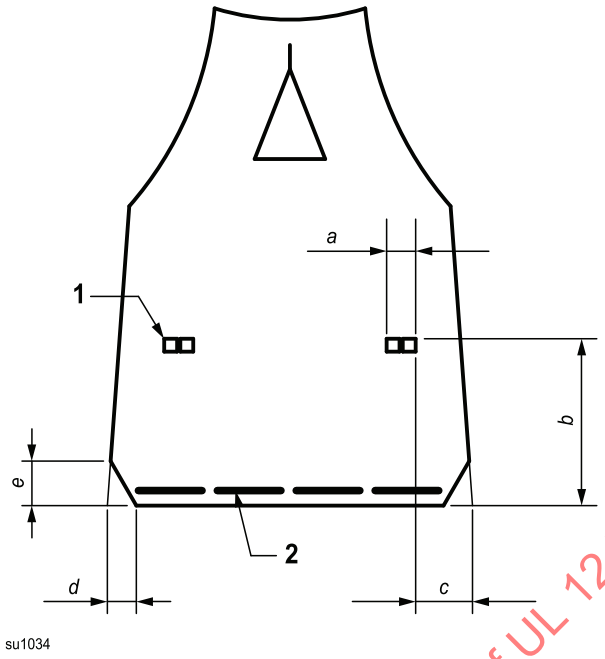
4 interior fabric retainer attachment to centre of inside front cover

5 belt loop webbing (89 mm) attachment to outside of cover

6 dart

Figure B.13

Attachments to inside cover (dimensions on pattern, before sewing)



Key

1 collar webbing (1 384 mm) attachment on the outside of the inner cover with reinforcement fabric inside

2 zipper (280 mm) attachment to the outer and inner covers

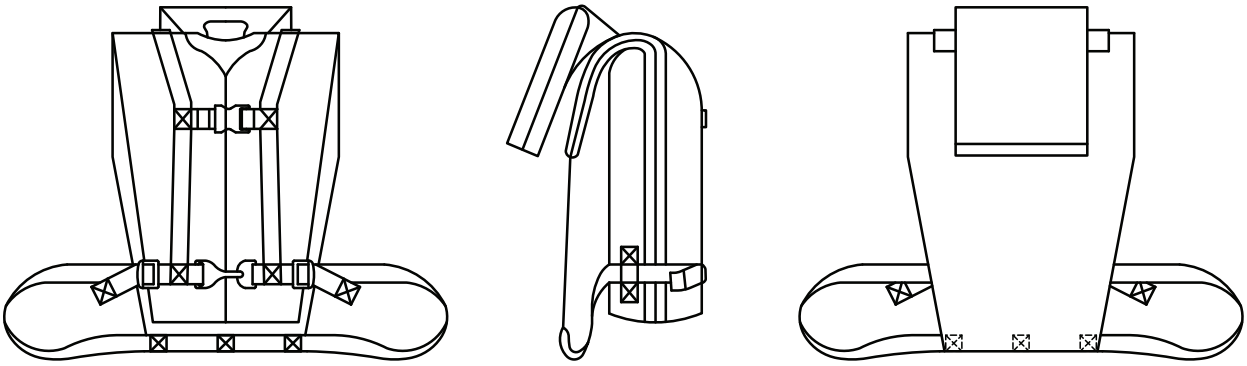
Figure B.14

Attachments to outer and inside collar cover (dimensions on pattern, before sewing)

Table B.5
List of dimensions shown in Figure B.16 and Figure B.17

Figure	Dimension											
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*
Figure B.16	450	530	980[a]	90	60	340	20	310	70	50	60	260
Figure B.17	260	340	230	120	215	210	60	290				
	m	*n*	*o*	*p*	*q*	*r*						
Figure B.16	240	270	130	80	70	30						
Figure B.17												

