



BSI Standards Publication

Personal flotation devices

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

National foreword

This British Standard is the UK implementation of EN ISO 12402-7:2020. It is identical to ISO 12402-7:2020. It supersedes BS EN ISO 12402-7:2007+A1:2011, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PH/3/6, Buoyancy garments.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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European foreword

This document (EN ISO 12402-7:2020) has been prepared by Technical Committee ISO/TC 188 "Small craft" in collaboration with Technical Committee CEN/TC 162 "Protective clothing including hand and arm protection and lifejackets" the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2021, and conflicting national standards shall be withdrawn at the latest by April 2021.

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

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Endorsement notice

The text of ISO 12402-7:2020 has been approved by CEN as EN ISO 12402-7:2020 without any modification.

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Foreword

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

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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

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

This second edition cancels and replaces the first edition (ISO 12402-7:2006), which has been technically revised. It also incorporates the Amendment ISO 12402-7:2006/Amd. 1:2011.

The main changes with respect to the previous edition are as follows:

- a) temperature of temperature cycling (4.1.6.3) was changed from $(65 \pm 2) ^\circ\text{C}$ into $(60 \pm 2) ^\circ\text{C}$;
- b) compliance criteria in Table 1, Sewing thread, were changed;
- c) requirements for fabrics performance were changed (see 4.3.2 and Table 2);
- d) new chromaticity coordinates x and y and luminance factor β for yellow, orange and red non-fluorescent colours of lifejacket material were added (see Table 3);
- e) new chromaticity coordinates x and y and luminance factor β for yellow, yellow-orange, orange and orange-red fluorescent colours of lifejacket material were added (see Table 4);
- f) compliance criteria of structural webbing (see Table 5) were modified;
- g) compliance criteria of structural tie tape (see Table 6) were modified;
- h) new subclause "General" to structural lacing was added (see 4.5.1);
- i) immersion of zippers, automatic and manual inflation systems in IRM 902 oil was deleted and ambient temperature replaced by $(20 \pm 2) ^\circ\text{C}$ (see Tables 8, 17 and 18);
- j) compliance criteria of webbing closures and adjusters were modified (see Table 9);
- k) compliance criteria of lacing closures and adjusters were modified (see Table 10);
- l) number of samples reduced for density test on foam flotation material (see Table 12);

- m) dimensional test for foam flotation material deleted;
- n) test method for the compressibility of inherently buoyant material was modified (see [4.8.2.4](#));
- o) compliance criteria of inflation chamber materials were modified (see [Table 15](#)).

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

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

Introduction

ISO 12402 (all parts):2020 deals with personal floatation devices (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 International Standard give a reasonable assurance of safety from drowning to a person who is immersed in water. ISO 12402 (all parts):2020 does not include the following:

- requirements for lifejackets on seagoing ships, which are regulated by the International Maritime Organization (IMO)¹⁾ under the International Convention for the Safety of Life at Sea (SOLAS);
- throwable devices and flotation cushions.

ISO 12402 (all parts):2020 allows for the buoyancy of a PFD to be provided by a variety of materials or designs, some of which can require preparation before entering the water (e.g. inflation of chambers by gas from a cylinder or blown in orally). 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), which all 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, if automatic operation would result in entrapment, or if 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 the ISO 12402 series:2020 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 (all parts):2020 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. 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 provided by ISO 12402 (all parts):2020 are the following:

- to provide higher levels of support (levels 100, 150, or 275) that generally float the user with greater water clearance, when required for increasingly severe conditions; 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 accommodate the sometimes conflicting needs of reliability and durability, in-water performance, and continuous wear;

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

- 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 PFDs 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 need to be secure when worn, in order to provide positive support in the water and to allow users to swim or actively assist themselves or others. The PFD selected ensures 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) can alter the performance of the PFD. Users, owners and employers need to ensure that this is taken into account when selecting a PFD. Similarly, it is possible that PFDs do not perform as well in extremes of temperature, although meeting ISO 12402 (all parts):2020 requirements. PFDs can also be affected by other conditions of use, such as chemical exposure and welding, and can require additional protection to meet the specific requirements of use. Taking a PFD into such conditions necessitates the assurance that the PFD will not be adversely affected. ISO 12402 (all parts):2020 also allows a PFD to be an integral part of a safety harness designed to conform to ISO 12401:2009, 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 expected to conform to ISO 12402 (all parts):2020.

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 use. 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 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 impair 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.

The characteristics of the product properties, alternative choices and the limitations to normal use are to be explained to potential buyers by manufacturers and distributors of PFDs prior to purchase.

Similarly, it is advised that regulators regarding the use of these garments 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 expected consequences. Requirements and recommendations for the correct selection and application of PFDs are given in ISO 12402-10:2020.

Personal flotation devices —

Part 7:

Materials and components — Safety requirements and test methods

1 Scope

This document specifies the minimum requirements for the construction and performance of materials and components of personal flotation devices, as well as the relevant test methods.

