

RESOLUTION MSC.200(80)  
(adopted on 13 May 2005)  
ADOPTION OF AMENDMENTS TO THE REVISED  
RECOMMENDATION ON TESTING OF  
LIFE-SAVING APPLIANCES

**ANNEX 17**

**RESOLUTION MSC.200(80)**  
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**ADOPTION OF AMENDMENTS TO THE REVISED RECOMMENDATION ON  
TESTING OF LIFE-SAVING APPLIANCES**

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

RECALLING ALSO resolution A.689(17) on Testing of life-saving appliances, by which the Assembly, at its seventeenth session, adopted recommendations for test requirements for life-saving appliances,

RECALLING FURTHER that the Assembly, when adopting resolution A.689(17), authorized the Committee to keep the Recommendation on testing of life-saving appliances under review and to adopt, when appropriate, amendments thereto,

NOTING resolution MSC.81(70), by which, at its seventieth session, it adopted the Revised recommendation on testing of life-saving appliances, recognizing the need to introduce more precise provisions for the testing of life-saving appliances based on the requirements of the International Life-Saving Appliances (LSA) Code,

BEING DESIROUS to identify and develop comprehensive performance testing and approval standards for personal life-saving appliances to ensure a good probability of survival for short duration water immersion,

HAVING CONSIDERED, at its eightieth session, amendments to the Revised recommendation on testing of life-saving appliances, proposed by the Sub-Committee on Ship Design and Equipment at its forty-eighth session,

1. ADOPTS amendments to the Revised recommendation on testing of life-saving appliances (resolution MSC.81(70)), the text of which is set out in the Annex to the present resolution;
2. RECOMMENDS Governments to apply the annexed amendments when testing life-saving appliances.

## ANNEX

### AMENDMENTS TO THE REVISED RECOMMENDATION ON TESTING OF LIFE-SAVING APPLIANCES (RESOLUTION MSC.81(70))

#### **PART 1 – *Prototype tests for life-saving appliances***

- 1 The existing subparagraph .3 of paragraph 1.1 is replaced by the following:

“**.3** if it is intended to operate the quick-release arrangement provided for a self-activated smoke signal and self-igniting light, the lifebuoy has a mass of not less than 4 kg (see 1.8); and”
- 2 In paragraph 1.2.1.1, the words “8 h cycle at +65°C” are replaced by “8 h exposure at a minimum temperature of +65°C”.
- 3 In paragraphs 1.2.1.2 and 1.2.1.4, the words “at a temperature of 20°C ± 3°C” are added after the words “under ordinary room conditions”.
- 4 In paragraph 1.2.1.3, the words “8 h cycle at -30°C” are replaced by the words “8 h exposure at a maximum temperature of -30°C”.
- 5 The existing paragraph 1.9.3 is replaced by the following:

“**1.9.3** The last three smoke signals taken from ordinary room conditions and attached by a line to a lifebuoy having a mass of not more than 4 kg should undergo the drop test into water prescribed in 1.3. The lifebuoy should have both a smoke signal and a lifebuoy light attached in the manner recommended by the manufacturers and be dropped from a quick-release fitting. The smoke signals should not be damaged and should function for a period of at least 15 min.”
- 6 The following new paragraph 1.9.6 is added:

“**1.9.6** A force of 225 N should be applied to the fitting that attaches the self-activating smoke signal to the lifebuoy. Neither the fitting nor the signal should be damaged as a result of the test.”
- 7 The existing section 2 is replaced by the following:

“**2 LIFEJACKETS**

**2.1 Temperature cycling test**

A lifejacket should be subjected to the temperature cycling as prescribed in 1.2.1 and should then be externally examined. The lifejacket materials should show no sign of damage such as shrinking, cracking, swelling, dissolution or change of mechanical qualities.

## **2.2 Buoyancy test**

The buoyancy of the lifejacket should be measured before and after 24 h complete submersion to just below the surface in fresh water. The difference between the initial buoyancy and the final buoyancy should not exceed 5% of the initial buoyancy.

## **2.3 Fire test**

A lifejacket should be subjected to the fire test prescribed in 1.5. The lifejacket should not sustain burning for more than 6 s or continue melting after being removed from the flames.

## **2.4 Tests of components other than buoyancy materials**

All the materials, other than buoyancy materials, used in the construction of the lifejacket, including the cover, tapes, seams and closures should be tested to an international standard acceptable to the Organization\* to establish that they are rot-proof, colour-fast and resistant to deterioration from exposure to sunlight and that they are not unduly affected by seawater, oil or fungal attack.

## **2.5 Strength tests**

### *Body or lifting loop strength tests*

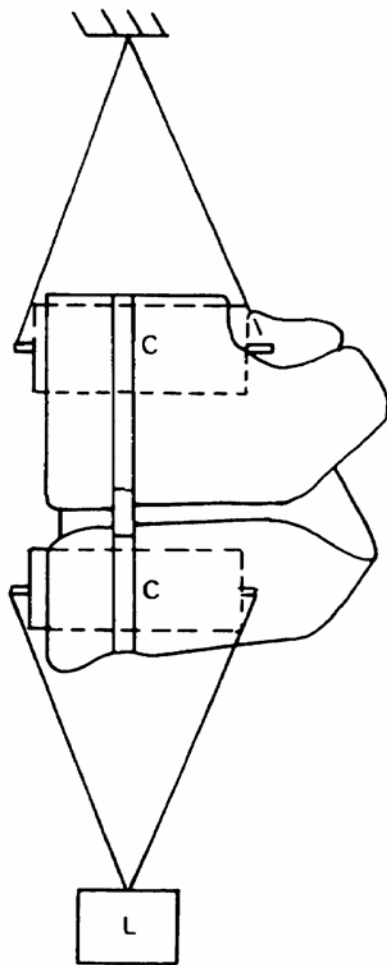
**2.5.1** The lifejacket should be immersed in water for a period of 2 min. It should then be removed from the water and closed in the same manner as when it is worn by a person. A force of not less than 3,200 N (2,400 N in the case of a child or infant-size lifejacket) should be applied for 30 min to the part of the lifejacket that secures it to the body of the wearer (see figure 1) and separately to the lifting loop of the lifejacket. The lifejacket should not be damaged as a result of this test. The test should be repeated for each encircling closure.

### *Shoulder lift test*

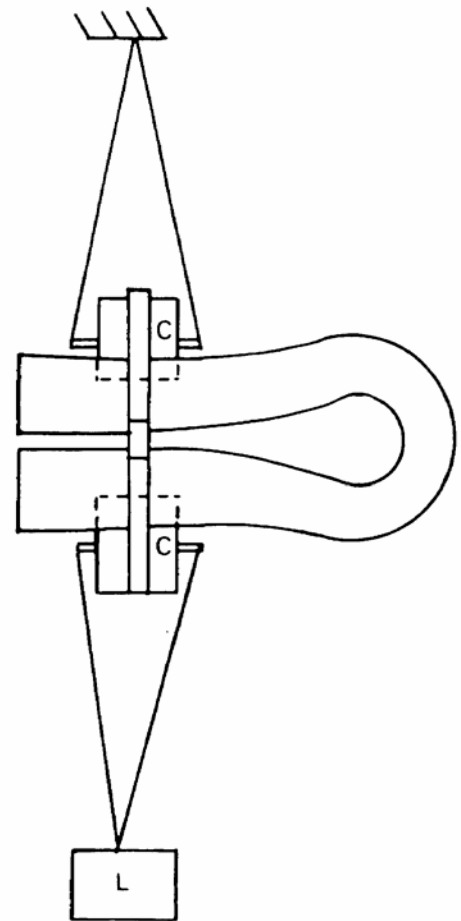
**2.5.2** The lifejacket should be immersed in water for a period of 2 min. It should then be removed from the water and closed on a form as shown in figure 2, in the same manner as when it is worn by a person. A force of not less than 900 N (700 N in the case of a child- or infant-size lifejacket) should be applied for 30 min across the form and the shoulder section of the lifejacket (see figure 3). The lifejacket should not be damaged as a result of this test. The lifejacket should remain secured on the form during this test.

