



Lifejackets

Part 2: Materials and components— Requirements and test methods



This Australian Standard® was prepared by Committee CS-060, Lifejackets and Personal Safety Equipment for Small Craft. It was approved on behalf of the Council of Standards Australia on 24 July 2015.

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Australian Standard[®]

Lifejackets

Part 2: Materials and components— Requirements and test methods

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PREFACE

This Standard was prepared by the Australian members of Joint Standards Australia/Standards New Zealand Committee CS-060, Lifejackets and Personal Safety Equipment for Small Craft, to supersede AS 4758.2—2008, *Personal flotation devices, Part 2: Materials and components—Requirements and test methods*, 2 years from the date of publication.

After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian Standard rather than an Australian/New Zealand Standard.

The objective of this Standard is to provide manufacturers with the requirements and test methods for the materials and components for use in the construction of lifejackets [also known as ‘personal flotation devices’ (PFDs)].

This Standard was revised to include requirements for:

- (a) Inflation indicators.
- (b) Gas cylinders.
- (c) Changes from personal floatation device to lifejacket.

This Standard is Part 2 of the following series:

AS

4758 Lifejackets

4758.1 Part 1: General requirements

4758.2 Part 2: Materials and components—Requirements and test methods (this Standard)

4758.3 Part 3: Test methods

This Standard is based on but not equivalent to ISO 12402-7:2006, *Personal flotation devices, Part 7: Materials and components—Safety requirements and test methods*. Content from this Standard has been reproduced with the permission of ISO. The International Standard is available from SAI Global. Copyright remains with ISO.

The term ‘normative’ has been used in this Standard to define the application of the appendix to which it applies. A ‘normative’ appendix is an integral part of a Standard.

Statements expressed in mandatory terms in footnotes to tables are deemed to be requirements of this Standard.

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STANDARDS AUSTRALIA

Australian Standard

Lifejackets

Part 2: Materials and components—Requirements and test methods

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies the requirements for the structural materials and components and test methods for the construction of lifejackets.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard.

AS

- | | |
|--------|------------------------------|
| 3570 | Automotive diesel fuel |
| 4758 | Lifejackets |
| 4758.1 | Part 1: General requirements |

ISO

- | | |
|---------|---|
| 139 | Textiles—Standard atmospheres for conditioning and testing |
| 1421 | Rubber- or plastics-coated fabrics—Determination of tensile strength and elongation at break |
| 1926 | Rigid cellular plastics—Determination of tensile properties |
| 2062 | Textiles—Yarns from packages—Determination of single-end breaking force and elongation at break using constant rate of extension (CRE) tester |
| 2411 | Rubber- or plastics-coated fabrics—Determination of coating adhesion |
| 3696 | Water for analytical laboratory use—Specification and test methods |
| 4674 | Rubber- or plastics coated fabrics—Determination of tear resistance |
| 4674-1 | Part 1: Constant rate of tear methods |
| 7229 | Rubber- or plastics-coated fabrics—Measurement of gas permeability |
| 7854 | Rubber- or plastics-coated fabrics—Determination of resistance to damage by flexing |
| 9073 | Textiles—Test methods for non-wovens |
| 9073-4 | Part 4: Determination of tear resistance |
| 9227 | Corrosion tests in artificial atmospheres—Salt spray tests |
| 13934 | Textiles—Tensile properties of fabrics |
| 13934-1 | Part 1: Determination of maximum force and elongation at maximum force using the strip method |
| 13934-2 | Part 2: Determination of maximum force using the grab method |
| 13937 | Textiles—Tear properties of fabrics |
| 13937-2 | Part 2: Determination of tear force of trouser-shaped test specimens (Single tear method) |

ISO	
13938	Textiles—Bursting properties of fabrics
13938-1	Part 1: Hydraulic method for determination of bursting strength and bursting distension
ASTM	
D882	Standard Test Method for Tensile Properties of Thin Plastic Sheeting
D2061	Standard Test Methods for Strength Tests for Zippers
D2062	Standard Test Methods for Operability of Zippers
D4157	Standard Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)
EN	
590	Automotive fuels—Diesel—Requirements and test methods

1.3 DEFINITIONS

For the purposes of this Standard, the definitions given in AS 4758.1 and those below apply.

1.3.1 Coated fabric

Flexible materials composed of a textile fabric and an adherent polymeric material.

1.3.2 Filling density

The mass of the gas charge for inflation medium containers, in kilograms, divided by the volume of the inflation medium container, in litres.

1.3.3 Foam flotation material

Closed-cell (cells not interconnecting) foamed polymeric material.

1.3.4 Inflation system

Means of inflating one or more compartments to make the lifejacket buoyant or more buoyant on demand, either actively or passively of the user's action.

1.3.5 Selvage

Uncut edge portion of a fabric.

1.3.6 Status indicator

Part or parts of an inflation system that provide user feedback to assist in keeping an inflatable lifejacket in an armed and ready condition.

1.3.7 Warp

Yarn running lengthwise, parallel to the selvage, in a woven fabric.

1.3.8 Weft

Yarn running from selvage to selvage at right angles to the warp in woven fabrics.

1.4 SAMPLE CONDITIONING

1.4.1 Standard conditioning

Standard conditions shall be as follows:

- (a) Except for textile products (e.g. 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 for not less than 24 h.
- (c) Where required to be tested under 'wet conditions', the sample shall to be soaked for 8 h in fresh water, or as otherwise specified.