2 Normative references

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

ISO 105-A02:1993, *Textiles — Tests for colour fastness — Part A02: Grey scale for assessing change in colour*

ISO 105-E02:2013, *Textiles — Tests for colour fastness — Part E02: Colour fastness to sea water*

ISO 105-X12:2016, *Textiles — Tests for colour fastness — Part X12: Colour fastness to rubbing*

ISO 139:2005/Amd 1:2011, *Textiles — Standard atmospheres for conditioning and testing*

ISO 188:2011, *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

ISO 846:2019, *Plastics — Evaluation of the action of microorganisms*

ISO 1302:2002, *Geometrical Product Specifications (GPS) — Indication of surface texture in technical product documentation*

ISO 13688:2013, *Protective clothing — General requirements*

ISO 1421:2016, *Rubber- or plastics-coated fabrics — Determination of tensile strength and elongation at break*

ISO 1926:2009, *Rigid cellular plastics — Determination of tensile properties*

ISO 2062:2009, *Textiles — Yarns from packages — Determination of single-end breaking force and elongation at break using constant rate of extension (CRE) tester*

ISO 2411:2017, *Rubber- or plastics-coated fabrics — Determination of coating adhesion*

ISO 3696:1987, *Water for analytical laboratory use — Specification and test methods*

ISO 4674-1:2016, *Rubber- or plastics-coated fabrics — Determination of tear resistance — Part 1: Constant rate of tear methods*

ISO 4892-1:2016, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance*

ISO 4892-2:2013, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

ISO 5470-2:2003, *Rubber- or plastics-coated fabrics — Determination of abrasion resistance — Part 2: Martindale abrader*

- ISO 6330:2012, *Textiles — Domestic washing and drying procedures for textile testing*
- ISO 7229:2015, *Rubber- or plastics-coated fabrics — Measurement of gas permeability*
- ISO 7854:1995, *Rubber- or plastics-coated fabrics — Determination of resistance to damage by flexing*
- ISO 9073-4:1997, *Textiles — Test methods for nonwovens — Part 4: Determination of tear resistance*
- ISO 9227:2017, *Corrosion tests in artificial atmospheres — Salt spray tests*
- ISO 12402-2:2020, *Personal flotation devices — Part 2: Lifejackets, performance level 275 — Safety requirements*
- ISO 12402-3:2020, *Personal flotation devices — Part 3: Lifejackets, performance level 150 — Safety requirements*
- ISO 12402-4:2020, *Personal flotation devices — Part 4: Lifejackets, performance level 100 — Safety requirements*
- ISO 12402-5:2020, *Personal flotation devices — Part 5: Buoyancy aids (level 50) — Safety requirements*
- ISO 12402-6:2020, *Personal flotation devices — Part 6: Special purpose lifejackets and buoyancy aids — Safety requirements and additional test methods*
- ISO 13934-1:2013, *Textiles — Tensile properties of fabrics — Part 1: Determination of maximum force and elongation at maximum force using the strip method*
- ISO 13934-2:2014, *Textiles — Tensile properties of fabrics — Part 2: Determination of maximum force using the grab method*
- ISO 13937-2:2000, *Textiles — Tear properties of fabrics — Part 2: Determination of tear force of trouser-shaped test specimens (Single tear method)*
- ISO 13938-1:2019, *Textiles — Bursting properties of fabrics — Part 1: Hydraulic method for determination of bursting strength and bursting distension*
- ISO 13938-2:2019, *Textiles — Bursting properties of fabrics — Part 2: Pneumatic method for determination of bursting strength and bursting distension*
- ISO 80000-1:2009, *Quantities and units — Part 1: General*
- ISO 80000-2:2019, *Quantities and units — Part 2: Mathematical signs and symbols to be used in the natural sciences and technology*
- ISO 80000-3:2019, *Quantities and units — Part 3: Space and time*
- ISO 80000-4:2019, *Quantities and units — Part 4: Mechanics*
- EN 590:2013/Amd 1:2017, *Automotive fuels — Diesel — Requirements and test methods*
- EN 10088-1:2014, *Stainless steels — Part 1: List of stainless steels*
- CIE publication No, 15.2, *Colorimetry*
- ASTM D412-16, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers — Tension*
- ASTM D471-16, *Standard Test Method for Rubber Property-Effect of Liquids*
- ASTM D412-92, *Tensile Strength Properties of Rubber and Elastomers*
- ASTM D2061-07, *Standard Test Methods for Strength Tests for Zippers*
- ASTM D2062, *Standard Test Methods for Operability of Zippers*

ASTM D882-12, *Standard Test Method for Tensile Properties of Thin Plastic Sheeting*

FTMS 191A, Federal Test Method Standard

3 Terms and definitions

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

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

NOTE Users of this document are encouraged to consult the Online browsing platform (OBP) for the terms and definitions given in ISO 12402-2:2020 to ISO 12402-6:2020.

3.1

coated fabric

flexible material composed of a textile fabric and an adherent polymeric material

3.2

cylinder seal indicator

visual display on an *inflation system* (3.8) which provides information regarding the status of the seal on an installed cylinder

3.3

design inflation range

range of buoyancy and pressure, as specified by the manufacturer, to which a chamber is capable of being inflated to provide the intended in-water performance

3.4

weft

yarn running from *selvage* (3.14) to selvage at right angles to the *warp* (3.18) in woven fabrics

Note 1 to entry: For knitted fabric see 4.3.2.3.