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\* Refer to the recommendations of the International Organization for Standardization, in particular publication ISO 12402-7 *Personal flotation devices – Part 7: Materials and components – Safety requirements and test methods*.



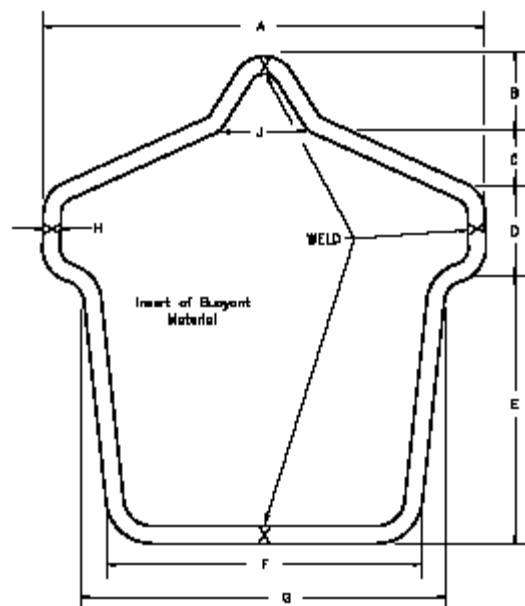
**Vest-type lifejacket**



**Yoke or over-the-head-type lifejacket**

- C - Cylinder  
125 mm diameter for adult sizes  
50 mm diameter for infant and child sizes  
L - Test load

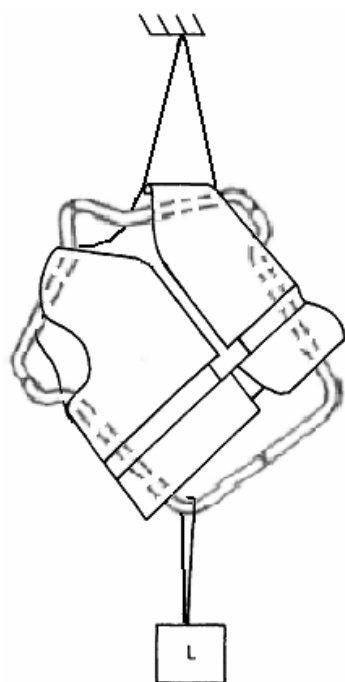
**Figure 1 – Body strength test arrangement for lifejackets**



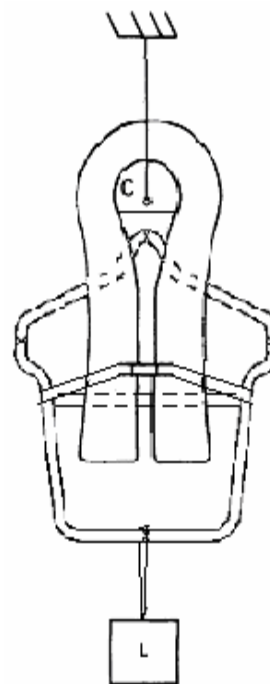
Dimensions in mm

Size	A	B	C	D	E	F	G	H	J
Adult	610	114	76.2	127	381	432	508	25.4	178
Child	508	102	76.2	102	279	330	406	22.2	152
Infant	305	63.5	38.1	63.5	191	203	241	19.1	76.2

**Figure 2 – Test form for shoulder lift test for lifejackets**



**Vest-type lifejacket**



**Yoke or over-the-head-type lifejacket**

- C - Cylinder  
125 mm diameter for adult sizes  
50 mm diameter for infant and child sizes
- L - Test load

**Figure 3 – Shoulder lift test arrangement for lifejackets**

## **2.6 Tests for lifejacket buoyancy material**

The following tests should be carried out on eight specimens of each lifejacket buoyancy material. The specimens should be at least 300 mm square and be of the same thickness as used in the lifejacket. In the case of kapok, the entire lifejacket should be subjected to the test. The dimensions should be recorded at the beginning and end of these tests. Where multiple layers of materials are used to achieve the total thickness desired for the lifejacket, the specimens should be of the thinnest material used.

### *Test for stability under temperature cycling*

**2.6.1** Six specimens should be subjected to temperature cycling as prescribed in 1.2.1.

**2.6.2** The dimensions of the specimens (except kapok) should be recorded at the end of the last cycle. The specimens should be carefully examined and should not show any sign of external change of structure or of mechanical qualities.

**2.6.3** Two of the specimens should be cut open and should not show any sign of internal change of structure.

**2.6.4** Four of the specimens should be used for compression and water absorption tests, two of which should be so tested after they have also been subjected to the diesel oil test as prescribed in 1.4.

*Tests for compression and water absorption*

**2.6.5** The tests should be carried out in fresh water and the specimens should be immersed for a period of seven days under a 1.25 m head of water.

**2.6.6** The tests should be carried out:

- .1** on two specimens as supplied;
- .2** on two specimens which have been subjected to the temperature cycling as prescribed in 2.6.1; and
- .3** on two specimens which have been subjected to the temperature cycling as prescribed in 2.6.1 followed by the diesel oil test as prescribed in 1.4.

**2.6.7** The results should state the buoyant force in N which each specimen exerts when submerged in water after one and seven days' immersion. The reduction of buoyancy should not exceed 10% for specimens which have been exposed to the diesel oil conditioning and must not exceed 5% for all other specimens. The specimens should show no sign of damage such as shrinking, cracking, swelling, dissolution or change of mechanical qualities.

*Tensile strength test*

**2.6.8** The tensile strength at break of the material should be measured before and after the combined exposure described in 2.6.6.3. When tested according to an international standard acceptable to the Organization\*, the materials should have a minimum tensile strength of 140 kPa before exposure, which should not be reduced by more than 25% following the combined exposures. In the case of kapok, the protective cover should have a minimum breaking strength of 13 kPa before exposure, which should not be reduced by more than 25% following the combined exposures.

**2.7 Donning test**

**2.7.1** To minimize the risk of incorrect donning by uninitiated persons, often in adverse conditions, lifejackets should be examined for the following features and tested as follows:

- .1** fastenings necessary for proper performance should be few and simple, and provide quick and positive closure that does not require tying of knots;

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\* Refer to the recommendations of the International Organization for Standardization, in particular publication ISO 12402-7, *Personal flotation devices – Part 7: Materials and components – Safety requirements and test methods*.



- .2 adult lifejackets should readily fit various sizes of adults, both lightly and heavily clad; and
- .3 all lifejackets should be capable of being worn inside-out, or clearly in only one way.