1.4.2 Accelerated weathering

Weathering resistance of components and fabrics for lifejackets shall be determined by accelerated weathering exposure to 500 kJ/m^2 at 340 nm of accelerated Xenon weathering exposure in accordance with the following specifications and follow after standard conditioning:

- (a) Irradiance: 0.55 W/m^2 at 340 nm
- (b) Filters: Quartz inner/sodium borosilicate outer
- (c) Black panel temperature: Light $70 \pm 2^\circ\text{C}$, dark $38 \pm 2^\circ\text{C}$
- (d) Dry bulb temperature: $47 \pm 2^\circ\text{C}$
- (e) Relative humidity (light only): Light $50 \pm 5\%$, dark $95 \pm 5\%$
- (f) Conditioning water temperature: Light 45°C , dark 40°C
- (g) Test cycle:
 - 60 min of dark, front and back water spray;
 - 40 min of light;
 - 20 min of light, front water spray;
 - 60 min of light.

SECTION 2 SEWING THREAD

2.1 CONSTRUCTION

Sewing thread shall not consist wholly of natural fibres or be monofilament. Where natural fibre is used as a component of the thread, it shall be treated to resist rotting.

2.2 PERFORMANCE

Sewing thread shall comply with the requirements specified in Table 2.1.

2.3 LOOP BREAKING STRENGTH

The loop breaking strength shall be determined using a constant rate of extension tensile testing machine described in ISO 2062 as follows:

- (a) Secure both ends of one piece of sewing thread in one clamp of the testing machine so that the length of the loop equals half the distance between the jaws.
- (b) Pass one end of the second piece through the loop formed by the first and secure both ends in the other clamp of the testing machine.
- (c) Operate the tensile testing machine at a constant rate of extension of 500 ± 10 mm/min.
- (d) Record the breaking strength.

TABLE 2.1
SEWING THREAD

Property	Conditioning	Test method	Compliance criteria
Single thread breaking and elongation	(a) Standard conditioning in accordance with Clause 1.4.1 (b) Accelerated weathering in accordance with Clause 1.4.2	ISO 2062 Method A	After conditioning (a), the average breaking strength of 5 samples shall be at least 25 N. After conditioning (b), the average breaking strength of 5 samples shall retain at least 60% strength of that determined following Standard conditioning. In addition, the average breaking strength of 5 samples shall be at least 23 N
Loop breaking strength	Standard conditioning	See Clause 2.3	Average breaking strength of 5 samples shall be at least 44 N

SECTION 3 FABRIC

Fabric used for structural components of lifejackets shall comply with the requirements specified in Table 3.1.

TABLE 3.1
FABRIC

Property	Conditioning	Test method	Compliance criteria
Tensile strength (woven fabrics only)	(a) Standard conditioning in accordance with Clause 1.4.1 (b) Accelerated weathering in accordance with Clause 1.4.2	ISO 13934-2	After conditioning (a), the average tensile breaking load shall be not less than 400 N in each direction. After conditioning (a) and (b), the average tensile load shall be not less than 290 N in each direction
Burst strength (knitted fabrics only)	(a) Standard conditioning in accordance with Clause 1.4.1 (b) Accelerated weathering in accordance with Clause 1.4.2	ISO 13938-1	After conditioning (a) and (b), the average burst strength shall be not less than 800 kPa
Elongation (woven fabrics only)	Standard conditioning in accordance with Clause 1.4.1	ISO 13934-1	After conditioning, the average elongation at break shall be not greater than 60% in each direction
Tearing strength (woven fabrics)	Standard conditioning in accordance with Clause 1.4.1	ISO 13937-2	After conditioning, the average tearing load shall be not less than 35 N in both directions
Adhesion strength*	Standard conditioning in accordance with Clause 1.4.1	ISO 2411	After conditioning, the mean coating adhesion strength shall be not less than 7 N/cm in both directions

* Applies to coated fabrics with a coating of 185 g/m² or more and where the base fabric or scrim does not comply with the applicable strength requirements for uncoated fabric.

SECTION 4 STRUCTURAL WEBBING

Structural webbing shall comply with the requirements specified in Table 4.1.

TABLE 4.1
STRUCTURAL WEBBING

Property	Conditioning	Test method	Compliance criteria
Tensile strength	(a) Standard conditioning in accordance with Clause 1.4.1	ISO 13934-2	After conditioning (a), the average tensile breaking load shall be not less than 1600 N
	(b) Accelerated weathering in accordance with Clause 1.4.2		After conditioning (a) and (b), the average tensile breaking load shall be not less than 60% of that obtained after conditioning (a)

SECTION 5 STRUCTURAL ZIPPERS

5.1 CONSTRUCTION

A hole shall be provided on the zipper pull.

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.

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

5.2 PERFORMANCE

Structural zippers shall comply with the requirements specified in Table 5.1.

NOTE: Non-structural zippers should not be closed during the test of a lifejacket.

