INTERNATIONAL STANDARD

ISO 12402-7

Second edition
2020-07

Personal flotation devices —

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

Équipements individuels de flottabilité —

Partie 7: Matériaux et composants — Exigences de sécurité et méthodes d'essai

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Foreword

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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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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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.

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

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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 ± 2) °C into (60 ± 2) °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 ± 2) °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);

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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.

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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.

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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.

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— 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.

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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.

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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*

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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*

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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*

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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*

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ISO 13937-2:2000, *Textiles — Tear properties of fabrics — Part 2: Determination of tear force of trouser-shaped test specimens (Single tear method)*

ISO 12402-7:2020
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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*

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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

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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

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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

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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

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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

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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

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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.

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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.

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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 ± 2) °C and (50 ± 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 ± 0,5) h at a temperature of (–30 ± 2) °C, then for (24 ± 0,5) h at a temperature of (60 ± 2) °C. Any damage shall be assessed by visual examination and be reported. The component or sample shall undergo ten cycles.

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4.1.6.4 Accelerated weathering

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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 kJ/(m^2 × 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 W/m^2 at 340 nm;

— filters: daylight filters;

— black panel temperature: (63 ± 2) °C;

— dry bulb temperature: (42 ± 2) °C;

— relative humidity: 50 % (during light-only cycle);

— water temperature: (20 ± 5) °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.

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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.

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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.

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