*Test subjects*

**2.7.2** These tests should be carried out with at least 12 able-bodied persons who are completely unfamiliar with the lifejacket and selected according to the heights and weights in table 2.1 and the following:

- .1 small test subjects need not be adults;
- .2 at least 1/3, but not more than 1/2 of test subjects should be females, including at least 1 per height category but excluding the tallest height;
- .3 at least one male and one female should be from the lowest and highest weight group;
- .4 at least one subject should be selected from each cell containing a “1”; and
- .5 enough additional subjects should be selected from cells containing a “X” to total the required number of test subjects, with no more than one subject per cell. A uniform distribution across weight ranges should be maintained.

**Table 2.1 – Test subject selection for adult lifejackets**

	Weight range – kg							
Height range (m)	40 - 43	43 - 60	60 - 70	70 - 80	80 - 100	100 - 110	110 - 120	>120
< 1.5	1	X	X	X				
1.5 - 1.6	X	1	1	X	X			
1.6 - 1.7		X	X	1	X	X		
1.7 - 1.8			X	X	1	X	X	X
1.8 - 1.9			X	X	X	1	1	X
> 1.9					X	X	X	1

*Clothing*

**2.7.3** Each test subject should be tested wearing the clothing specified for the test and appropriate to their size as follows:

- .1 *Normal clothing* means normal indoor clothing, which would not normally interfere with the donning of a lifejacket; and
- .2 *Heavy-weather clothing* means the attire appropriate for a hostile environment, including a hooded arctic parka and warm cotton gloves.

**2.7.4** Each test should be timed from when the order is given until the test subject declares that donning is complete. For assessment purposes donning is considered complete when the subject has donned and securely adjusted all methods of securing the lifejacket to the extent needed to meet the in-water performance requirements, including inflation, if needed.

*Test without instruction*

**2.7.4.1** The test subjects may be tested individually or as a group. Wearing normal clothing, the first attempt should be with no assistance, guidance or prior demonstration. The lifejacket, with closures in the stored condition, should be placed on the floor, face up, in front of the test subject. The instruction provided should be identical for each subject and should be equivalent to the following: "PLEASE DON THIS LIFEJACKET AS QUICKLY AS POSSIBLE AND ADJUST IT TO A SNUG FIT SO YOU CAN ABANDON SHIP." The lifejacket should be capable of being donned by at least 75 % of the subjects, and within 1 min. If a subject dons the lifejacket substantially correctly but fails to secure and/or adjust all closures, the jump test in 2.8.8 and in-water performance tests in 2.8.5 and 2.8.6 should be performed with the lifejacket as donned to establish whether the performance is acceptable and the donning is successful.

*Test after instruction*

**2.7.4.2** For each subject whose first attempt exceeds 1 min or is incomplete, after demonstration or instruction to familiarize the subject with the donning procedure, the test subject should then don the lifejacket without assistance while wearing normal clothing, using the same instruction and timing method as in 2.7.4.1. Each subject should correctly don the lifejacket within a period of 1 min.

*Heavy-weather clothing test*

**2.7.4.3** Each subject should then don the lifejacket without assistance while wearing heavy-weather clothing, using the same instruction and timing method as in 2.7.4.1. Each subject should don the lifejacket correctly within a period of 1 min.

**2.8 Water performance tests**

**2.8.1** This portion of the test is intended to determine the ability of the lifejacket to assist a helpless person or one in an exhausted or unconscious state and to show that the lifejacket does not unduly restrict movement. The in-water performance of a lifejacket is evaluated by comparison to the performance of a suitable size standard reference lifejacket, i.e. Reference Test Device (RTD) as specified in appendices 1 to 3. All tests should be carried out in fresh water under still conditions.

*Test subjects*

**2.8.2** These tests should be carried out with at least 12 persons as described in 2.7.2. Only good swimmers should be used, since the ability to relax in the water is rarely otherwise obtained.

### *Clothing*

**2.8.3** Subjects should wear only swimming costumes.

### *Preparation for water performance tests*

**2.8.4** The test subjects should be made familiar with each of the tests set out below, particularly the requirement regarding relaxing and exhaling in the face-down position. The test subject should don the lifejacket, unassisted, using only the instructions provided by the manufacturer. After entering the water, care should be taken to ensure that there is no significant amount of air unintentionally trapped in the lifejacket or swimming costume.

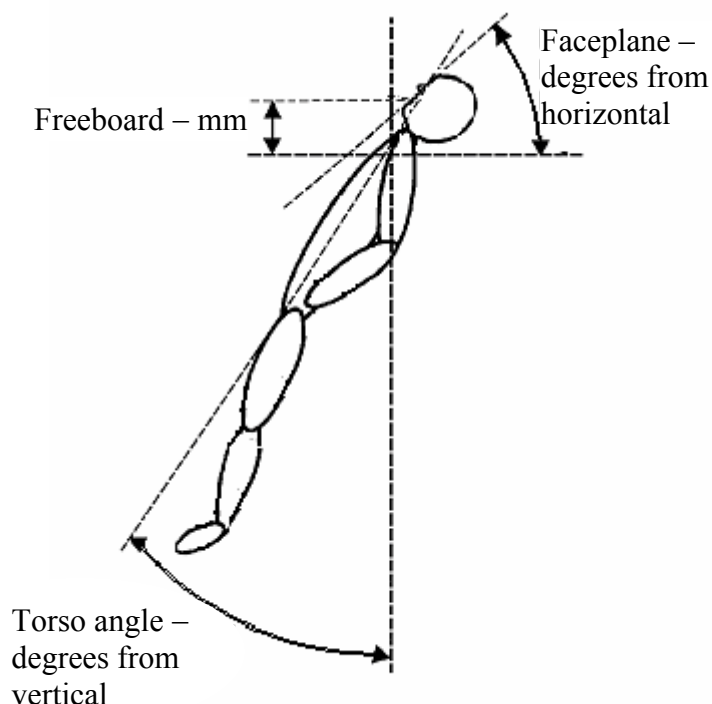
### *Righting tests*

**2.8.5** Each test subject should assume a prone, face down position in the water, but with the head lifted up so the mouth is out of the water. The subject's feet should be supported, shoulder width apart, with the heels just below the surface of the water. After assuming a starting position with the legs straight and arms along the sides, the subject should then be instructed in the following sequence to allow the body to gradually and completely relax into a natural floating posture: allow the arms and shoulders to relax; allow the legs to relax; and then the spine and neck, letting the head fall into the water while breathing out normally. During the relaxation phase, the subject should be maintained in a stable face down position. Immediately after the subject has relaxed with the face in the water, simulating a state of utter exhaustion, the subject's feet should be released. The period of time until the mouth of the test subject comes clear of the water should be recorded to the nearest 1/10 of a second, starting from when the subject's feet are released. The above test should be conducted for a total of six times, and the highest and lowest times discarded. The test should then be conducted for a total of six times in the RTD and the highest and lowest times discarded.