TABLE 5.1
STRUCTURAL ZIPPERS

Property	Conditioning	Test method	Compliance criteria
Operability force	(a) Standard conditioning in accordance with Clause 1.4.1 (b) 70 h immersion in diesel fuel in accordance with EN 590* (c) 96 h of neutral salt spray in accordance with ISO 9227† (d) Accelerated weathering in accordance with Clause 1.4.2	ASTM D2062	After each separate conditioning (a) to (d), the tensile load required to open or close the zipper shall not be greater than 65 N
Crosswise strength	(a) Standard conditioning in accordance with Clause 1.4.1 (b) 70 h immersion in diesel fuel complying with EN 590 and AS 3570.* (c) 96 h of neutral salt spray in accordance with ISO 9227† (d) Accelerated weathering in accordance with Clause 1.4.2.	ASTM D2061	After each separate conditioning (a) to (d), the average breaking load shall not be less than: (a) 220 N for the top (including slider); (b) 220 N for the chain (crosswire); and (c) 130 N for the separating unit (crosswire).
Resistance to pull-off of slider	Standard conditioning in accordance with Clause 1.4.1	ASTM D2061	When subjected to a tensile load of 180 N, the pull-and-slider assembly shall not be dislodged
Resistance to twist of pull and slider	Standard conditioning in accordance with Clause 1.4.1	ASTM D2061	When subjected to a torsional load of 0.79 Nm, there shall be no significant deformation or rupture of the pull-and-slider assembly
Holding strength of slider lock	Standard conditioning in accordance with Clause 1.4.1	ASTM D2061	When subjected to a tensile load of 20 N the locking mechanism shall remain locked and the slider shall be operable

* Samples shall be blotted dry to remove surface moisture and shall be rested for 30 min before testing.

† Applies to zippers employing metallic parts, except those of stainless steel or equivalent corrosion-resistant materials.

SECTION 6 WEBBING CLOSURES AND ADJUSTERS

6.1 CONSTRUCTION

Closures and adjusters, such as buckles and slide adjusters shall comply with the criteria specified in Table 6.1 when subjected to the tests specified in that table.

6.2 PERFORMANCE

6.2.1 Tensile strength

The assembly shall consist of the hardware component with two lengths of webbing 150 mm in length attached as they are for use.

A constant rate-of-extension tensile testing machine with a rate of extension of 300 ± 10 mm/s and jaws not less than the width of the webbing shall be used.

A tensile load shall be applied until breakage, disengagement, slipping in excess of 75 mm or a similar condition occurs.

The tensile load at failure shall be reported.

6.2.2 Strength/slippage

An assembly consisting of the hardware component with webbing attached as for use shall be subject to a tensile load for 10 min using either the fixed straight-length method or the loop assembly methods as follows:

(a) *Fixed straight-length method*

Two lengths of webbing not less than 600 mm in length shall be used to make up the assembly as shown in Figure 6.1(a).

One end of the assembly shall be secured to a fixed point and a steady load shall be applied to the other.

(b) *Loop assembly method*

The assembly shall be made up with a single piece of webbing not less than 1200 mm in length as shown in Figure 6.1(b).

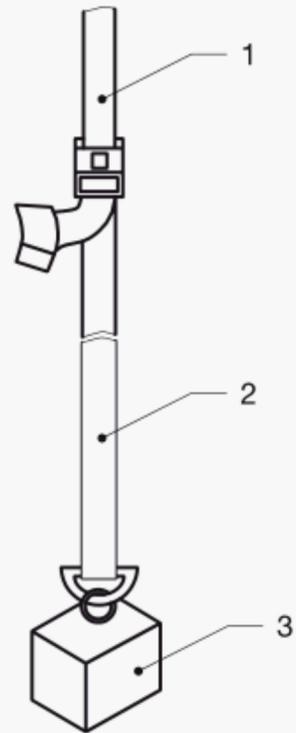
The assembly loop shall be supported vertically over a cylinder and a second cylinder shall provide the means for applying a steady load [see Figure 6.1(b)].

6.2.3 Tab disengagement

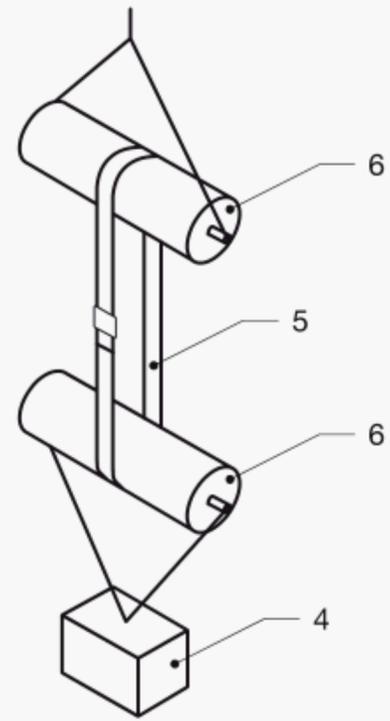
The assembly shall consist of the hardware component with two lengths of webbing not less than 600 mm in length attached as for use.

One end of the assembly shall be secured to a rigid fixture and a mass of 2.25 kg shall be attached to the other end.

The mass shall be raised 300 mm above the attachment point and shall be released to apply a shock load to the assembly.



