

Subject 1517

January 19, 2007

SUMMARY OF TOPICS

The following changes in requirements are being proposed:

- 1. An editorial new Third Edition of the Standard for Hybrid Personal Flotation Devices, UL 1517.**

STP BALLOTS DUE: March 20, 2007

COMMENTS DUE: March 20, 2007

- 1. An editorial new Third Edition of the Standard for Hybrid Personal Flotation Devices, UL 1517.**

RATIONALE

UL is proposing a new edition of UL 1517. The proposed new edition is a periodic re-issuance and includes the following type editorial revisions:

The units of measurement, undated reference, and component paragraphs which are common standard requirements have been added to the introduction;

Wording changes have been made in order to adhere to standards writing style; and

Sections, paragraphs, and corresponding references may have been renumbered.

If the new edition is accepted by the Standards Technical Panel for Personal Flotation Devices, STP 1123, and is adopted, the standard will gain first time approval as an American National Standard.

PROPOSAL

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INTRODUCTION

1 Scope

1.1 These requirements cover wearable buoyant devices having:

- a) At least one compartment that relies upon inflation by gas or other medium to provide buoyancy, and
- b) A quantity of inherently buoyant material.

1.2 The hybrid devices covered by this standard are intended for United States Coast Guard (USCG) approval under 46 CFR 160.077 as recreational use devices.

2 Units of Measurement

2.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

3 Undated References

3.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

4 Glossary

4.1 For the purpose of this standard the following definitions apply.

4.2 AUTOMATIC INFLATION SYSTEM – A system that automatically inflates one or more compartments when the buoyant device is submerged in the water, and operates independently of any action by the wearer.

4.3 BELT – A device that wraps around the torso but does not cover the shoulders or arms in the deflated condition.

4.4 CLOSURES

a) Primary – A means of securing the device onto the body so that the device can be expected to function substantially in the intended manner without the use of any other means of fastening the device onto the body.

b) Secondary – A closure that:

- 1) If it is the only closure that is closed on the device, does not result in the device being donned as intended; and
- 2) Is not usually required to be closed in order for the device to substantially comply with the requirements in this standard

4.5 DESIGN PRESSURE RANGE – The range of pressures, as specified by the manufacturer, to which a compartment may be inflated to provide the intended in-water performance.

4.6 FACE PLANE ANGLE – The angle, relative to the surface of the water, of the plane formed by the most forward part of the forehead and chin of a wearer floating in the attitude of static balance in which respiration is least likely to be impeded.

4.7 FOAM – Closed-cell foamed polymeric material.

4.8 FREEBOARD – A distance measured perpendicularly from the surface of the water to the lowest point where the wearer's respiration may be impeded. The freeboard of a test subject in the water is measured with the subject at FRC (see 4.9) and in the attitude of static balance in which respiration is least likely to be impeded.

4.9 FUNCTIONAL RESIDUAL CAPACITY (FRC) – The amount of lung volume that a person has remaining at the bottom of the normal breathing cycle when at rest.

4.10 FULL INFLATION – A chamber inflated to any value of pressure within the design pressure range.

4.11 INFLATABLE COMPARTMENT – A container that is inflated by a gas or other medium through an automatic, manual, or oral system.

4.12 INHERENT BUOYANCY – That buoyancy provided by means that does not rely on an inflation system; that is, the buoyancy provided by inherently buoyant material.

4.13 INSERT – A quantity of inherently buoyant material that has been cut or formed for insertion into a device.

4.14 JACKET – A device having sleeves.

4.15 LOCK STITCH – A stitch that will not unravel when a force is applied to any of the threads forming the stitch, such as the stitch designated as Type 301 in Federal Standard No. 751a (January 25, 1965).

4.16 MANUAL INFLATION SYSTEM – A system that inflates one or more compartments when a mechanism is actuated by a deliberate manual action on the part of the wearer, such as by the pulling of a lanyard.

4.17 ORAL INFLATION SYSTEM – A system through which a wearer exhales air to inflate a compartment.

4.18 PERFORMANCE TYPES – The intended performance of a hybrid device, when fully inflated, is classed as one of the following:

a) Type II – Turns most unconscious wearers from a face-down position in the water to a position in which the wearer's respiration is not impeded.

b) Type III – Supports a conscious wearer in an upright position in the water, and has no tendency to turn a slightly back of vertical wearer (see Figure 16.1) face-down in the water.

4.19 REFERENCE VEST – An AK-1 PFD constructed in accordance with 46 CFR 160.047 except as follows:

a) Each front insert has:

1) At least 8.25 ounces (234 g) of kapok; and

2) A total volume displacement in water that provides a buoyancy of 9.0 ± 0.25 pounds-force (40 ± 1 N).

b) The back insert has:

1) At least 5.5 ounces (150 g) of kapok; and

2) A total volume displacement in water that provides a buoyancy of 6.0 ± 0.25 pounds-force (27 ± 1 N).