### *Static balance measurements*

**2.8.6** At the conclusion of the righting tests without making any adjustments in body or lifejacket position, measurements should be made with the subject floating in the relaxed face-up position of static balance resulting from the preceding tests. The following measurements should be made (see figure 4):

- .1** freeboard – the distance measured perpendicularly from the surface of the water to the lowest point of the subject's mouth where respiration may be impeded, if the mouth were not held shut. The lowest side of the mouth should be measured if the left and right sides are not level;
- .2** faceplane angle – the angle, relative to the surface of the water, of the plane formed between the most forward part of the forehead and the chin;
- .3** torso angle – the angle, relative to vertical, of the line formed by the forward points of the shoulder and hipbone (ilium portion of the pelvis); and
- .4** list angle – the angle relative to the surface of the water and a line between the left and right shoulder or a line through the ears if only the head is tilted.



**Figure 4 – Static balance measurements**

*Assessment*

**2.8.7** After the water tests described in 2.8.5 and .6 above:

- .1** *Turning time:* The average turn time for all subjects in the candidate lifejacket should not exceed the average time in the RTD, and the number of “no-turns”, if any, should not exceed the number in the RTD;
- .2** *Freeboard:* The average freeboard of all the subjects should not be less than the average for the RTD;
- .3** *Torso angles:* The average of all subjects’ torso angles should be not less than the average for the RTD minus 5°;
- .4** *Faceplane (head) angles:* The average of all subjects’ faceplane angles should be not less than the average for the RTD minus 5°;
- .5** *Lifejacket light location:* The position of the lifejacket light should permit it to be visible over as great a segment of the upper hemisphere as is practicable.

*Jump and drop tests*

**2.8.8** Without readjusting the lifejacket, the test subject should jump vertically into the water, feet first, from a height of at least 1 m while holding the arms over the head. Upon entering the water, the test subject should relax to simulate a state of utter exhaustion. The freeboard to the mouth should be recorded after the test subject comes to rest. The test should be repeated from a height of at least 4.5 m but, when jumping into

the water, the test subject should hold on to the lifejacket during water entry to avoid possible injury. Upon entering the water, the test subject should relax to simulate a state of utter exhaustion. The freeboard to the mouth should be recorded after the test subject comes to rest. The lifejacket and its attachments should be examined for any damage. If injury is believed likely from any jump or drop test the lifejacket should be rejected or the test delayed until tests from a lower height or with additional precautions demonstrate that the risk from the required test is acceptable.

#### *Assessment*

**2.8.9** Following the drop test, the lifejacket should:

- .1** surface the test subject in a face up position with an average freeboard for all the subjects of not less than the average for the RTD determined in accordance with 2.8.6;
- .2** not be dislodged or cause harm to the test subject;
- .3** have no damage that would affect its in-water performance or buoyancy; and
- .4** have no damage to its attachments.

#### *Stability test*

**2.8.10** The test subject should attain a relaxed face-up position of static balance in the water. The subject should be instructed to assume a foetal position as follows: “place your elbows against your sides, your hands on your stomach, under the lifejacket if possible, and bring your knees up as close to your chest as possible.” The subject should be rotated clockwise around the longitudinal axis of the torso by grasping the subject’s shoulders or upper areas of the lifejacket so that the subject attains a  $55 \pm 5$  degree list. The subject should then be released. The subject should return to a stable face-up position. The test should then be conducted with the subject rotated counter-clockwise. The entire test should then be repeated with the test subject wearing the RTD. The candidate lifejacket should not roll any subject face down in the water. The number of subjects who are returned to the stable face-up foetal position in the candidate lifejacket should be at least equal to the number who are returned to the stable face-up foetal position in the RTD.

#### *Swimming and water emergence test*

**2.8.11** All test subjects, without wearing the lifejacket, should attempt to swim 25 m and board a liferaft or a rigid platform with its surface 300 mm above the water surface. All test subjects who successfully complete this task should perform it again wearing the lifejacket. At least two thirds of the test subjects who can accomplish the task without the lifejacket should also be able to perform it with the lifejacket.

### **2.9 Infant and children’s lifejacket tests**

As far as possible, similar tests should be applied for approval of lifejackets suitable for infants and children.

*Infant and child test subjects*

**2.9.1** For child-size lifejackets, tests should be carried out with at least 9 able-bodied persons, and for infant-size lifejackets, tests should be carried out with at least 5 able-bodied persons. All test subjects should be selected according to table 2.2 or table 2.3 as follows:

- .1** One subject should be selected per each cell containing a “1”.
- .2** Remaining subjects should be selected from cells containing an “X”, without repeating a cell.
- .3** At least 40% of the subjects should be male and at least 40% female.
- .4** Devices for infants should be tested on infants as small as 6 kg mass.
- .5** A manikin or manikins may be substituted for infant lifejacket test subjects if the manikin or manikins have been demonstrated to provide representative results compared to human subjects.

**Table 2.2 – Selection of child test subjects**

Height range (cm)	Weight range (kg)										
	14-17	17-20	20-22	22-25	25-28	28-30	30-33	33-36	36-38	38-41	41-43
79-105	1	X									
90-118		X	1								
102-130				1	X						
112-135					X	1					
122-150							1	1	X		
145-165									X	1	1

**Table 2.3 – Selection of infant test subjects**

Height range (cm)	Weight range (kg)		
	Less than 11	11-14	14-17
Less than 83	1	X	
79-105	X	1	1
90-118			X

**2.9.2** When conducting water performance tests under 2.8, infant and child-size lifejackets should meet the following requirements for their critical flotation stability characteristics:

- .1** *Turning time:* The average turn time for all subjects in the candidate lifejacket should not exceed the average time in the appropriate size RTD;

- .2 *Freeboard:* The average results for clearance of the mouth above the water for all subjects should not be less than the average for the appropriate size RTD;
- .3 *Torso angle:* The average of all subjects' results should be not less than the average for the appropriate size RTD minus 10°;
- .4 *Faceplane (head) angle:* The average of all subjects' results should be not less than the average for the appropriate size RTD minus 10°; and
- .5 *Mobility:* Mobility of the subject both in and out of the water should be given consideration in determining the acceptability of a device for approval and should be compared to mobility when wearing the appropriate size RTD when climbing out of the water, going up and down stairs, picking up an article from the floor, and then drinking from a cup.

**2.9.3** With the exception of reducing freeboard and self-righting performance, the requirements for infant lifejackets may be relaxed if necessary in order to:

- .1 contribute to the rescue of the infant by a caretaker;
- .2 allow the infant to be fastened to a caretaker and contribute to keeping the infant close to the caretaker;
- .3 keep the infant dry, with free respiratory passages;
- .4 protect the infant against bumps and jolts during the evacuation; and
- .5 allow a caretaker to monitor and control heat loss by the infant.

## **2.10 Tests for inflatable lifejackets**

### *2.10.1 Inflation tests*

**2.10.1.1** Two inflatable lifejackets should be subjected to the temperature cycling test prescribed in 1.2.1 in the uninflated condition and should then be externally examined. The inflatable lifejacket materials should show no sign of damage such as shrinking, cracking, swelling, dissolution or change of mechanical qualities. The automatic and manual inflation systems should each be tested immediately after each temperature cycling test as follows:

- .1 After a high temperature cycle, the two inflatable lifejackets should be taken from the stowage temperature of +65°C. One should be activated using the automatic inflation system by placing it in seawater at a temperature of +30°C and the other should be activated using the manual inflation system. Each should fully inflate.
- .2 After a low temperature cycle, the two inflatable lifejackets should be taken from the stowage temperature of -30°C. One should be activated using the automatic inflation system by placing it in seawater at a

temperature of  $-1^{\circ}\text{C}$  and the other should be activated using the manual inflation system. Each should fully inflate.