(a) Fixed straight-length method



(b) Loop assembly method

Legend

1 = 600 mm length body strap rigged to hoist and hardware

2 = 600 mm length body strap rigged to weight No. 1

3 = Weight No. 1 (for fixed straight-length test)

4 = Weight No. 2 (for closed loop test, twice weight No. 1)

5 = 1200 mm length body strap rigged to hardware

6 = Cylinder of 124 mm diameter

FIGURE 6.1 STRENGTH/SLIPPAGE TEST ASSEMBLIES

TABLE 6.1
WEBBING CLOSURES AND ADJUSTERS

Property	Conditioning	Test method	Sample size compliance criteria
Tensile strength	(a) Standard conditioning in accordance with Clause 1.4.1 (b) 70 h immersion in diesel fuel according to EN 590* (c) 70 ±2°C for 7 days (d) -30 ±2°C for 24 h† (e) 96 h of neutral salt spray in accordance with ISO 9227‡ (f) Fatigue§ (g) Accelerated weathering in accordance with Clause 1.4.2	See Clause 6.2.1	After each separate conditioning (a) to (f), the tensile strength shall be not less than 890 N Also, for conditioning (b) to (g), the tensile strength shall be not less than 60% of that determined after conditioning (a)
Slippage strength	(a) Standard conditioning in accordance with Clause 1.4.1 (b) 2 min water soak	See Clause 6.2.2	After conditioning (a) and (b), the assembly shall withstand a tensile force of not less than 890 N for the fixed straight-length assembly or 1780 N for the loop assembly for 10 min without breaking, distorting or slipping more than 25 mm
Tab disengagement	Standard conditioning in accordance with Clause 1.4.1	See Clause 6.2.3	The tab shall remain closed after shock loading as specified

* Samples shall be blotted dry to remove surface moisture and shall rest for 30 min at ambient room temperature before determining the tensile strength.

† Immediately following removal from the cold chamber, the samples shall be dropped using different orientations onto a concrete floor five times from a height of 1800 mm. Each sample shall then to be manually operated five times and then examined for signs of cracking. The samples shall then to be returned to the cold chamber for 15 min. The samples shall then to be individually removed and subjected to the ultimate breaking strength test and strength/slippage test.

‡ For items incorporating metal components.

§ Each flexible or moveable tab of polymeric part shall be mechanically operated 5000 cycles at a rate to 1 cycle/s before determining the tensile strength. The tab shall be completely engaged/disengaged. Also, for hardware which is designed to separate into two parts (i.e. buckles), the parts shall completely engaged/disengaged. In addition, the samples shall be manually operated 5 times prior to the ultimate breaking strength test and strength/slippage test.

SECTION 7 WHISTLES

Whistles shall be non-metallic and robust in construction, free from all burrs, and not rely on any moving part for the production of sound.

Three specimens shall be tested by being blown as hard as possible by a subject of between 20 and 30 years of age and free from all known impairments to pulmonary function, in an outside and open area during calm clear weather. When measured at a distance of 5 ± 0.1 m directly in front of the whistle, the sound generated by the whistle exceeds at least for an instant 100 dB(A) at a predominant frequency of 2 ± 0.1 kHz.

The whistle shall also be shown to be capable of producing sound in air immediately following immersion in fresh water. The whistle shall be attached to cord or line of a length sufficient to permit its use, which shall in turn be attached securely to the lifejacket or buoyancy aid. It shall be stowed on the device in such a way that the performance of the lifejacket is not affected, but so that they can be removed from use with either hand of the wearer, and can be stowed by the wearer.

SECTION 8 FOAM FLOTATION MATERIAL

8.1 THERMAL STABILITY

When tested as follows the change in volume of the foam flotation material shall not be greater than 5% and there shall be no cracking, dissolution or change in mechanical properties:

- (a) Condition samples of foam flotation material 200 ± 2 mm by 200 ± 2 mm and 20 ± 2 mm thick in air at $23 \pm 2^\circ\text{C}$ and $50 \pm 5\%$ relative humidity for not less than 24 h. Where the buoyancy material is of granular form, or consists of sheets thinner than 20 mm, then either a number of layers shall be used to achieve a minimum thickness of 20 mm, or a minimum volume of material of 100 cm^3 shall be tested as appropriate.
- (b) Determine the volume of the sample. Where the volume is determined by displacement of water, the sample shall be conditioned in air at $23 \pm 2^\circ\text{C}$ and a relative humidity of $50 \pm 5\%$ for 24 ± 0.5 h.
- (c) Place the sample on a flat surface in an oven maintained at a temperature of $60 \pm 2^\circ\text{C}$ for a period of 68 ± 0.5 h.
- (d) Remove the sample from the oven and place it on a flat surface at $23 \pm 2^\circ\text{C}$ and a relative humidity of $50 \pm 5\%$ for 16 ± 0.5 h.
- (e) Determine the volume of the sample and calculate the percentage change in volume.
- (f) Examine the sample for cracking, dissolution and change of mechanical properties.

8.2 BUOYANCY RETENTION FACTOR

When tested as follows the loss of buoyancy of foam flotation material shall be not greater than 10%.

The procedure is as follows:

- (a) Measure the initial buoyancy of a sample of foam buoyancy material 100 ± 2 mm \times 100 ± 2 mm.
- (b) Determine the corrected initial buoyancy of the sample as follows:

$$B_{ci} = B_i \times \frac{P_i}{101.3} \times \frac{293.15}{T_i + 273.15}$$

where

B_{ci} = the corrected initial buoyancy, in newtons

B_i = the initial measured buoyancy, in newtons

P_i = the initial atmospheric pressure, in kilopascals

T_i = the initial temperature, in degrees Celsius

- (c) Immerse sample in fresh water at ambient temperature under a flat plate and compress it at a rate of 200 mm/min until a pressure of 50 kPa has been reached.
- (d) Mark the point when the pressure of 50 kPa is reached.
- (e) Allow the sample to decompress completely.
- (f) Repeat the compression cycle four times using the marked point as the limit of compression.