3.5

filling density

mass of the gas charge for gas-filled cylinders or other inflation-medium containers, in kilograms, divided by the volume of the inflation-medium container, in litres

3.6

foam flotation material

closed-cell (cells not interconnecting) foamed polymeric material

3.7

full inflation

chamber or chambers inflated to any value within the *design inflation range* (3.3)

3.8

inflation system

means of inflating one or more chambers to make the PFD buoyant or more buoyant on demand, either actively or passively of the user's action

3.9

initial jaw separation

distance between the bottom of the top clamp and the top of the bottom clamp of a tensile test machine prior to testing

3.10

fabric-laminated foam

layered fabric structure wherein a fabric is combined with a continuous sheet of foam flotation material, either by heat or by an adhesive in such a way that the identity of the continuous sheet material is retained

3.11

multi-eyelet guide

polymeric part designed to be sown into a PFD and having a series of holes to insert lacing for adjustment of the fit of a PFD

3.12

multiple-point status indicator

status indicator (3.17) which utilises two or more independent visual display points to communicate *inflation system* (3.8) readiness

3.13

polymeric foam coating

coating applied to flotation foam in place of a fabric covering to protect and strength the finished PFD

3.14

selvage

uncut edge portion of a fabric

3.15

serviceability

ease with which the *inflation system* (3.8) mechanism is properly rearmed

3.16

single-point status indicator

status indicator (3.17) which combines all system checks into a single visual display point to communicate *inflation system* (3.8) readiness

3.17

status indicator

part or parts of an *inflation system* (3.8) which provide user feedback to assist in keeping an inflatable PFD in an armed and ready condition

3.18

warp

yarn running lengthwise, parallel to the *selvage* (3.14), in a woven fabric

Note 1 to entry: For knitted fabrics see 4.3.2.3.

4 Materials and components

4.1 General

4.1.1 Principles

All structural materials and components of personal flotation devices shall meet the requirements specified in this document.

The human subject performance tests shall be witnessed by a test panel of at least 2 experts familiar with testing and with 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 test 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 experience of observing (or conducting under the supervision of a qualified observer) the specific test on at least 3 occasions.

4.1.2 Sampling

Two samples (one from each end of the range) of materials and components common to a range of products may be submitted and the results used to cover the full range of products.

Unless otherwise specified by the test method, the sampling of components shall be representative of the production.

4.1.3 Pass or fail criteria

4.1.3.1 All required samples shall pass all objective tests for the component or material to meet the requirements of this document.

4.1.3.2 For any test identified as subjective or which uses human test subjects, because of the high variability between subjects and the difficulty in assessing some subjective measures, a component may be accepted on the basis of the following additional testing. If a component does not completely meet the requirements of a test for a particular measurement or does so but with only one test subject, another two samples or subjects (with similar physical characteristics, if applicable) shall be subjected to the same test and before the same test personnel. Such subjective tests shall be witnessed by a test panel of at least two experts familiar with testing the products specified in the ISO 12402:2020 series and repeated with three experts if there is any question about the performance observed. If this additional test is still not clearly passed in accordance with this document, then the component or material shall be deemed to have failed. The test panel should deem that the component or material has passed the test only if it has now fulfilled the test requirements completely.

4.1.4 Units of measurement

Units of measurement shall be in accordance with ISO 80000-1:2009, ISO 80000-2:2019, ISO 80000-3:2019 and ISO 80000-4:2019.

4.1.5 Material

4.1.5.1 Non-metallic components and fabrics

Non-metallic components and fabrics shall not be damaged when tested in accordance with the relevant Tables of this document.

4.1.5.2 Corrosion of metal components

When tested in accordance with ISO 9227:2017 for a minimum of 160 h, metal components shall not be significantly affected by corrosion as specified in the relevant Tables of this document.

4.1.5.3 Magnetic properties

No metallic component shall affect a magnetic compass of a type commonly used in small boats by more than 1° when placed 500 mm from the compass according to ISO 12402-9:2020, 5.4.

4.1.5.4 Innocuousness

Innocuousness material shall comply with ISO 13688:2013, 4.2.

4.1.6 Sample conditioning

4.1.6.1 General

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

Prior to testing, materials and components shall be conditioned.

4.1.6.2 Standard conditioning

- a) Except for textile products (i.e., fabric, webbing, thread, tie tape), the applicable number of samples specified in each section shall be conditioned at $(23 \pm 2) ^\circ\text{C}$ and $(50 \pm 5) \%$ relative humidity for not less than 24 h prior to the tests.
- b) For textile products, the samples shall be conditioned according to ISO 139:2005/Amd 1:2011 for not less than 24 h.
- c) If it is specified that the sample is to be tested under “wet conditions”, the sample shall be soaked for $6^{+0,2}_0$ h in fresh water, or as specified by the test procedure itself.