**2.10.1.2** After exposure to a temperature of  $-15^{\circ}\text{C}$  for a period of at least 8 h, two lifejackets should be activated using the manual inflation system and should fully inflate.

**2.10.1.3** After exposure to a temperature of  $+40^{\circ}\text{C}$  for a period of at least 8 h, two lifejackets should be activated using the manual inflation system and should fully inflate.

**2.10.2** The test in 2.7 should be conducted using lifejackets both in the inflated and uninflated conditions.

**2.10.3** The tests in 2.8 should be conducted using lifejackets that have been inflated both automatically and manually, and also with one of the compartments uninflated. The tests with one of the compartments uninflated should be repeated as many times as necessary to perform the test once with each compartment in the uninflated condition.

**2.10.4** *Tests of materials for inflatable bladders, inflation systems and components*

The material used for the inflatable bladder, inflation system and components should be tested to establish that they are rot-proof, colour fast and resistant to deterioration from exposure to sunlight and that they are not duly affected by seawater, oil or fungal attack.

**2.10.4.1** *Material tests*

Resistance to rot and illumination tested according to AATCC Method 30:1981 and ISO 105-B04:1988 Illumination should take place to class 4-5.

Following exposure to rot or illumination tests above the tensile strength should be measured using the grab method given in ISO 5082. Minimum tensile strength should be not less than 300 N per 25 mm in the warp and weft direction.

**2.10.4.2** *Coated fabrics*

Coated fabrics used in the construction of inflatable buoyancy chambers should comply with the following requirements:

- .1 Coating adhesion should be tested in accordance with ISO 2411:1991 using the method described in paragraph 5.1 at 100 mm/min and should be not less than 50 N per 50 mm width.
- .2 Coating adhesion should be tested when wet following ageing according to ISO 188 with an exposure of  $336 \pm 0.5$  h in fresh water at  $(70 \pm 1)^{\circ}\text{C}$ , following which the method at ISO 2411:1991, paragraph 5.1 should be applied at 100 mm/min and should not be less than 40 N per 50 mm width.
- .3 Tear strength should be tested in accordance with ISO 4674:1977 using method A1 and should not be less than 35 N.



- .4 Resistance to flex cracking should be tested in accordance with ISO 7854:1984 method A using 9000 flex cycles, there should be no visible cracking or deterioration.
- .5 Breaking strength should be tested in accordance with ISO 1421:1977 using the constant-rate-of-extension (CRE) or constant-rate-of-traverse (CRT) method, following conditioning for  $24 \pm 0.5$  h at room temperature and should not be less than 200 N per 50 mm width.
- .6 Breaking strength should be tested in accordance with ISO 1421:1977 using the CRE or CRT method, following conditioning immersed in fresh water for  $24 \pm 0.5$  h at room temperature and should not be less than 200 N per 50 mm width.
- .7 Elongation to break should be tested in accordance with ISO 1421:1977 using the CRE or CRT method following conditioning at room temperature for  $24 \pm 0.5$  h and should not be more than 60%.
- .8 Elongation to break should be tested in accordance with ISO 1421:1977 using the CRE or CRT method following conditioning immersed in fresh water at room temperature for  $24 \pm 0.5$  h and should not be more than 60%.
- .9 The resistance to exposure to light when tested in accordance with ISO 105-BO2:1988 and the contrast between the unexposed and exposed samples should not be less than class 5.
- .10 The resistance to wet and dry rubbing when tested in accordance with ISO 105-X12:1995 and should not be less than class 3.
- .11 The resistance to seawater should not be less than class 4 in accordance with ISO 105 EO2:1978 and the change in colour of the specimen should not be less than class 4.

#### **2.10.4.3** *Operating head load test*

The operating head load test should be carried out using two lifejackets one lifejacket to be conditioned at  $-30^{\circ}\text{C}$  for 8 h and the other at  $+65^{\circ}\text{C}$  for 8 h. After mounting on the manikin or the test form the lifejackets should be inflated, and a steady force of  $220 \pm 10$  N applied to the operating head as near as possible to the point where it enters the buoyancy chamber. This load should be maintained for 5 min during which the direction and angle in which it is applied should be continuously varied. On completion of the test the lifejacket should remain intact and should hold its pressure for 30 min.

#### **2.10.4.4** *Pressure test*

**2.10.4.4.1** *Overpressure test:* The inflatable buoyancy chambers should be capable of withstanding an internal over pressure at ambient temperature. A lifejacket should be inflated using the manual method of inflation, after inflation the relief valves should be disabled and a fully charged gas cylinder according to the manufacturers recommendation

should be fitted to the same inflation device and fired. The lifejacket should remain intact and should hold its pressure for 30 min. The lifejackets should show no signs of damage such as cracking, swelling or changes of mechanical qualities and that there has been no significant damage to the lifejacket inflation component. All fully charged gas cylinders used in this test should be sized according to the markings on lifejacket.

**2.10.4.4.2** *Relief valve test:* With one buoyancy chamber inflated, the operating head on the opposite buoyancy chamber should be fired manually, using a fully charged gas cylinder according to the manufacturers recommendations. The operation of the relief valves should be noted to ensure that the excess pressure is relieved. The lifejacket should remain intact and should hold its pressure for 30 min. The lifejackets should show no signs of damage such as cracking, swelling or changes of mechanical qualities and that there has been no significant damage to the lifejacket inflation component.

**2.10.4.4.3** *Air retention test:* One inflation chamber of a lifejacket is filled with air until air escapes from the over-pressure valve or, if the lifejacket does not have an over-pressure valve, until its design pressure, as stated in the plans and specifications, is reached. After 12 h the drop in pressure should not be greater than 10%. This test is then repeated as many times as necessary to test a different chamber until each chamber has been tested in this manner.

#### **2.10.4.5** *Compression test*

The inflatable lifejacket, packed in the normal manner should be laid on a table. A bag containing 75 kg of sand and having a base of 320 mm diameter should be lowered onto the lifejacket from a height of 150 mm in a time of 1 second. This should be repeated ten times, after which the bag should remain on the jacket for not less than 3 h. The lifejacket should be inflated by immersion into water and should inflate fully, the jacket to be inspected to ensure that no swelling or change of mechanical properties has occurred, the jacket should be checked for leaks.

#### **2.10.4.6** *Test of metallic components*

**2.10.4.6.1** Metal parts and components of a lifejacket should be corrosion-resistant to seawater and should be tested in accordance with ISO 9227:1990 for a period of 96 h. The metal components should be inspected and should not be significantly affected by corrosion, or affect any other part of the lifejacket and should not impair the performance of the lifejacket.

**2.10.4.6.2** Metal components should not affect a magnetic compass of a type used in small boats by more than 1°, when placed at a distance of 500 mm from it.