- (g) Remove the sample from the water and dry it for 7 d in air at $23 \pm 2^\circ\text{C}$ and $50 \pm 5\%$ relative humidity.
- (h) Repeat the compression cycles in air 500 times. If permanent deformation occurs adjust the start point for each cycle in order to keep the decompression/compression time equal during the whole test period.
- (i) Place the sample in air at $23 \pm 2^\circ\text{C}$ and $50 \pm 5\%$ relative humidity for not less than 3 d.
- (j) Measure the final buoyancy determine the corrected final buoyancy as follows:

$$B_{CF} = B_F \times \frac{P_F}{101.3} \times \frac{293.15}{T_F + 273.15}$$

where

- B_{CF} = the corrected final buoyancy, in newtons
- B_F = the final measured buoyancy, in newtons
- P_F = the final atmospheric pressure, in kilopascals
- T_F = the final temperature, in degrees Celsius

- (k) Determine the loss of buoyancy as follows:

$$B_L = \frac{B_{Ci} - B_{CF}}{B_{Ci}} \times 100$$

where

- B_L = loss of buoyancy, as a percentage
- B_{Ci} = corrected initial corrected buoyancy, in newtons
- B_{CF} = corrected final buoyancy, in newtons

8.3 TENSILE STRENGTH

When foam buoyancy material that forms a structural part of a lifejacket (not retained by a cover fabric) is tested in accordance with ISO 1926, the tensile strength shall be not less than 140 kPa.

8.4 RESISTANCE TO OIL

When foam buoyancy material is tested as follows there shall be no visible change in volume, softening or deterioration and the loss of tensile strength shall be not greater than 25%.

A dumbbell-shaped sample in accordance with ISO 1926 is immersed for 70 h in ASTM Reference Oil No.2 at $23 \pm 2^\circ\text{C}$ and after removal and drying compared with an unconditioned sample of the same dimensions for evidence of volume change, softening and deterioration followed by tensile testing in accordance with ISO 1926.

8.5 COMPRESSION DEFLECTION

When foam buoyancy material is tested as follows the pressure required to compress the material to 75% of its thickness shall be not less than 7 kPa:

A sample of foam flotation material $100 \pm 3 \text{ mm} \times 100 \pm 3 \text{ mm}$ is compressed at a rate of 10 mm/min to 50 mm/min in a compression testing machine by 25% of its original thickness and the compression deflection pressure is determined as follows:

$$P_{CD} = \frac{F}{A}$$

where

- P_{CD} = the compression deflection pressure, in kilopascals
 F = the force required to compress the specimen by 25% of the thickness, in kilonewtons
 A = is the specimen compression contact surface area, in square metres

8.6 COLD FLEXIBILITY

When foam buoyancy material is tested as follows there shall be no cracking when examined under a magnification of 5×.

Within 5 s of conditioning for 4 h at a temperature of $18 \pm 1^\circ\text{C}$ the longest dimension of a sample of foam buoyancy material is wrapped around a bar with a diameter not greater than twice the thickness of the foam and examine for cracking under a magnification of 5×.

8.7 POLYMERIC FOAM COATINGS

8.7.1 Performance

Structural polymeric foam coating material shall comply with the requirements specified in Table 8.1.

8.7.2 Cold flexibility

The cold flexibility performance of polymeric foam coating material shall be determined as follows:

A sample of polymeric foam coating, 25 mm × 200 mm is bent within 5 s of conditioning at $-30 \pm 2^\circ\text{C}$ for 4 h around steel mandrel 10 mm in diameter that has been conditioned with the sample. The sample is examined for cracking or other damage under 5× magnification.

8.7.3 Blocking resistance

The blocking resistance of polymeric foam coating material shall be determined as follows:

- (a) Fold a sample of polymeric foam coating, 200 mm × 200 mm, along its centre-line with external surfaces laid together.
- (b) Place sample in a chamber at a temperature of $82 \pm 2^\circ\text{C}$ under a load of 50 N per 50 cm² for 30 min.
- (c) Remove sample from chamber and allow to cool to ambient temperature for 2 h.
- (d) Unfold the sample and examine it for blocking under 5× magnification.

Blocking is defined as follows:

- (i) *No blocking* Surfaces are free or adhere slightly.
- (ii) *Slight blocking* Surfaces need to be lightly peeled to separate.
- (iii) *Blocking* Surfaces separate with difficulty.

8.7.4 Water absorption

The water absorption property of polymeric foam coating material shall be determined as follows:

A weighed sample, 25 mm × 75 mm, of polymeric foam coating material is immersed in grade 3 water complying with ISO 3696 at $21 \pm 2^\circ\text{C}$ for 214 h and weighed again after removal from the water and the removal of adherent water.

8.7.5 Volatile loss

The volatile loss of polymeric foam coating material shall be determined as follows:

A weighed sample of polymeric foam coating material is placed in a chamber at $105 \pm 2^\circ\text{C}$ for 48 h, cooled to room temperature for 2 h and weighed again.