4.1.6.3 Temperature cycling

Where required by the test method, the component or sample of fabric shall be conditioned, in its normal storage state, and then immediately exposed for $(24 \pm 0,5)$ h at a temperature of $(-30 \pm 2) ^\circ\text{C}$, then for $(24 \pm 0,5)$ h at a temperature of $(60 \pm 2) ^\circ\text{C}$. Any damage shall be assessed by visual examination and be reported. The component or sample shall undergo ten cycles.

4.1.6.4 Accelerated weathering

Laboratory exposure of components and fabrics for lifejackets to conditions representative of elements found in a severe outdoor environment, including light and water, shall be conducted by exposing samples in a xenon weathering machine in accordance with ISO 4892-1:2016 and ISO 4892-2:2013 as further defined by the following specifications:

- exposure: $500 \text{ kJ}/(\text{m}^2 \times \text{nm})$ at 340 nm of UV radiation;
- sample mounting: mount samples with the face side (the side normally exposed to sunlight in service) toward the light so that the centre of each sample is in the same plane as the perpendicular to the centreline of the light source;
- irradiance: $0,55 \text{ W}/\text{m}^2$ at 340 nm;
- filters: daylight filters;
- black panel temperature: $(63 \pm 2) ^\circ\text{C}$;
- dry bulb temperature: $(42 \pm 2) ^\circ\text{C}$;
- relative humidity: 50 % (during light-only cycle);
- water temperature: $(20 \pm 5) ^\circ\text{C}$;
- test cycles: 102 min of light/18 min of light and continuous water spray/24 min dark and water spray.

4.2 Sewing thread

4.2.1 Construction

Sewing thread shall not contain natural fibres or be monofilament.

4.2.2 Performance

Sewing thread shall comply with the requirements specified in [Table 1](#) where they contribute to the structural strength of the lifejacket.

4.2.3 Loop breaking strength

For the loop breaking strength test, the test machine described in ISO 2062:2009 shall be used. Secure both ends of one piece in one clamp of the testing machine so that the length of the loop equals half the total length between the jaws. Pass one end of the second piece through the loop formed by the first, and secure both ends of the second piece in the other clamp of the machine. Separate the clamps at a rate of (300 ± 10) mm/min.

Table 1 — Sewing thread

Property	Exposure	Test method	Number of samples	Sample size ^a mm	Requirement ^b
Single strand breaking	1) Standard conditioning 2) Accelerated weathering according to 4.1.6.4	ISO 2062:2009	5 for each colour for each exposure	1 000 ± 10	For exposure 1, the breaking strand strength shall be at least 25 N. For exposure 2, the breaking strength shall be at least 15 N. Results shall be given as average of the five samples.
Loop breaking strength	Standard conditioning ^a	4.2.3	5 (each consisting of two pieces)	500	The loop breaking strength shall be at least 44 N. Results shall be given as average of the five samples.
^a Where various colours are tested, as a minimum both the brightest and the darkest colours and the brightest and the darkest fluorescent colours shall be tested.					
^b For compliance see 4.1.3 .					

4.3 Fabric

4.3.1 General

Only fabrics which are structural to maintain the performance of the product under test shall be tested. Decorative and other fabrics shall not be tested.

4.3.2 Performance

4.3.2.1 Fabric used as drainage material shall comply with all of the applicable fabric requirements. Following weathering according to [4.1.6](#), the tensile strength shall be measured using the grab method given in ISO 13934-2:2014.

4.3.2.2 Textile woven fabrics shall have an as-received tensile strength as specified in [Table 2](#), measured using the grab method given in ISO 13934-2:2014.

4.3.2.3 Textile knitted fabrics shall have an as-received burst strength as specified in [Table 2](#), measured using the method given in ISO 13938-1:2019 or ISO 13938-2:2019.

4.3.2.4 Fabrics used in the construction of covers of buoyant compartments, the ride-up prevention system, and any other component the failure of which would render the lifejacket non-conformant with this document, shall comply with the requirements of [Table 2](#) when tested according to the standards specified in [Table 2](#).

4.3.2.5 Fabric shall comply with the acceptance criteria specified in [Table 2](#) when subjected to the tests therein. Separate samples shall be used for each different conditioning exposure.