4.20 SECOND-STAGE DONNING – Donning or adjustment that is required, after the device is inflated while being worn, to achieve the intended flotation characteristics.

4.21 SERVICEABLE – Exhibits no signs of functional deterioration (deformation of hardware, a rip or tear, a loose seam, or the like) sufficient to make the device unacceptable for continued intended use.

4.22 STRUCTURAL SEAM – A seam that serves a functional purpose, as distinguished from a decorative purpose.

4.23 TURNING TIME – The time required for a device to turn a face-down wearer to a position in which the wearer's respiration is not impeded.

4.24 UNIVERSAL SIZE – A size of device constructed to fit persons in the 5th through 95th percentile of the adult U. S. population with respect to height and girth.

4.25 VEST – A device that covers the shoulders but has no sleeves. A yoke-style device is considered to be a vest.

5 Components and Materials

5.1 A component of a device covered by this standard shall (see Table 5.1):

a) Comply with the requirements in the Standard for Components for Personal Flotation Devices, UL 1191, except as specified in Table 5.2; or

b) If not covered by specific requirements in UL 1191, be acceptable when investigated with respect to the application. In addition, if the USCG has specific requirements for the component, it shall comply with those requirements.

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Table 5.1
Component requirements

Component	Application	Applicable UL 1191 ^a (USCG) requirements
Body strap	Primary closure	Webbing, Section 7
	Secondary closure	Tie Tape and Reinforcing Tape, Section 9
Drawstrings	Secondary closure	Tie Tape and Reinforcing Tape, Section 9
Fabric	Envelope ^b	Fabrics for Wearable Devices, Section 5 (Type V)
	Cover for inflatable compartment ^c	Fabrics for Wearable Devices, Section 5 (Type V)
Foam	Buoyant material ^d	Closed-Cell Foamed Polymeric Material, Section 13
Hardware	Primary closure	Hardware, Section 10
Kapok	Buoyant material	(46 CFR 164.003)
Lacing	Any	Lacing, Section 8
Polymeric film	Kapok enclosure	Plastic Film for Kapok or Fibrous Glass Enclosures, Section 14
Reflective fabric or tape	Any	(46 CFR 164.018)
Survivor locating light	Any	(46 CFR 161.012)
Thread	Structural seam	Thread, Section 3
Tie tape	Secondary closure	Tie Tape and Reinforcing Tape, Section 9
Vinyl-dip coating	Any	Vinyl-Dip Coatings, Section 12
Zipper	Primary closure	Zippers, Section 11
Any material used to form an inflatable compartment		Compartment Materials for Hybrid Devices, Section 17
Any component (valve, cartridge, tube, or the like) used in an inflation system ^e		Inflation Systems, Section 18
NOTE: Not applicable to nonfunctional (decorative) components. ^a The requirements for Components for Personal Flotation Devices, UL 1191. ^b Does not reinforce or restrain an inflatable compartment. ^c Also, see Abrasion Resistance Test, Section 35, of this standard. ^d Material relied upon for compliance with the requirements in 19.1.1 of this standard. ^e Also includes overpressure relief valves and deflation valves.		

Table 5.2
Component properties

Applicable UL 1191 requirements			
Component	Test ^a	Conditioning	Minimum required values ^{a,b}
Fabric	Breaking Strength	As-received and after 100 hours of accelerated weathering	90 pounds-force (400 N) average in direction of both greater thread count and lesser thread count ^c
	Tear Strength	As-received	8.5 pound-force (38 N) in direction of both greater thread count and lesser thread count ^d
Hardware	Strength	After salt spray exposure (metal), as-received and after 100 hours of accelerated weathering and high and low temperature exposures (plastic)	225 pounds-force (1000 N)

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Table 5.2 Continued

Applicable UL 1191 requirements			
Component	Test ^a	Conditioning	Minimum required values ^{a,b}
Webbing	Breaking Strength	As-received and after 100 hours of accelerated weathering	400 pounds-force (1800 N) average
^a Also, see 5.3 and 5.5. ^b Also, shall retain at least 60 percent of the as-received breaking strength after accelerated weathering conditioning. ^c A fabric used as an inner liner need only have a 70 pounds-force (311 N) average in both directions. ^d A fabric used as an inner liner need only have a 6.0 pounds-force (27 N) average in both directions.			

5.2 A component covered in Table 5.2 shall have at least the minimum properties specified in Table 5.2 when tested in accordance with the applicable specifications in the requirements for Components for Personal Flotation Devices, UL 1191.