#### **2.10.4.7** *Inadvertent inflation test*

**2.10.4.7.1** The resistance of an automatic inflation device to inadvertent operation should be assessed by exposing the entire lifejacket to sprays of water for fixed period. The lifejacket should be fitted correctly to a free-standing manikin of adult size, with a minimum shoulder height of 1,500 mm (see figure 5), or alternatively to an appropriately sized form as shown in figure 2. The lifejacket should be deployed in the mode in which it is worn ready for use but not deployed as used in the water (i.e. if it is equipped with a cover which is normally worn closed, then the cover should be closed for the test). Two

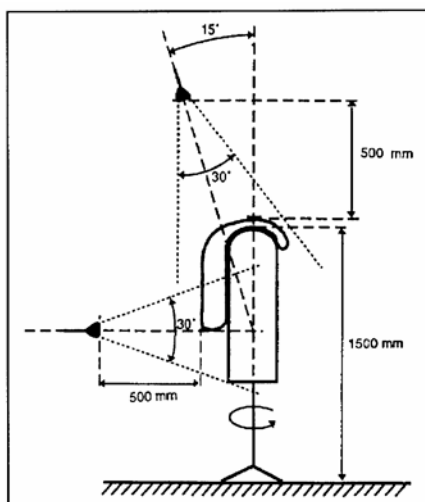
sprays should be installed so as to spray fresh water onto the lifejacket, as shown in the diagram. One should be positioned 500 mm above the highest point of the lifejacket, and at an angle of 15° from the vertical centre line of the manikin and the bottom line of the lifejacket. The other nozzle should be installed horizontally at a distance of 500 mm from the bottom line of the lifejacket, and points directly at the lifejacket. These nozzles should have a spray cone of 30°, each orifice being  $1.5 \pm 0.1$  mm in diameter, and the total area of the orifice should be  $50 \pm 5$  mm<sup>2</sup>, the orifice being evenly spread over the spray nozzle area.

**2.10.4.7.2** The air temperature should be 20°C, and water should be supplied to the sprays at a pressure of 0.3 kPa - 0.4 kPa, a flow of 600 l/h, and a temperature of 18°C to 20°C.

**2.10.4.7.3** The sprays should be turned on, and the lifejacket exposed to the following series of test to access the ability of the jacket to resist inadvertent inflation:

- .1 5 min with the high spray on the front of the lifejacket;
- .2 5 min with the high spray on the left side of the lifejacket;
- .3 5 min with the high spray on the back of the lifejacket; and
- .4 5 min with the high spray on the right side of the lifejacket.

During exposures .1, .2 and .4, the horizontal spray should be applied for 10 periods of 3 s each to the front, left or right sides (but not back) as with the high spray.



**Figure 5 – Test set-up for test of automatic inflation system**

**2.10.4.7.4** After completing the above test, the lifejacket should be removed from the manikin and immersed in water to verify that the auto-inflation system functions.”

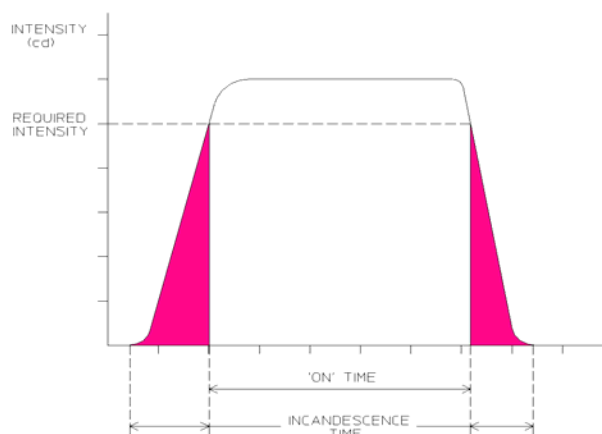
- 8 The existing paragraph 3.1.1 is replaced by the following:

“**3.1.1** These tests should be carried out with at least six able-bodied persons of the following heights and weights:

Height	Weight
1.4 m - 1.6 m	1 person under 60 kg 1 person over 60 kg
1.6 m - 1.8 m	1 person under 70 kg 1 person over 70 kg
over 1.8 m	1 person under 80 kg 1 person over 80 kg

At least one and not more than two of the persons should be females with not more than one female in the same height range.”

- 9 In paragraph 3.1.5, the word “shall” is replaced by the word “should”.
- 10 At the end of paragraph 3.1.7, the sentence “The position of the lifejacket light should permit it to be visible over as great a segment of the upper hemisphere as is practicable.” is added.
- 11 In paragraph 3.1.10, the words “and its attachments” are inserted between the words “anti-exposure suit” and “should not be damaged”.
- 12 In paragraph 3.1.15, the words “for more than 6 s” are inserted between “sustain burning” and “or continue melting”.
- 13 At the end of paragraph 10.4.9, the note is deleted.
- 14 At the end of paragraph 10.4.9, the following new paragraph is added:
- “Flashing lights with a flash duration of not less than 0.3 s may be considered as fixed/steady lights for the measurement of their luminous intensity. Such lights should provide the required luminous intensity in all directions of the upper hemisphere. The time interval between switching on and reaching the required luminous intensity (incandescence time) and all time spent below the required luminous intensity when the light switches off should be disregarded (see figure 10.4.1.)



**Figure 10.4.1 – “On-time” measurement diagram”**

## **PART 2 – *Production and installation tests***

15 In paragraph 2.2, the word “shall” is replaced by the word “should”.

16 The words “, using a dummy smoke signal, if necessary” are inserted between the words “should be” and “to demonstrate” in paragraph 3.1. In the same paragraph, the word “will” is inserted between the words “their attachments” and “drop clear”.

17 The following new appendices 1 to 3 are added after part 2:

### **“APPENDIX 1**

#### **ADULT REFERENCE TEST DEVICE (RTD) DESIGN AND CONSTRUCTION**

1 **General.** The RTD is intended for use only as a test reference standard to represent the desired level of in-water performance of a lifejacket required by the 1974 SOLAS Convention, and is not considered representative of any other required lifejacket performance. The adult RTD is designed to fit persons from a chest size of 700 mm to 1,350 mm and to be comfortable to wear as a non-reversible device such that it would be obvious to the wearer as to which is the inside and outside of the device, even under reduced lighting conditions. The adult RTD is made with two types of buoyant foam in a vest style using a heavy nylon cover fabric shell secured to the body with 25 mm webbing, closures and adjustments. The shell is made with slide fasteners (zippers) in place of closing seams to hold the foam within, in order that the foam inserts can be easily removed to check their buoyancy and renew or supplement them if they are out of tolerance. Hook and loop fasteners are used on the interior foam retainers to position and prevent shifting of the foam panels.

2 **Materials.** All materials used should comply with ISO 12402-7.

2.1 **Foam requirements.** The performance of the RTD is dependent on using plastic foam of the proper stiffness, shape and buoyancy.

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

**2.1.2 Shape.** The shape of each foam insert is specified in figures A.8 to A.11. For dimensions see tables A.2 and A.4.

**2.1.3 Buoyancy.** The total design buoyancy of the device is 155,6 N. Table A.3 specifies the foam characteristics, the buoyancy for each insert and its tolerances and the overall buoyancy distribution to be verified when using the RTD for certification testing.