Table 2 — Fabric

Property	Exposure	Test method	Number of samples	Sample size ^a mm	Requirement ^f
Tensile strength (woven fabrics only)	1) Standard conditioning 2) Accelerated weathering according to 4.1.6.4 3) 70 h immersion in fuel B according to ASTM D471-16 or diesel fuel according to EN 590:2013/ Amd 1:2017 ^b 4) 70 h immersion in 0,5 % detergent ^c according to ISO 6330:2012	ISO 13934-2:2014, except that jaw breaks may be included in the average results	5 warp and 5 weft for each separate exposure	As specified by test method	Following exposure 1, the tensile strength shall be at least 400 N for each direction. Following each separate exposure 2 and 3, the tensile strength shall be at least 260 N. Results shall be given as average of the five samples.
Bursting strength (knitted fabrics only)	1) Standard conditioning 2) Accelerated weathering according to 4.1.6.4 3) 70 h immersion in fuel B according to ASTM D471-16 or diesel fuel according to EN 590:2013/ Amd 1:2017 ^b 4) 70 h immersion in 0,5 % detergent ^c according to ISO 6330:2012	ISO 13938-1:2019 or ISO 13938-2:2019	6 for each separate exposure	130 × 130	Following exposure 1, the bursting strength shall be at least 800 kPa. Following each separate exposure in 2 and 3, the bursting strength shall be at least 480 kPa. Results shall be given as average of the six samples.
Tearing strength (woven fabrics only)	Standard conditioning	ISO 13937-2:2000	5 warp 5 weft	50 × 200	The tearing strength shall be at least 25 N for each direction. Results shall be given as average of the five samples.
Yarn slippage (woven fabrics only)	Standard conditioning	4.3.2.1	5 warp 5 weft	100 × 150	The yarn slippage shall be at least 220 N. Results shall be given as average of the five samples.
Openness of weave ^d	Standard conditioning	4.3.2.2			The openness of weave shall not exceed 20 %.

Table 2 (continued)

Property	Exposure	Test method	Number of samples	Sample size ^a mm	Requirement ^f
Adhesion strength ^e	Standard conditioning	ISO 2411:2017	2 warp and 2 weft or 5 warp and 5 weft	50 × 200 or 75 × 200	The coating adhesion shall be at least 7 N/cm.
^a Applies to each colour except for fabrics related to lifejackets complying with ISO 12402-5:2020 where a minimum of one colour shall be tested. ^b Exposure tests to be based on typical fuels used in the intended area of application. ^c ECE non phosphate detergent. ^d Applies to external cover fabrics only; does not apply to gusset, lining, or drainage fabric. ^e Applies only to coated fabric with a coating of 185 g/m ² or more and where the base fabric or scrim does not comply with the applicable strength requirements when fabric is uncoated. ^f For compliance see 4.1.3 .					

4.3.2.6 Yarn slippage (woven fabrics only)

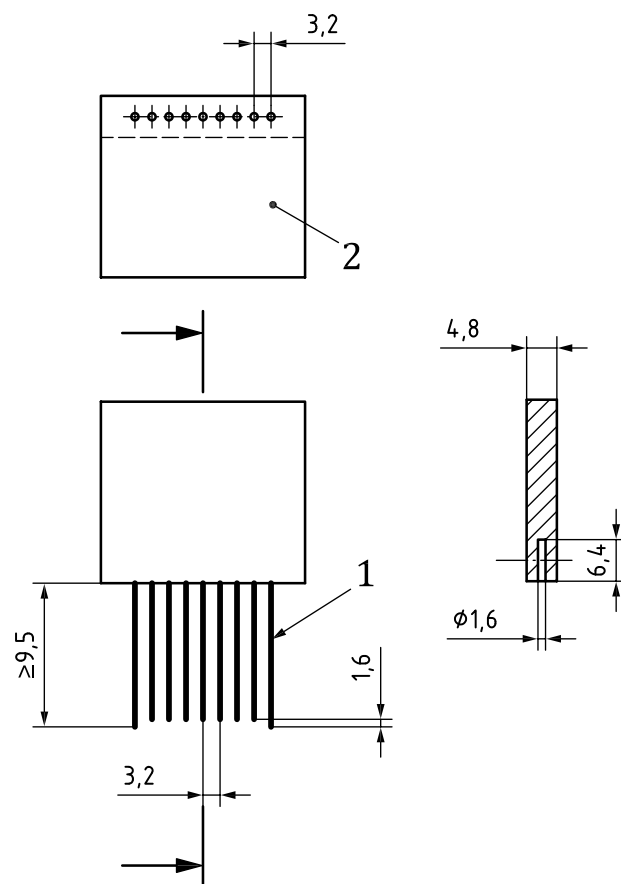
The warp samples specified in [Table 2](#) shall be cut with the long dimension parallel to the warp yarns, and weft samples shall be cut with the long dimension parallel to the weft yarns. No two warp samples shall contain the same warp yarns and no two weft samples shall contain the same weft yarns. No sample shall include selvage.

The narrow end of the sample shall be inserted approximately 5 mm into the nine-hole spacer illustrated in [Figure 1](#) and centred. A nine-needle bit shall be aligned with the holes in the chuck so that the smooth side of the needles faces the 5 mm edge of the sample. The needles shall be forced through the fabric past the scarf joint so that the fabric lies against the blade of the needles.

The tensile machine shall be a constant-rate-of-traverse (CRT) or constant-rate-of-extension (CRE) machine.

The tensile machine shall be equipped with clamps having front jaws 25 mm × 25 mm and back jaws 25 mm × 38 mm or more wider. The nine-hole chuck shall be centred and clamped in the upper jaws of the machine so the sample hangs lengthwise. The holes in the chuck shall be perpendicular to the direction of pull. The fabric shall be clamped to the lower jaws of the machine. Separation between the holes in the chuck and the top of the jaws shall be 65 mm. The yarns shall be parallel to the direction of pull. The jaws shall then be separated at a rate of (300 ± 10) mm/min.

The maximum force required to cause rupture shall be recorded.