5.3 A nonmetallic component of a hybrid device shall retain at least 40 percent of its as-received strength after being subjected to 300 hours of light and water exposure in accordance with Method I of the Standard Practice for Operating Light Exposure Apparatus (Carbon-Arc Type) With or Without Water for Exposure of Nonmetallic Materials, ASTM G23, using apparatus designated Type D, DH, or E in ASTM G23.

Exception: This requirement does not apply to fabric used as the inner liner on the device, if the liner is protected from exposure to the weather when the device is worn as intended.

5.4 Unless inherently resistant to fungus, a nonmetallic component of a hybrid device shall retain at least 90 percent of its strength after being subjected to the mildew resistance test specified in Federal Test Method, Standard 191 (Method 5762) when untreated cotton is used as the control specimen. In addition, the gas transmission rate of the inflation chamber shall not increase by more than 10 percent. Covered materials may be tested with the covering.

5.5 A metallic component of a hybrid device shall be formed from AISI 300 or 400 Series stainless steel or other material having at least equivalent resistance to the corrosive effects of salt spray exposure.

Exception: An expendable component (for example, a gas cylinder) need not comply with this requirement, and shall be provided with a zinc or cadmium plating, or equivalently protected against corrosion.

5.6 Metals shall be used in combinations that are galvanically compatible.

5.7 An exposed edge or projection of a component shall not be sufficiently sharp to damage the material of an inflatable compartment or constitute a risk of injury to persons during intended use.

5.8 Referee measurements necessary to determine compliance with the requirement in 5.7 are to be those described in the requirements for Tests for Sharpness of Edges on Equipment, UL 1439.

5.9 Adhesive shall be a waterproof type that is acceptable for use with the materials being bonded.

5.10 Material used in the manufacture of a hybrid device shall be new.

5.11 The inherent buoyancy of a hybrid device shall be provided by either kapok or foam.

5.12 Foam shall have a V factor of 85 or more as determined in accordance with the requirements in the Standard for Components for Personal Flotation Devices, UL 1191.

Exception No. 1: This requirement does not apply to foam that is not relied upon for compliance with the requirements in Section 19, Buoyancy and Permeability Tests, when the device complies with the requirements in Sections 15, Inherent Flotation Characteristics Test and 16, Inflated Flotation Stability Test, both with and without the foam in place.

Exception No. 2: Foam may have a V factor of not less than 80 when the device complies with the requirement in 20.2.1.

5.13 The V factor (as determined in accordance with the requirements in the Standard for Components for Personal Flotation Devices, UL 1191) of foam forward of the body axis (see Figure 16.1) shall be greater than or equal to the V factor of foam aft of the body axis.

Exception: A device that complies with the requirement in 20.2.1 need not comply with this requirement.

CONSTRUCTION

6 General

6.1 The construction and assembly of a hybrid device shall be judged with respect to its intended use in addition to the requirements in this standard.

6.2 The construction of a hybrid device shall acceptably reduce the likelihood of shifting or bunching of internal materials.

6.3 Fibrous buoyant material shall be:

- a) Completely encased in a flexible, sealed polymeric film; and
- b) Provided in at least three separate inserts in a manner that gives a distribution similar to that of the reference vest (see 4.19).

6.4 A device shall have provision for drainage in areas that may entrap water. See Water Entrapment Test, Section 21.

7 Sizing and Arrangement

7.1 General

7.1.1 A hybrid device shall not be constructed for persons weighing 90 pounds or less.

7.1.2 A hybrid device shall be constructed to fit chest sizes within a range of at least 2 inches (51 mm). A universal size device shall be constructed to fit chest sizes within the range of 30 – 52 inches (80 – 130 cm).

7.1.3 A hybrid device shall be supplied in a ready-to-use condition. A device that employs cartridges for inflation shall be provided with three spare cartridges. A device that employs an automatic inflation system shall be provided with three spare automatic-activating devices.

7.1.4 A hybrid device shall in both the deflated and fully-inflated conditions, as well as during inflation:

- a) Be as comfortable, nonrestrictive of motion, respiration, and vision, and as nonbulky for the wearer as practicable, consistent with intended use.
- b) Be such that the intended method of donning the device, including the second-stage donning, is obvious to an untrained person. A device designated as having Type II performance shall not require second-stage donning.
- c) Incorporate strapping or other means of attachment that provides a secure fit (as tight as possible without causing discomfort). See Donning and Operability Tests, Section 13, and Jump Tests, Section 14.

7.1.5 The construction of a hybrid device shall permit the device to be partially inflated to a level that provides a total buoyancy of at least 13 pounds-force (60 N) without significantly changing the appearance, fit, or comfort of the device. For the purpose of this requirement, bulging or swelling of the device that does not cause the release of snaps holding compartment flaps or the like is acceptable.

7.1.6 Hardware shall be:

- a) Arranged to facilitate operation; and
- b) Attached in a manner that reduces the likelihood of improper operation.