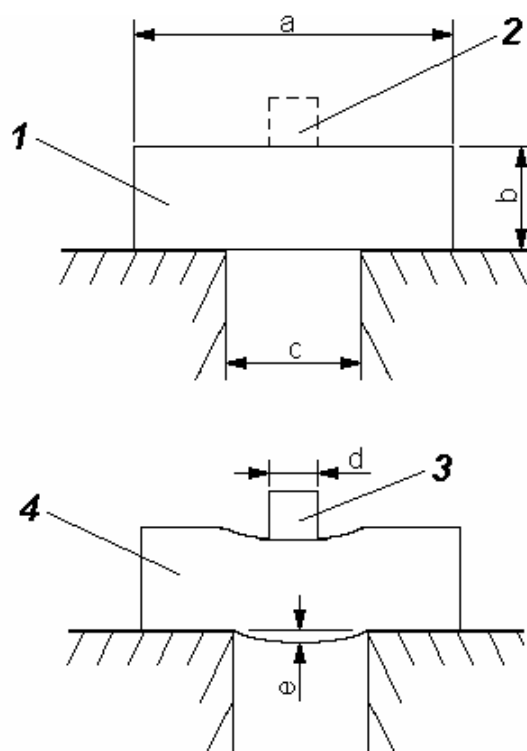
**2.2 Other component requirements.** See table A.2.

**3 Construction.** The construction and assembly of the device should be in accordance with tables A.2 to A.4 and figures A.2 to A.14. A tolerance of  $\pm 6$  mm is used throughout for fabric cutting and stitching assembly. A tolerance of  $\pm 6$  mm is also used for foam cutting, however, the buoyancy requirements of table A.3 should be met.

**3.1 Seams.** The seam allowances are 13 mm, unless otherwise specified. All structural seams use a lock type stitch so that the seam will not unravel when a force is applied in the direction of the seam on any of the threads forming the stitch. Stitching should have a density of 7 to 12 stitches per 25 mm of stitch length. The box-x stitching on the webbing is 15 mm  $\times$  18 mm, unless otherwise specified. The bar-tack stitching on the webbing is 15 mm  $\times$  2 mm.

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

**3.1.2** Tabs on the ends of the waist belt are formed by turning under 40 mm of material twice and stitching 19 mm from the end of the folds with box-x or bar tack stitching.



**Key**

- 1 Foam at initial setup
- 2 Centre load
- 3 Load
- 4 Foam bridge deflection after 30 seconds

**Figure A.1 – Foam bridge deflection test**

**Table A.1 — Specifications for the foam bridge deflection test**

Foam type	Dimension shown in figure A.1						Load mass kg
	a (Length) mm	(Not shown) (Width) mm	b (Thickness) mm	c (Span) mm	d (Load width) mm	e (Deflection) mm	
Stiff	394	110	83	300	120	< 20	8,6
Soft	394	110	45	150	30	≥ 25	0,75

**Table A.2 — Parts, quantity and assembly**

Component	Description	Quantity	See figure	Construction notes
<b>1 Cover fabric</b>	420 denier nylon, with ravel resistant coating, orange			
1.1 Front outer cover		1	A.2	
1.2 Back outer cover		1	A.2	
1.3 Inside cover		1	A.3	
1.4 Centre gusset		2	A.4	

Component	Description	Quantity	See figure	Construction notes
1.5 Collar, outer and inside cover		2	A.5	
1.6 Fabric reinforcement		4	A.6 A.14	Attach to inside of collar cover, as attachment 1, for reinforcement at webbing attachment (see figure A.14).
1.7 Interior fabric retainers for foam inserts 1		2	A.7 A.13	Attach to inside of front cover, as attachment 3, stitch to cover at each side to form a foam retainer for inside front foam insert components 2.2.1 and 2.2.2 (see figure A.13).
1.8 Interior fabric retainers for foam inserts 2		2	A.7 A.14	Attach hoop and loop fasteners to the ends and stitch at centre to the inside of front cover, as attachment 4, to form a foam retainer for front foam insert components 2.1.1 and 2.1.2 (see figure A.13).
<b>2 Foam</b>				
2.1 Stiff	See tables A.1 and A.3			
2.1.1 Front foam insert, right side	81 mm thick	1	A.8	
2.1.2 Front foam insert, left side	81 mm thick	1	A.8	
2.1.3 Collar foam insert	56 mm thick	1	A.10	
2.2 Soft	See tables A.1 and A.3			
2.2.1 Inside front foam insert, right side	46 mm thick	1	A.9	
2.2.2 Inside front foam insert, left side	46 mm thick	1	A.9	
2.2.3 Back foam insert	32 mm thick	1	A.11	
<b>3 Webbing</b>	25 mm, polypropylene, with easy adjustment and no significant slippage when used with the specified hardware.			
3.1 Chest strap	127 mm, black	2	A.12	On left side of front cover, attach webbing with male buckle. On right side of front cover attach webbing with female buckle. The free ends of the chest strap are folded under the yellow



Component	Description	Quantity	See figure	Construction notes
				webbing (collar attachment webbing), with reinforcing fabric (see figure A.6) on inside of cover fabric. A box-x stitch is used to attached the chest strap to the front cover.
3.2 Waist belt	152 mm, black	2	A.12	On left side attach waist belt with slide and buckle clip waist belt. On right side attach bottom belt with D-ring and slide.
3.3 Waist belt	1,867 mm, black	1	A.12 A.13	Form 40 mm tab on each end. Attach to back cover using three box-x stitches (after front and back covers are assembled).
3.4 Belt loop on front cover	76 mm, black	2	A.12	Attach webbing to front outer cover and form a belt loop (one on each side) by two sets of double bar tack stitches
3.5 Belt loop on inside cover	89 mm, black	2	A.13	Attach webbing to inside cover and form a belt loop (one on each side) by two box-x stitches
3.6 Collar attachment	1,384 mm, yellow	1	A.14 A.6 A.12	Attach webbing to collar and reinforcing fabric, in two places using box-x stitch
<b>4 Hook and loop fastener</b>	50 mm × 70 mm, black generic	2	A.13 A.7	Hook and loop fasteners are attached to the ends of interior fabric retainer for foam insert
<b>5 Thread</b>	Generic synthetic	AR		
<b>6 Hardware</b>				
6.1 Buckle	Male and female 25 mm, plastic, 890 N single-end strength	1		Chest strap
6.2 Slide	Adjuster 25 mm, plastic, 1,600 N single-end strength	2		Waist belt
6.3 Snap hook	25 mm, SS, 1,600 N single-end strength	1		Waist belt
6.4 D-ring	25 mm, SS, 1,600 N single-end strength	2		Waist belt
6.5 Zipper	280 mm, plastic (zipper chain and pulls)	1	A.14	Foam access for collar cover