TABLE 8.1
POLYMERIC FOAM COATING MATERIAL

Property	Conditioning	Test method	Compliance criteria
Tensile strength and elongation	(a) Standard conditioning in accordance with Clause 1.4.1 (b) Accelerated weathering in accordance with Clause 1.4.2 (c) At $70 \pm 2^\circ\text{C}$ for 7 days	ASTM D882 Method A	After conditioning (a) and (c), the average tensile strength for each direction shall be not less than 8.3 Mpa and the breaking load for each direction shall be not less than 25 N or 100 f/mm, whichever is the greater. After conditioning (a) and (b), the elongation shall be not less than 320%. After conditioning (b) and (c), the tensile strength shall be greater than 60% of the strength determined after conditioning (a) and (c).
Tear resistance	(a) Standard conditioning in accordance with Clause 1.4.1 (b) Accelerated weathering in accordance with Clause 1.4.2 (c) At $70 \pm 2^\circ\text{C}$ for 7 days	ISO 4674-1 Method B	After conditioning (a) and (c), the tear strength for each direction shall be not less than 13 N/mm. After conditioning (b), the tear strength for each direction shall be not less than 60% of the strength determined after conditioning (a) and (c).
Cold flexibility	At $-30 \pm 2^\circ\text{C}$ for 4 h	See Clause 8.7.2	There shall be no cracking or other damage when examined under $5\times$ magnification
Blocking resistance	At $82 \pm 2^\circ\text{C}$ for 30 min	See Clause 8.7.3	There shall be no evidence of blocking or surface damage as defined in Clause 8.7.3
Adhesion to foam	Standard conditioning in accordance with Clause 1.4.1	ISO 2411 Method 1	The adhesion of the foam to the film for each direction shall be not less than 7 N/cm or the foam shall tear in lieu of peeling
Water absorption	At $21 \pm 2^\circ\text{C}$ for 24 h	See Clause 8.7.4	The increase in mass shall be not greater than 0.5%
Volatile loss	At $105 \pm 2^\circ\text{C}$ for 48 h	See Clause 8.7.5	The mass loss shall be not greater than 8.0%

8.8 KNITTED FABRIC LAMINATED TO FOAM FLOTATION MATERIAL

Structural knitted fabric laminated to foam flotation material either one sided or two sided, shall comply with the requirements specified in Table 8.2.

Where the foam provides buoyancy for the lifejacket, it shall comply with the requirements for foam buoyancy material except that the properties shall be assessed in the thickness provided and not stacked as required by the test methods.

TABLE 8.2
REQUIREMENTS FOR KNITTED FABRIC LAMINATED TO FOAM

Property	Conditioning	Test method	Compliance criteria
Tensile strength	Standard conditioning in accordance with Clause 1.4.1	ISO 1421 Method 2	The tensile strength shall be not less than 310 N for each direction
Tear resistance	Standard conditioning in accordance with Clause 1.4.1	ISO 4674-1 Method B	The tear strength shall be not less than 25 N
Adhesion to foam	Standard conditioning in accordance with Clause 1.4.1	ISO 2411 Method 1	The adhesion of the foam to the film for each direction shall be not less than 7 N/cm or the foam shall tear in lieu of peeling

SECTION 9 INFLATION CHAMBER MATERIALS

Woven compartment materials for hybrid and fully inflatable lifejackets shall comply with the criteria specified in Table 9.1 when subjected to the tests therein.

TABLE 9.1
INFLATION CHAMBER MATERIALS

Property	Conditioning	Test method	Compliance criteria
Tensile strength (woven fabrics only)	(a) Standard conditioning in accordance with Clause 1.4.1 (b) 168 h at 70°C (c) Accelerated weathering in accordance with Clause 1.4.2	ISO 13934-2 Gauge length 75 ±1.0 mm Rate of extension 300 ±10 mm/min	After conditioning (a), the tensile strength shall be not less than 930 N in the warp direction and 800 N in the weft direction. After conditioning (b), the tensile strength shall be not less than 90% of the values determined following conditioning (a). After conditioning (c) the tensile strength shall be not less than 60% of the values determined following conditioning (a)
Trapezoid tear strength (woven fabrics only)	(a) Standard conditioning in accordance with Clause 1.4.1 (b) 168 h at 70°C	ISO 9073-4	After conditioning (a), the tear strength shall be not less than 45 N in the warp direction and 36 N in the weft direction. After conditioning (b), the tear strength in each direction shall be not less than 90% of the values determined following conditioning (a)
Permeability	(a) Standard conditioning in accordance with Clause 1.4.1 (b) After accelerated ageing 168 h at 70°C (c) 360 h at 65 ±1°C and 95% relative humidity	ISO 7229 Using CO ₂	After conditioning (b) and (c), the permeability for each direction shall not be greater than 110% of that determined following conditioning (a)
Abrasion resistance (Woven fabrics only)	(a) Standard conditioning in accordance with Clause 1.4.1 (b) After abrasion resistance, 9 N pressure and 100 000 double rubs	Appendix A	Following conditioning (a) and (b) except for a material intended for use under a fabric envelope or otherwise protected, the abrasion resistance in each direction shall be not less than 75% of the values determined following conditioning (a)
Flexibility	Standard conditioning in accordance with Clause 1.4.1	ISO 7854 Method A	No cracking after 9000 cycles
Adhesion strength*	Standard conditioning in accordance with Clause 1.4.1	ISO 2411	After conditioning, the mean coating adhesion strength shall be not less than 7 N/cm in both directions

* Applies to coated fabrics with a coating of 185 g/m² or more and where the base fabric or scrim does not comply with the applicable strength requirements for uncoated fabric.