7.1.7 The arrangement of a hybrid device shall acceptably reduce the likelihood of snagging, such as by providing means to secure the free ends of body straps and the like.

7.1.8 A hybrid device shall not provide access to inserts by means of zippers or the like, but inflatable compartments may be removable for servicing.

7.1.9 A hybrid device shall not form channels having a tendency to direct water into the face of the wearer to a degree greater than the reference vest.

7.2 Inflation systems and compartments

7.2.1 A hybrid device shall be provided with an oral inflation system for each inflatable compartment. A device designated as having Type II performance shall be provided with both an automatic and an oral inflation system.

7.2.2 Inflation systems in addition to those required by 7.2.1 may be provided.

7.2.3 The operating mechanism, actuation means, and related components of an inflation system shall be external to the inflatable compartment the system supplies.

7.2.4 An inflatable system shall be constructed to provide the required in-water performance by the device when operated as intended both:

- a) Alone; and
- b) In any combination with other inflation systems permitted by the construction of the device.

7.2.5 An inflation system shall be located and arranged to:

- a) Be operated by either hand of the wearer in a single deliberate action (also, see 7.2.6). Moving an unsecured flap, or the like, to gain access to the actuation means is not to be considered a deliberate action. See 13.1.6.
- b) Acceptably reduce the likelihood of components abrading or otherwise damaging the inflatable compartment or compartments of the device.
- c) Be easily reset after use. A gas cylinder or similar (expendable or rechargeable) component shall not require the use of tools to be removed for servicing.

7.2.6 For an oral inflation system, the requirement in 7.2.5(a) applies with the device in any intended condition of inflation. In this regard, the term "operated" refers only to the action of bringing the inflation tube to the mouth (not to the act of inflating the device).

7.2.7 An inflatable compartment shall be provided with means to be deflated, which may be integral with or separate from any inflation system provided for the compartment. The deflation means shall be located and arranged to:

- a) Be operated by either hand without the use of tools;
- b) Reduce the likelihood of unintentional operation; and
- c) Permit reinflation of the compartment after operation.

7.2.8 For a compartment supplied by an oral inflation system:

- a) The minimum value of the design pressure range shall be not greater than 0.6 psig (4 kPa); and
- b) The maximum value of the design pressure range shall be not less than 2 psig (14 kPa) or the maximum final pressure permitted by an overpressure-relief valve, whichever is less.

7.2.9 A compartment that is supplied by more than one inflation system shall be constructed so that the combined use of the systems, in any practicable sequence, does not result in a compartment pressure greater than the maximum value of the design pressure range. This may be accomplished by the provision of an over-pressure-relief valve or other equivalent means (see 29.2.1 and 29.2.2).

Exception: The pressure may be greater than the maximum value of the design pressure range, and not greater than the value at which the compartment was tested in the over-pressure test described in 29.1.1 – 29.1.4, when the device is marked and information is provided in accordance with 38.3.3 and 41.5.

7.2.10 For the purpose of the requirement in 7.2.9, it is to be assumed that an inflation pressure of 2 psig (14 kPa) will be achieved through the oral inflation system, unless limited to a lesser value by an over-pressure-relief valve (see 29.1.1 and 29.2.2).

7.2.11 An over-pressure-relief valve shall be located and arranged to acceptably reduce the likelihood of the valve becoming blocked or otherwise rendered ineffective.

7.2.12 The location and arrangement of an automatic inflation system shall acceptably reduce the likelihood of actuation from exposure to water other than that of complete submersion. See Environmental Tests, Section 32.

7.2.13 An inflation medium shall not generate compounds more toxic than carbon dioxide, including any compounds formed from reaction with water, compartment walls, or the like.

7.2.14 Window material used as a non-load bearing component for viewing the indicator(s) of the inflation system, shall comply with the requirements of Section 31.8, of the Standard for Components for Personal Flotation Devices, UL 1191.

8 Closures and Attachment Means

8.1 The cut ends of a body strap, tie tape, belt loop, or the like shall be turned under and stitched, or the equivalent, to reduce the likelihood of unraveling. Synthetic materials may be heat sealed in lieu of being turned under.

8.2 The free end of a body strap shall be provided with means to reduce the likelihood of unintentional disengagement from the hardware, such as a tab formed by box-x stitching two 1-1/2-inch (40-mm) turn unders. See 33.1 and 33.2.

8.3 A body strap shall be prevented from disengaging by means of belt loops or equivalent means that will attach at least one end of the strap to the device (the use of only a snap is not acceptable for this purpose). A belt loop used to secure a body strap to the device shall not permit the primary closure of the body strap to pass through the loop.

8.4 The width of the opening in a closure such as a buckle or dee ring shall be not more than 1/8 inch (3 mm) greater than the width of the associated webbing, as measured at the line of contact.