Key

- 1 Singer® thin ball-point needles (size 18)^{a,b}
 2 nine-hole spacer

- ^a The needles used have a conventional cylindrical profile (not U-bladed) and standard scarf. The grooves of the needles all face in the same direction, perpendicular to the plane formed by the nine needles.
^b Singer® is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

Figure 1 — Nine-needle apparatus

4.3.2.7 Openness of weave

The openness of weave, see [Table 2](#), shall be determined using a full width sample at least 1 000 mm long. Five separate measurements shall be taken across the width of the roll. For each measurement, a 650 mm² area shall be marked on the fabric. No measurement shall be within 25 mm of the selvage edge.

In the area of the marked fabric material, the size of each opening shall be measured using an optical comparator with a magnification of 5×. Openings on the edge of a 650 mm² area shall be counted as one whole opening only if more than 50 % of the opening is inside the marked square.

The openness of the weave shall be calculated according to [Formula \(1\)](#):

$$\theta = \frac{100 \times S}{n} \quad (1)$$

where

- θ is the openness of weave;
- S is the total surface area of openings, in mm²;
- n is the number of 650 mm² areas.

4.3.3 Colour

4.3.3.1 The colour of the exposed portions (excluding components such as webbing, zips and other fittings) of a lifejacket when deployed in normal floating position shall be in the colour range from yellow to red; the chromaticity for non-fluorescent colours shall lie within one of the areas defined in [Table 3](#) and the luminance factor shall exceed the corresponding minimum in [Table 3](#). The chromaticity coordinates and the minimum luminance factor for fluorescent colours shall comply with [Table 4](#).

4.3.3.2 The colour of the material samples shall be measured with the procedures defined in CIE publication No. 15.2 with polychromatic illumination D₆₅, 45/0 geometry and 2° standard observer. The specimen shall have a black underlay with reflectance of less than 0,04. The specimens shall be conditioned for at least 24 h at (20 ± 2) °C and (65 ± 5) % relative humidity. If the test is carried out in other conditions, the test shall be conducted within 5 min after withdrawal from the conditioning atmosphere.

A tolerance of ±5 % shall be allowed in the x- and y-chromaticity coordinates expressed in [Table 3](#) and [Table 4](#).

4.3.3.3 The colour fastness (dry and wet) of lifejacket material, when determined in accordance with ISO 105-A02:1993, shall be resistant to rubbing (wet and dry) when tested in accordance with ISO 105-X12:2016 to at least step 4, and to salt water when tested in accordance with ISO 105-E02:2013 to at least step 4.

Table 3 — Chromaticity coordinates x and y and luminance factor β for yellow, orange and red non-fluorescent colours of lifejacket material

Colour	Chromaticity coordinates		Luminance factor β
	x	y	
Yellow	0,389	0,610	>0,35
	0,320	0,490	
	0,405	0,400	
	0,500	0,500	
Orange	0,500	0,500	>0,25
	0,405	0,400	
	0,470	0,330	
	0,600	0,400	
Red	0,600	0,400	>0,15
	0,470	0,330	
	0,525	0,270	
	0,700	0,300	

Table 4 — Chromaticity coordinates x and y and luminance factor β for yellow, yellow-orange, orange and orange-red fluorescent colours of lifejacket material

Colour	Chromaticity coordinates		Luminance factor
	x	y	β
Fluorescent yellow	0,380	0,610	>0,60
	0,320	0,490	
	0,370	0,440	
	0,440	0,550	
Fluorescent yellow-orange	0,440	0,550	>0,50
	0,370	0,440	
	0,420	0,390	
	0,505	0,490	
Fluorescent orange	0,505	0,490	>0,40
	0,420	0,390	
	0,460	0,350	
	0,575	0,425	
Fluorescent red-orange	0,575	0,425	>0,30
	0,460	0,350	
	0,488	0,320	
	0,630	0,360	
Fluorescent red	0,630	0,360	>0,20
	0,488	0,320	
	0,525	0,280	
	0,695	0,300	

4.4 Structural webbing and tie tape

4.4.1 General

Structural webbing and tie tape shall comply with this document when subjected to the tests described in [Table 5](#) and [Table 6](#).

If the component has no influence on the in-water performance test or the load test, it can be considered to be a non-structural component.

4.4.2 Torsional stiffness

Three samples shall be used. The samples specified in [Table 6](#) shall be laid flat on a hard surface, straight, and not under tension. One end of the sample shall be marked as the reference end. Marks are to be placed on the sample 32 mm and 1 000 mm from the reference end.

The reference end of the sample shall be held in a clamping surface by taking the end of the sample at the reference end and folding it over until the end is even with the mark drawn 32 mm from the reference end. The reference end shall then be placed in a fabric clamp in accordance with the test methods for tensile strength and elongation of textile fabrics specified in ISO 13934-1:2013, centred and perpendicular to the clamp bars.

The end of the sample opposite the reference end shall be placed in a clamp. The clamping surface area shall be 12,5 mm × 115 mm and the jaws shall not be padded. The end of the sample shall be placed in

the jaws of the clamp so that the 1 000 mm mark is even with the outside bottom edge of the larger jaw of the clamp. The distance between the fabric clamp and the upper jaw shall be 880 mm.