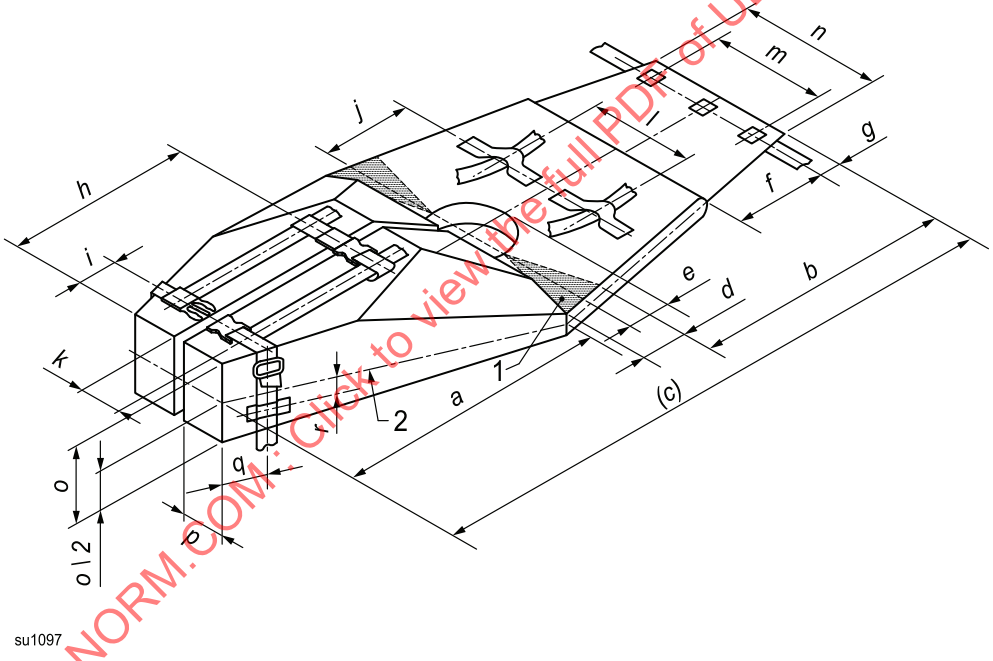
[a] Dimension *c* in Figure B.16 = dimensions *a* + *b* (i.e. dart closed).



su1096

Figure B.15

Assembly views of finished reference vest



su1097

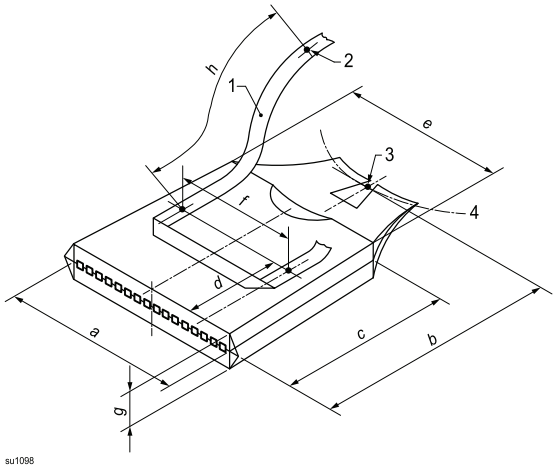
Key

1 dart at shoulder seam; shown spread out

2 seam line and side zipper location

Figure B.16

Assembly dimensions of finished reference vest body with collar removed



Key

1 collar attachment webbing

2 nearest point of attachment to chest of vest

3 centre of neck seam on vest

4 assembly seam in neck of vest

NOTE *h* is measured along the webbing to the nearest point of attachment.

Figure B.17

Assembly dimensions of finished reference vest collar

Annex C
(normative)

Child reference vest for test subject disqualification and test subject group validation

C.1 General

This annex specifies the design and construction of the child lifejacket used to disqualify individual test subjects and to verify that the group of test subjects used represents a valid cross-section of the potential user population when testing lifejackets according to ISO 12402-1 to ISO 12402-6.

C.2 Description

This reference vest is made with layers of buoyant foam in a bib-style design using a heavy nylon shell cover fabric secured to the body with a waist belt with quick and positive closure and adjustment, along with a chest strap at the neck for closure and adjustment. The shell is made with slide fasteners (zippers) in place of closing seams to hold the foam within, in order that the foam inserts can be easily removed to check their buoyancy and renew or supplement them if they are out of tolerance. The vest is designed to fit persons of chest size from 500 mm to 700 mm. The vest was designed to be reasonably comfortable to use as a non-reversible device.

C.3 Materials

C.3.1 General

All materials used shall comply with ISO 12402-7.

C.3.2 Foam requirements

C.3.2.1 Stiffness and quality

The buoyant inserts are made of layers of medium stiffness foam to create a flexible but firm buoyancy element.

C.3.2.2 Shape

The shape of each foam layer is identified in Figure C.2 and Figure C.3. Dimensions are given in Table C.1, Table C.2 and Table C.3.

C.3.2.3 Buoyancy

The total design buoyancy of the device is 88 N. Table C.4 identifies, for each insert, the buoyancy, buoyancy tolerances, and distribution when checked at the time of testing.

C.3.3 Other component requirements

See Table C.1.

C.4 Construction

C.4.1 The construction and assembly of the device shall be in accordance with Table C.1 and Table C.5 and Figure C.1 through Figure C.9.

C.4.2 Seam allowances are 13 mm, unless otherwise specified.