8.5 Hardware shall have a quick and positive lock mechanism.

8.6 A zipper shall be:

- a) Easily initiated;
- b) Nonjamming;
- c) Right-handed; and
- d) A locking type.

8.7 Drawstrings shall:

- a) Be not less than 1 inch (25 mm) wide;
- b) Have a positive closing mechanism; or
- c) Comply with the tieability requirements for tie tapes in the requirements in the Standard for Components for Personal Flotation Devices, UL 1191.

8.8 The extended, finished length of a body strap shall be not more than 3 inches (76 mm) greater than the minimum length required to secure the device on a person having the maximum chest size.

8.9 Compliance with the requirement in 8.8 is to be determined by either of the following methods:

- a) The length of each body strap is to be measured with all adjustments made to provide the maximum length. The outside circumference of the device at each strap location then is to be measured with the device fitted as intended on a subject of the maximum chest size (see 8.10). The difference between the strap measurement and the circumference measurement at the strap location shall not exceed 3 inches (76 mm).
- b) The device is to be fitted as intended on a subject of the maximum chest size (see 8.10). A measurement is to be made along the means of adjustment to some reference mark on the strap. Then, with all adjustments made to provide the maximum length, a second measurement is to be made along the means of adjustment to the reference mark. The difference between the two measurements shall not exceed 3 inches (76 mm).

8.10 The subject specified in 8.9 is to be the subject having the largest chest size from the group specified in Table 12.1. The subject is to meet the qualifications specified in 13.1.4.

8.11 A hybrid device shall not provide means that may be used to fasten the device to a boat.

Exception No. 1: This requirement does not apply to the closures of the device.

Exception No. 2: This requirement does not apply to harness assemblies, or the like, intended to be attached to harness lines during activities such as boardsailing or hiking out on a sailboat, and that have been investigated and found to be acceptable for the application.

Exception No. 3: This requirement does not apply to a means that is rendered inoperative when subjected to the test described in 31.3.1.

Exception No. 4: This requirement does not apply to a device marked in accordance with 38.3.8 and provided with the text specified in 41.4.

9 Seams

9.1 A lock stitch, such as the stitch designated as Type 301 in Federal Standard No. 751a (January 25, 1965), shall be used for a structural seam formed by sewing. Also, see Seam Strength Test, Section 34.

9.2 Monofilament thread shall not be used for making structural seams.

9.3 Thread and fabric combinations shall be compatible. Cotton threads shall be used only with cotton fabrics; synthetic threads may be used with any fabric.

9.4 A structural seam joining uncoated woven fabrics shall:

- a) Be 3/4 inch (19.1 mm) wide;
- b) Consist of two rows of a lock stitch; or
- c) Be of a type having equivalent mechanical characteristics.

9.5 Window material attachments to the PFD shall have minimum seam strength (sewn or welded) of 53 N (12 lbs) for a 1-inch grip, in an as received condition, using the test method in Section 34, Seam Strength Test.

10 Coatings

10.1 A dip coating shall be applied smoothly and evenly and shall be free of visible blemishes. The coating may have a greater thickness at a stressed area than at an unstressed area.

10.2 A pocket comparator having a magnifying power not less than 6X is to be used to determine the uniformity of the thickness of a coating. Measurements are to be made at each of the following locations, as applicable:

- a) At the top of one armhole;
- b) At the bottom of one armhole;
- c) On the left side of the neck edge;
- d) On the right side of the neck edge;
- e) On the left front panel near the lower center front;
- f) On the right front panel near the lower center front; and
- g) On the lower edge at the center back.

Three readings are to be taken at each location, and the average of the three readings is to be considered the thickness for that location.

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PERFORMANCE

GENERAL

11 Configurations for Tests

11.1 Representative samples of a hybrid device shall be subjected to the applicable tests described in Sections 12 – 32. Components or material specimens are to be used for the tests specified in Sections 33 – 35.

11.2 A device having an optional feature, such as a harness assembly, is to be tested both with and without the use of the feature.

11.3 A device is to be tested in conditions of inflation as specified in Table 11.1. For tests involving inflation of the compartments of a sample to specific pressures, the inflation systems provided on the device may be modified to permit external pressurization, measurement of pressure, and the like.