The clamp shall then be mounted so that the sample hangs freely down with the clamps parallel to each other.

The fabric clamp shall then be rotated five complete turns clockwise and released. After the release from the fabric clamp, the sample winds itself back up counter-clockwise. The fabric clamp shall be stopped immediately when the starting position is reached. The time from which the strip was let go until the twisting motion first stopped shall be recorded. For tie-tape material that has an unsymmetrical weave, the procedure shall then be repeated with the sample rotated counter-clockwise.

Table 5 — Structural webbing

Property	Exposure	Test method	Number of samples ^a	Sample length mm	Requirement ^b
Tensile strength	1) Standard conditioning 2) Accelerated weathering according to 4.1.6.4	ISO 13934-1:2013	5 for each separate exposure	≥300	Following exposure 1, the tensile strength shall be at least 1 600 N. Following exposure 2, the tensile strength shall be at least 960 N. Results shall be given as average of the five samples.
^a Where various colours are tested, as a minimum both the brightest and the darkest colours and the brightest and the darkest fluorescent colours shall be tested.					
^b For compliance see 4.1.3 .					

Table 6 — Structural tie tape

Property	Exposure	Test method	Number of samples ^a	Sample length mm	Requirement ^b
Tensile strength	1) Standard conditioning 2) Accelerated weathering according to 4.1.6.4	ISO 13934-1:2013	5 for each separate exposure	≥300	Following exposure 1, the tensile strength shall be at least 890 N. Following exposure 2, the tensile strength shall be at least 530 N. Results shall be given as average of the five samples.
Torsional stiffness	Standard conditioning	4.4.2	5	1 200	The torsional stiffness shall be not less than 5 s.
^a Where various colours are tested, as a minimum both the brightest and the darkest colours and the brightest and the darkest fluorescent colours shall be tested.					
^b For compliance see 4.1.3 .					

4.5 Structural lacing

4.5.1 General

If the component has no influence on the in-water performance test or the load test, it can be considered to be a non-structural component.

4.5.2 Construction

Structural lacing shall be at least 3 mm in diameter or 6 mm in width.

4.5.3 Performance

Structural lacing shall comply with the acceptance criteria specified in [Table 7](#) when subjected to the tests specified in this table.

Table 7 — Structural lacing

Property	Exposure	Test method	Number of samples ^a	Sample length mm	Requirement ^b
Tensile strength	1) Standard conditioning 2) Accelerated weathering according to 4.1.6.4	ISO 13934-1:2013	5 for each separate exposure	≥300	Following exposure 1, the tensile strength shall be at least 530 N. Following exposure 2, the tensile strength shall be at least 320 N. Results shall be given as average of the five samples.
^a Where various colours are tested, as a minimum both the brightest and the darkest colours and the brightest and the darkest fluorescent colours shall be tested.					
^b For compliance see 4.1.3 .					

4.6 Structural zippers

4.6.1 Construction

A zipper pull shall be at least 24 mm long. Projections (i.e. raised material) on the end of the zipper pull shall be provided to make the zipper pull easier to grasp.

When the pin is properly seated for closing the zipper, the retainer of a zipper shall engage with the separable pin and the slider shall engage the chain.

The slider of the zipper shall be of the automatic locking type.

4.6.2 Performance

4.6.2.1 General

Zippers shall comply with the acceptance criteria specified in [Table 8](#) when subjected to the tests specified in this table.

4.6.2.2 Operability force test

For each set of six samples (see [Table 8](#)), three shall be used to determine the force required to open the zipper, and three shall be used to determine the force required to close the zipper. Samples for opening force shall be closed for conditioning. Samples for closing force shall be open (separated) for conditioning. Tests shall be conducted on the slider and on the moveable retainer, when provided.

Table 8 — Zippers

Property	Exposure	Test method	Number of samples ^a	Sample length mm	Requirement ^f
Operability force	1) Standard conditioning 2) 70 h immersion in fuel B according to ASTM D471-16 or diesel fuel according to EN 590:2013/ Amd 1:2017 ^{b,c} 3) 70 h immersion in 0,5 % detergent ^d according to ISO 6330:2012 4) 720 h of salt spray according to 4.1.5.2^e 5) Accelerated weathering according to 4.1.6.4	ASTM D2062	Six for each separate exposure	150	Following each separate exposure 1 to 5, the operability force exerted to open or close the zipper shall not be greater than 65 N.
Cross-wise strength	1) Standard conditioning 2) 70 h immersion in fuel B according to ASTM D471-16 or diesel fuel according to EN 590:2013/ Amd 1:2017 ^{b,c} 3) 70 h immersion in 0,5 % detergent ^d according to ISO 6330:2012 4) 720 h of salt spray according to 4.1.5.2^e 5) Accelerated weathering according to 4.1.6.4	4.6.2.3	Samples used in the operability force tests	150	Following exposure 1, the crosswise strength shall be not less than: a) 220 N for the top (including slider); b) 220 N for the chain (crosswise); and c) 130 N for the separating unit (crosswise). Following exposures 2 to 4, the crosswise strength shall be at least: a) 130 N for the top (including slider); b) 130 N for the top (for the chain (crosswise); and c) 80 N for the separating unit (crosswise).