SECTION 10 INFLATION SYSTEMS FOR LIFEJACKETS

10.1 GENERAL

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

Automatic inflation systems shall initiate firing in automatic mode within 5 s of immersion.

The force required to operate the pull toggle on an inflation operating head shall be not greater than 75 N, but shall be greater than 20 N when tested and when pulled in the direction stated by the manufacturer.

Any exposed edge or projection of an inflation system shall not be so sharp as to damage the material of an inflatable compartment or constitute a risk of injury to persons during intended use.

Inflation systems shall be non-return, allowing the inflation gas to flow in the direction that supplies the buoyancy chambers only, unless intentionally over-ridden.

10.2 METALLIC COMPONENTS

After exposure to a neutral salt spray in accordance with ISO 9227 for 720 h, metallic components of an inflation system, except for the following, shall be capable of performing their intended functions and there shall be no visible pitting or other damage to the surfaces:

- (a) An expendable component, such as a gas cylinder when the component is provided with a durable zinc coating or an equivalent protection against corrosion.
- (b) A component where failure does not affect the ability of the device to meet the requirements of this Standard.
- (c) Sacrificial anodes, where fitted.

Combination of metal components shall be compatible unless otherwise protected against galvanic corrosion.

10.3 DEFLATION

Inflatable lifejackets shall have a simple method for deflation.

10.4 ORAL INFLATION SYSTEMS

The oral inflation tube shall be free from burrs and shall incorporate an effective non-return valve. The non-return valve shall open at an applied pressure of between 1.0 kPa and 3.0 kPa.

Where the non-return valve can be separated from the tube, the force required to separate the components shall be not less than 90 N

The minimum airflow through the oral inflation tube shall be not less than 100 L/min with an inlet pressure of 7.0 kPa.

An oral inflation system shall be provided with a pressure-actuated inlet valve. The inlet valve shall not require a pull, push, or other mechanical action to open the inflation valve.

An oral inflation mechanism shall not be able to be locked in open or closed position. A friction fit dust cap shall not be used to lock the mechanism open.

A mouthpiece for an oral inflation system shall not contain the following:

- (a) Lead compounds of which the lead content exceeds 0.5% of the total mass of the contained solids (including pigments, film solids, and driers).
- (b) Compounds of antimony, arsenic, mercury, or selenium of which the metal content individually or in total exceeds 0.06% by mass of the contained solids (including pigments, film solids, and driers).
- (c) Barium compounds of which the water-soluble barium exceeds 1% of the total barium.

10.5 ACTUATION AND REARMING OF MANUAL AND AUTOMATIC INFLATION SYSTEMS

Rearming of a manual or automatic inflation system shall not require the use of tools, unless the tool is a non-detachable part of the inflation system or is provided with every inflation system rearm kit.

Devices shall be designed such that only the proper rearming sequence is possible and only the correct component orientation is achieved for systems in which the correct rearming of a manual or automatic inflation system is dependent upon the sequence of rearming actions or the orientation of user situated components. For example, an automatic system, which utilizes a water-sensing element whose orientation within the device is critical to the proper functioning of the device, shall be designed such that it can only be installed in the correct orientation.

A manual inflation system shall be capable of being actuated by one deliberate action by the user.

A manual inflation system shall be designed so that the manual system cannot be reset without removing the used gas cylinder.

An automatic inflation system shall not permit installation of a full gas cylinder unless the system is reset.

The pull mechanism of a manual inflation system shall be of a highly visible colour.

10.6 MEANS FOR VERIFICATION OF MECHANISM OPERATION

A manual or automatic inflation system shall be designed so that the user is capable of testing the system during rearming to verify that all mechanisms are correctly installed using only components that are integral to the device and without discharging a cylinder.

10.7 INDICATORS

Automatic and manual inflation systems shall be provided with status indicators as follows:

- (a) The inflation system shall incorporate a cylinder seal indicator. The indicator shall be integral to the device or inflation-medium container and reset to an armed or 'ready' condition upon correct installation of a full cylinder.
- (b) Status indication shall provide information to the user as to whether the device is correctly armed. The readiness of the system shall be displayed using single- or multiple-point status indicator(s).
- (c) Status indicators shall be designed to provide a visual indication of when the system is ready for use.
- (d) An armed or 'ready' condition shall be indicated by the colour green. An unarmed or 'not ready' condition shall be indicated by the colour red. The system shall only be ready for use when all indicators are green.

- (e) All status indicators shall be grouped or located such that when installed on a device in their intended position, they can be viewed simultaneously and shall be readily visible.
- (f) Electronic status indicators shall be provided with a means to test the working condition of the circuitry and the adequacy of the power supply, unless the device has a prominent battery service marking, visible within the indicator, confirming an expiration date to the user.