Table 11.1
Inflation conditions for tests

Test	Deflated ^a	Inflated
Donning and Operability Tests, Section 13		
Deflated donning and operability	D ^b	
Inflated donning		M
Jump Tests, Section 14	D	M ^c
Inherent Flotation Characteristics Test, Section 15	D ^d	
Inflated Flotation Stability Test, Section 16		d
Water Emergence Test, Section 17		e
Operation Force and Inflation Pressure Test, Section 18	D ^b	
Buoyancy and Permeability Test, Section 19		
Inherent buoyancy	D	
Inflated buoyancy and permeation loss		f
Distribution Tests, Section 20		
Buoyancy	D	
Loss	D	
Water Entrapment Test, Section 21	D	
Dynamic Strength Test, Section 22	D ^g	M
Tensile Tests, Section 23	D ^g	M ^h
Temperature Cycling Tests, Section 24	D ^g	M
Solvent Exposure Test, Section 25	D ^g	
Flame Exposure Test, Section 26	D ^g	M
Abrasion/Compression Test, Section 27	D ^g	
Puncture Resistance Test, Section 28		M
Over-Pressure Tests, Section 29		
Device		i
Over-pressure relief valve		k
Air Retention Test, Section 30		M
Strength of Attachment Tests, Section 31		
Inflation systems	D ^g	M

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Table 11.1 Continued

Test	Deflated ^a	Inflated
Pull	D ^g	
Environmental Tests, Section 32	D	
Note: Upper-case letters in this table refer to the following: D – Tested or conditioned in deflated condition. M – Maximum value of the design pressure range. ^a A vacuum of not greater than 0.1 psig (0.7 kPa) may be applied to a compartment to obtain complete deflation. ^b Initially. ^c See 14.3.1. ^d See 16.1 and 16.2. ^e See 17.4. ^f See 19.3.1. ^g Followed by inflation to maximum pressure. ^h Not required if portions of the device that will be stressed do not change under conditions of intended inflation. ⁱ Twice the maximum value of the design pressure range or 8 psig (55 kPa), whichever is greater. ^j See 29.2.2.		

USE TESTS

12 General

12.1 For the tests described in Sections 13 – 17, human test subjects as specified in Table 12.1 are to be employed. Each subject is to be wearing a swimsuit; except when the attire customary to the designated purpose of the device may adversely affect the test results, the tests are to be repeated with at least one subject wearing such attire. A subject shall not be familiar with the particular device under test, but may be familiar with PFDs in general. Unless specifically indicated otherwise, a subject is not to make adjustments to a device after donning is completed.

Table 12.1
Test participant selection

Chest size adjustment range of device, inches (mm)	Number of test participants
6 (150) or less	6
More than 6 but not more than 12 (300)	12
More than 12 (300)	18
NOTES: 1) Test participants selected are to be of varying height and weight so as to represent endomorphic, mesomorphic, and ectomorphic anatomic builds. The chest sizes of the subjects are to be within the intended chest size range of the device; except one subject having a chest size 1 ± 0.5 inch (25 $\pm$ 13 mm) larger than the marked maximum size, and one subject shall have a chest size 1 ± 0.5 inch smaller than the marked minimum size. 2) May be any combination of males and females, provided that at least one male and one female are used.	

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Table 12.1 Continued

Chest size adjustment range of device, inches (mm)	Number of test participants
3) For each set of six test participants, in the group, three of the participants are to be as follows: a) One having an in-water weight of less than 7.5 pounds (3.4 kg); b) One having an in-water weight of at least 10.5 pounds (4.9 kg), but less than 11 pounds (5.0 kg); and c) One having an in-water weight of at least 11 pounds. 4. Should a test participant having a chest size 1 ± 0.5 inch (25 ± 13 mm) smaller than the marked minimum size be unavailable, a test participant having the required chest size and a weight of 80 lbs. (36.4 kg) or more may be used to demonstrate acceptable performance of the device. However, should the candidate device perform unacceptably on such a participant, it shall not constitute failure of the device to comply with the requirements of this Standard, and another participant shall be selected. 5. A youth test participant may be used to satisfy specific anthropomorphic characteristics for weight, chest size, or girth of an adult-size device. When testing an adult-size device, when the youth is less than 13 years of age, his or her test results may be excluded for Donning and Operability Test, Section 13; Jump Tests, Section SA6; or In-Water Removal Test, Section SA9 due to the participant's inherent limitations in dexterity, strength, and maturity. For an adult-size device, where the results for a youth test participant are excluded, a substitute test participant shall be used for the excluded test. The substitute participant shall have anthropomorphic characteristics within the candidate devices specified range, that are similar to, and not necessarily identical to the excluded participant.	

12.2 With reference to note c to Table 12.1, the in-water weight of a subject is to be determined as follows (see Figure 12.1):

a) The subject is to be placed in an assembly that does not restrict the subject's breathing, and the assembly attached to a scale. The subject then is to be immersed in a pool of fresh water until the tips of the chin and ear lobes touch the surface of the water.

b) The weight at FRC for each of ten normal breathing cycles of the subject then is to be recorded to the nearest 1/4 pound (0.11 kg). The in-water weight of the subject is to be as follows:

- 1) The maximum value of observed weight if the value is observed more than once;
- 2) The second-highest observed weight if this value is observed more than once and the criteria specified in (a) is not satisfied; or
- 3) The third-highest observed weight when neither the criteria specified in (a) or (b) are satisfied.