Table 8 (continued)

Property	Exposure	Test method	Number of samples ^a	Sample length mm	Requirement ^f
					Following exposure 5 the cross wise strength shall be at least: a) 90 N for the top (including slider); b) 90 N for the top (for the chain (crosswise); and c) 50 N for the separating unit (crosswise). Results shall be given as average of the six samples.
Resistance to pull-off of slider pull	Standard conditioning	ASTM D 2061-07	3	150	The pull-and-slider zipper assembly shall not dislodge when subjected to a force of 180 N.
Resistance to twist of pull and slider	Standard conditioning	ASTM D 2061-07	4 (2 for each direction)	150	The pull and slider shall resist a force of 0,50 Nm torsional stress without significant deformation or rupture.
Holding strength of slider lock	Standard conditioning	ASTM D 2061-07	3	150	The locking mechanism shall remain locked when subjected to a force of 20 N and the slider shall be operable.

^a Where various colours are tested, as a minimum both the brightest and the darkest colours and the brightest and the darkest fluorescent colours shall be tested.

^b Samples are to be blotted dry to remove surface moisture and are to rest for 30 min at $(20 \pm 2) ^\circ\text{C}$ prior to the operability force and strength tests.

^c Exposure tests to be based on typical fuels used in the intended area of application.

^d ECE non phosphate detergent.

^e Applies to zippers employing metallic parts, except those of stainless steel or equivalent corrosion-resistant metals.

^f For compliance see [4.1.3](#).

4.6.2.3 Crosswise strength test

The same samples subjected to the operability force test are to be used. The zippers are to be closed for these tests.

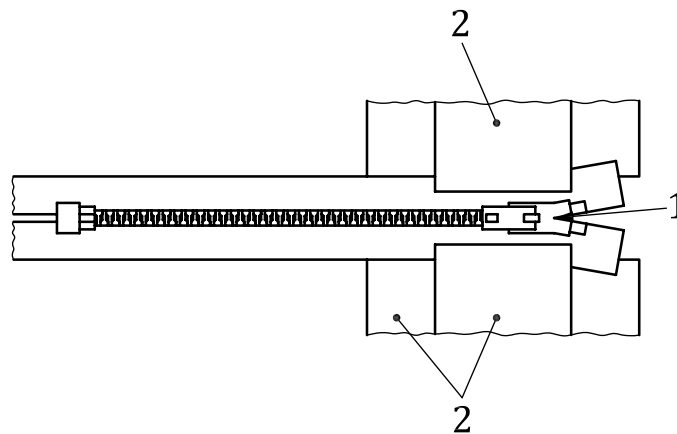
The following tests are to be conducted in accordance with the methods for strength tests for zippers described in ASTM D2061-07:

- a) for the chain (crosswise);
- b) for a separating unit (crosswise) or for a bottom stop holding (crosswise).

The test shall be conducted at the top of the zipper including slider, and at the bottom of the zipper when a moveable retainer (second slider) is used.

The apparatus used for the strength test at the top of the zipper including the slider, and for the test at the bottom of the zipper when a moveable retainer (second slider) is used, shall be as described in ASTM D2061-07.

The tapes of each zipper shall be mounted in the clamps of the tension machine as illustrated in [Figure 2](#), with the edges of the jaws parallel to and approximately 3 mm from the sides of the slider. The slides shall be positioned so that the exposed end of the slider is aligned with the sides of the front jaws as illustrated in [Figure 2](#). The load shall be applied until the slider comes apart, until the tape breaks or until some other kind of malfunction occurs. The maximum load to obtain rupture shall be recorded.



Key

- 1 slider
- 2 testing machine clamp

Figure 2 — Crosswise strength test at the top of the zipper (including slider)

4.7 Hardware

4.7.1 Webbing closures and adjusters

4.7.1.1 Construction

Structural closures and adjusters, such as buckles, slide adjusters, snap hooks, D rings, and hook-and-eye clasps shall comply with [Table 9](#) when subjected to the tests specified in this table.

4.7.1.2 Performance

4.7.1.2.1 Tensile strength

Each assembly shall consist of the conditioned sample with two lengths of 150 mm of unconditioned webbing for lifejackets with specifications as they are for use.

The tester used shall be a constant-rate-of-extension (CRE) tensile test machine, as described in the specification for tensile testing machines for textiles, with a rate of extension of (300 ± 10) mm/min. The front and back jaws of the clamps shall be at least as wide as the webbing being used on the samples. The gauge length shall be (50^{+5}_0) mm longer than the length of the sample being tested.

The sample shall be mounted in the tensile machine by securing each length of webbing in opposite clamps so that the sample is centred between the clamps both vertically and horizontally. For the end of the sample in which friction adjustment of the webbing is possible, only the end of that piece of webbing which results in the binding of the webbing to the hardware when under load shall be secured to the