SECTION 11 GAS CYLINDERS

11.1 GENERAL

11.1.1 Cylinder body

The cylinder shall be of seamless construction manufactured by deep drawing and forming, or from seamless tube with formed ends. No attachments (other than the welded cap and label, if used) shall be welded/screwed or affixed in any manner to the cylinder. The stresses induced at the test pressure shall be less than the yield point of the material of the cylinder and the cylinder shall show no permanent distortion after the application of the test pressure.

11.1.2 Cap

The cap shall incorporate a central pierceable area having a minimum diameter of—

- (a) 4 mm for cylinders with ½ inch 20 UNF threaded neck; and
- (b) 2.5 mm for cylinders with 3/8 inch 24 UNF threaded neck.

The cap shall be welded to the neck opening after filling and the weld shall be leak free.

The cap may be designed to serve as a pressure relief device. The relief pressure shall exceed the test pressure, and be less than the burst pressure.

11.1.3 Gas charge

The mass of the gas charge shall be as stated. When the gas is carbon dioxide the filling density shall not exceed 0.75 kg/L. When a permanent gas, such as nitrogen, is used the maximum pressure in the cylinder shall not exceed 20 MPa at 15°C.

11.1.4 Surface protection

The outer surfaces shall be protected against corrosion by any suitable environmentally acceptable means. Cadmium shall not be used. The surfaces shall be smooth and free of any defects likely to adversely affect the integrity of the cylinder. Shot blasting or peening of the outer surface is permitted.

11.2 MATERIALS

11.2.1 Cylinder body

The cylinder body shall be of low carbon steel (max. 0.55% C) made by the basic oxygen process or in an electric furnace, fully killed quality with non-ageing properties or austenitic stainless steel. Aluminium shall not be used.

11.2.2 Cap

The cap material shall be steel and may be carbon steel, low alloy steel or austenitic stainless steel suitable for the production processes and for the use intended.

11.2.3 Gas

Carbon dioxide shall have a purity equal to or greater than 99.5% and a dew point equal to or less than -45°C. Where other gases are used they shall not be flammable or more toxic, nor shall they generate compounds formed by interaction with water buoyancy compartment walls and the like, that are flammable or more toxic than carbon dioxide.

11.3 PERFORMANCE

11.3.1 Proof pressure

11.3.1.1 *CO₂-filled cylinder*

When an hydraulic pressure is applied at a rate not greater than 2 MPa/s to a cylinder intended to be filled with CO₂ to a maximum of not less than 25 MPa and held for not less than 1 min, there shall not be any damage or distortion to the cylinder.

11.3.1.2 *Permanent gas-filled cylinders*

When an hydraulic pressure is applied at a rate not greater than 2 MPa/s to a cylinder intended to be filled with a permanent gas to a maximum of not less than 1.5 times the filling pressure and held for not less than 1 min, there shall not be any damage or distortion to the cylinder.

11.3.2 Burst pressure

When an hydraulic pressure is applied at a rate not greater than 2 MPa/s until failure the burst pressure shall not be less than 56 MPa and the burst shall be ductile.

11.4 MARKING

The cylinders shall be marked, directly on to the surface by any suitable means, or on a label fixed to the surface. The markings shall be permanent, legible and durable when subjected to normal handling, transport and exposure to the environment over the life of the cylinder and shall minimally include the following statement:

- (a) Nominal gas charge or gas pressure, chemical symbol of gas.
- (b) Minimum gross weight of cylinder.
- (c) Manufacturer's symbol, part number, country, month/year of filling.
- (d) Cautionary statements, e.g. do not heat.

A manual or automatic inflation system shall be designed so that the user is capable of testing the system during rearming to verify that all mechanisms are correctly installed using only components that are integral to the device and without discharging a cylinder.

APPENDIX A

METHOD FOR DETERMINING THE ABRASION RESISTANCE OF INFLATION
CHAMBER FABRIC

(Normative)

A1 PRINCIPLE

Fabric specimens are subject to unidirectional rubbing action under controlled conditions of pressure, tension and abrasive action and the abrasion resistance is assessed by determining the loss of tensile strength after abrasion.

A2 APPARATUS

The following apparatus is required:

- (a) As oscillating cylinder abrasion resistance testing machine as described in ASTM D4157.
NOTE: A Wyzenbeek abrasion resistance testing machine has been found to be suitable.
- (b) A constant rate-of-extension tensile testing machine with a rate of extension of 300 ± 10 mm/s.
- (c) No.8 cotton duck (610 ± 25 g/m²) abradant.

A3 PROCEDURE

The procedure shall be as follows:

- (a) Fix the cotton duck abradant to the oscillating cylinder of the abrasion resistant testing machine.
- (b) Place the test sample in the abrasion testing machine under a load of 9 N and with a tension of 27 N.
- (c) Subject the test sample to 250 continuous abrasion cycles.
- (d) Remove the sample from the abrasion testing machine and determine its tensile strength (A) with the abraded portion located midway between the jaws of the testing machine.
- (e) Determine the tensile strength (B) of an unabraded sample of fabric from the same batch.
NOTE: It is recommended that the tensile strengths of the abraded and unabraded samples be determined by the same operator using the same tensile testing machine.
- (f) Determine change of tensile strength with the following equation:

$$\theta = \left(\frac{B - A}{B} \right) 100$$

where

- θ = change of tensile strength, as a percentage
- B = the tensile strength before abrasion, in newtons
- A = the tensile strength after abrasion, in newtons

A4 REPORT

The change of tensile strength shall be reported.

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