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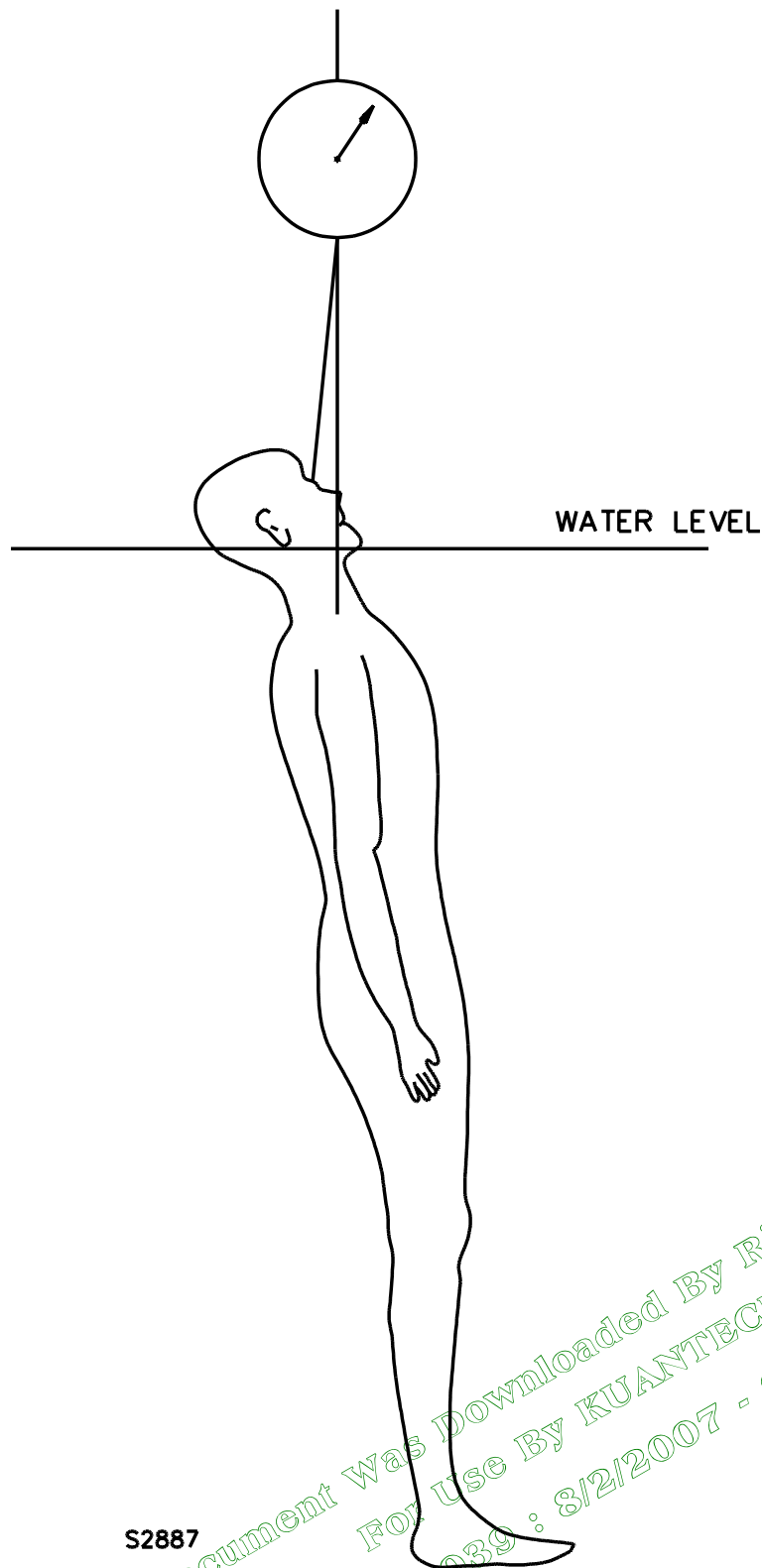
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Figure 12.1
In-water weight measurement



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12.3 Automatic inflation systems on samples of a hybrid device are to be rendered inoperative prior to being subjected to the tests described in Sections 13 – 17.

13 Donning and Operability Tests

13.1 Deflated donning and operability test

13.1.1 Complete donning (including any second-stage donning required), adjustment to a secure fit [see 7.1.4(c)], and full inflation shall be accomplished within 1 minute by each test subject when a hybrid device is tested as described in 13.1.2 – 13.1.5. Each inflation system shall be accessible by either hand of each subject with the deflated device donned and adjusted. In addition, the deflation mechanism and oral inflation system shall be accessible by either hand of each subject with the device donned, adjusted, and inflated.

13.1.2 The deflated device is to be given to the subject at pool side with the instruction "Please don as quickly as possible, adjust to fit snugly, and inflate." The donning attempt then is to be timed. All size adjustments are to be at the halfway point when the device is given to the subject.

13.1.3 When the subject, because of lack of familiarity with the device, is not able to adjust the device to fit or inflate the device within the specified time limit, the subject is to enter the water and be tested with the device as donned. The breathing of the test subject shall not be impaired and the test subject shall show no tendencies to turn face down or the like in the water. Then, the subject is to exit the water and be given the written instructions from the owner's manual regarding the proper donning technique. The procedure specified in 13.1.2 is then to be repeated.

13.1.4 When donning, adjustment, and full inflation of the hybrid device on a subject is not achieved within 1 minute after the instructions specified in 13.1.3 have been given, the test is to be repeated by the subject with a reference vest. When the reference vest is not donned and adjusted within 45 seconds, the subject is to be disqualified and replaced.

13.1.5 When, after 1 minute has elapsed, the subject is still making efforts to inflate the device, the subject's efforts are to be halted and the test specified in 14.3.1 and 14.3.2 conducted with the device in the condition achieved after the 1 minute.

13.1.6 Following each successful donning attempt, the accessibility by either hand of the wearer to each inflation system and each deflation mechanism is to be verified.

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13.2 Inflated donning test

13.2.1 Donning and complete adjustment of an inflated device to a secure fit shall be accomplished within 1 minute by each test subject when a hybrid device is tested as specified in 13.2.2.

13.2.2 This test is to be conducted after the test specified in 13.1.1. A sample of the device, with each compartment inflated at the maximum value of the design pressure range, is to be given to the subject with the instruction "Please don as quickly as possible and adjust to fit snugly." Further instructions are not to be given.

14 Jump Tests

14.1 General

14.1.1 When tested as described in 14.2.1 – 14.3.2, a hybrid device shall:

- a) Not present a risk of injury to persons;
- b) Not be damaged;
- c) Maintain its intended use position on each subject; and
- d) Not tend to turn any subject face down.

14.2 Deflated device

14.2.1 Each subject is to don and adjust a deflated device prior to water entry (as specified in 13.1.2, but without inflating the device). After donning, secondary closure fabric belts and drawstrings that the subject has adjusted to obtain a fit are to be loosened.

14.2.2 Each subject is to jump feet first into a test pool from a height of 3 feet (0.91 m) while holding both hands above the head with arms extended. Before jumping, each subject is to be instructed that after surfacing, the device may be pulled down and tightened in order to see or breathe more easily.

14.2.3 The device is to be considered in the intended use position if:

- a) The subject's arms are not trapped in the overhead position;
- b) The device remains in a usable position on the subject; and
- c) The device complies with the applicable requirements in Section 15 for the deflated condition.

When the subject elects to make any adjustments in accordance with the instructions specified in 14.2.2, the determination of compliance with (c) is to be made after the subject has made the adjustments and then has relaxed.

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14.3 Inflated device

14.3.1 The procedure specified in 14.2.1 and 14.2.2 then is to be performed twice by each subject; first with the device donned and inflated in accordance with 13.1.2 – 13.1.5, and then after the device has been donned and inflated in accordance with 13.2.1 and 13.2.2.

14.3.2 For the test specified in 14.3.1, the intended-use position is to be considered maintained if there is compliance with 14.2.3, except that no subject's breathing shall be impeded in the static floating position.

14.4 Belts

14.4.1 The tests described in 14.2.2 and 14.3.1 are to be repeated, except that each subject is to dive head first into the water from the 3-foot (0.91-m) height. The belt shall comply with the requirements in 14.1.1.

15 Inherent Flotation Characteristics Test

15.1 When tested as described in 15.2 – 15.5, a deflated hybrid device shall comply with the following:

a) Each subject having an in-water weight of less than 7.5 pounds (3.4 kg) shall be floated in a manner complying with the requirements for Type III flotation stability in 16.4.1; except that:

1) The average freeboard shall be not less than 1 inch (25 mm) and no subject shall have a freeboard less than zero; and

2) The face plane angle requirement in 16.4.1(d) does not apply.

b) The device shall permit each subject having an in-water weight of 7.5 pounds or more, but less than 11 pounds (5.0 kg), to attain a position in which respiration is not impeded without swimming or treading water (no subject shall have a freeboard less than zero).

c) The device shall permit each subject having an in-water weight of 11 pounds or more to attain, by means of body movement, a position in which respiration is not impeded.

d) Regardless of the subject's in-water weight, the device shall:

1) Have no tendency to turn a subject face down at any time; and

2) Permit each subject to achieve sufficient inflation in not more than 30 seconds by means of the oral system,

to comply with the applicable requirements in Inflated Flotation Stability Tests, Section 16.

15.2 This test is to be conducted after each subject has entered the water as specified in 14.2.2 while wearing the deflated device.

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