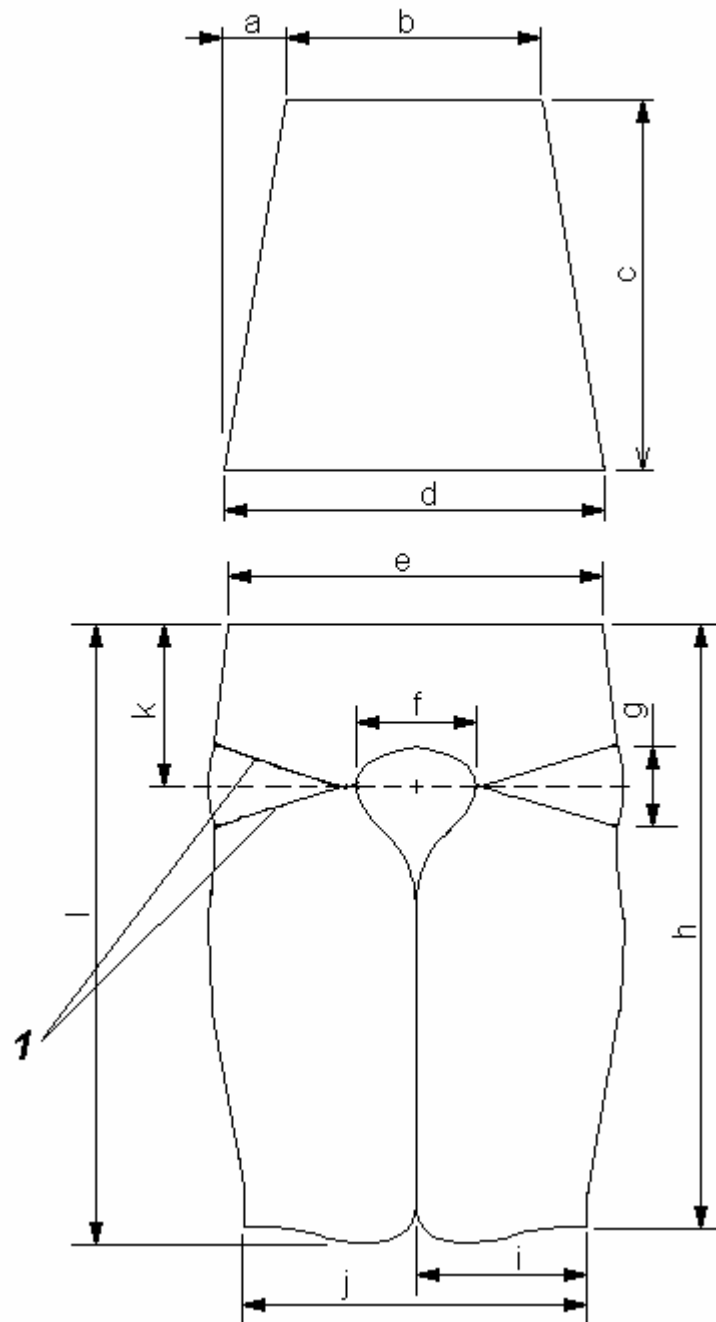
Component	Description	Quantity	See figure	Construction notes
6.6 Zipper	370 mm, plastic (zipper chain and pulls)	1	A.12	Foam access for back cover
6.7 Zipper	440 mm, plastic (zipper chain and pulls)	2	A.12 A.13	Foam access for front cover

**Table A.3 — Foam insert specifications**

Values in Newtons (N)						
	Front right	Front left	Inside front right	Inside front left	Back	Collar
Foam type <sup>a</sup>	Stiff	Stiff	Soft	Soft	Soft	Stiff
Buoyancy <sup>b</sup>	34 ± 1.2	34 ± 1.2	17.5 ± 0.65	17.5 ± 0.65	18 ± 0.8	28 ± 1
<sup>a</sup> The buoyancy of most foams will change over time with the greatest change occurring in the first several months after manufacture. The exact kind of foam selected with need to be evaluated to determine the amount of additional buoyancy needed at the time of manufacture to maintain the values specified.						
<sup>b</sup> Buoyancy distribution: 69 % front ± 1.5 percentage points						

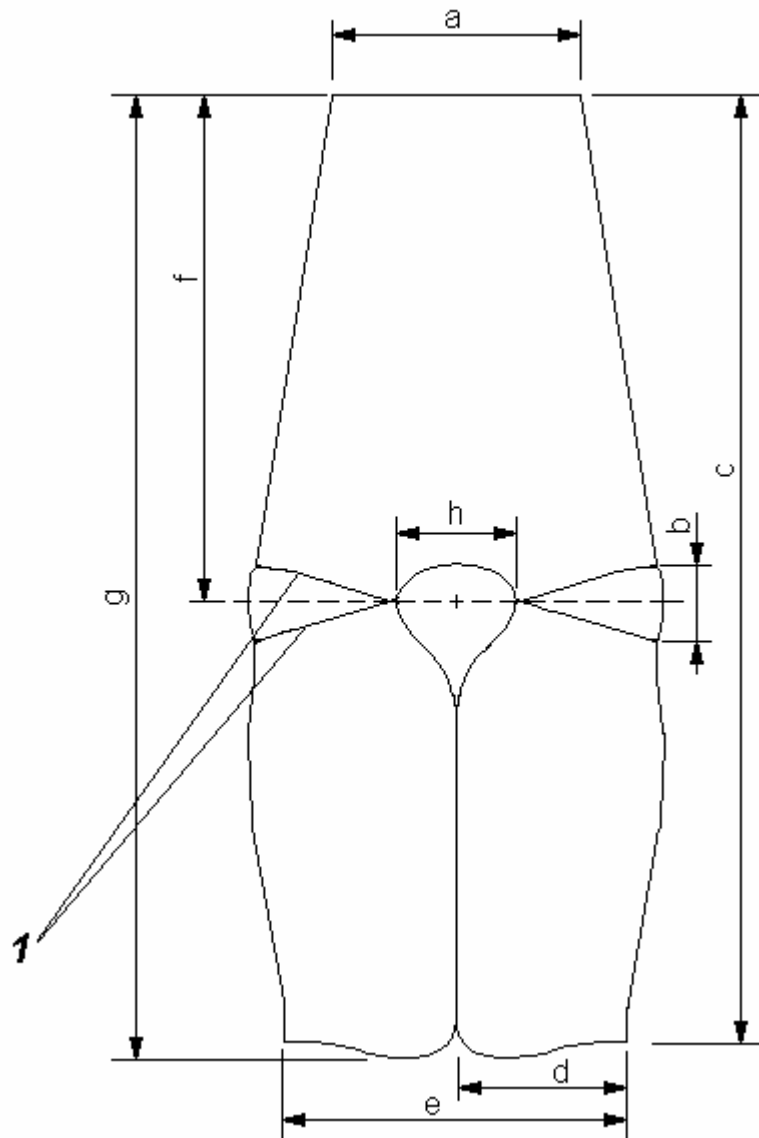
**Table A.4 – List of dimensions shown in figures A.2 to A.14**

Dimensions in millimetres												
Letter	Figure											
	A.2	A.3	A.4	A.5	A.6, A.7	A.8	A.9	A.10	A.11	A.12	A.13	A.14
<i>a</i>	72	294	23	308	73	198	76	20	188	100	100	25
<i>b</i>	298	100	516	142	73	46	46	56	274	35	35	160
<i>c</i>	438	1,106	618	10	130	76	394	51	414	20	20	53
<i>d</i>	442	199	102	288	205	81	38	216	343	35	300	25
<i>e</i>	432	398		342	72	76	51	229	147	120	30	45
<i>f</i>	141	597		476	470	157	165	259	223	260		
<i>g</i>	100	1,124		65		394		45		85		
<i>R</i>								70				
<i>h</i>	705	141				46				40		
<i>i</i>	199					8				55		
<i>j</i>	398					20				225		
<i>k</i>	188					20				75		
<i>l</i>	723					76						
<i>m</i>						46						
<i>n</i>						38						
<i>o</i>						165						
<i>p</i>						25						



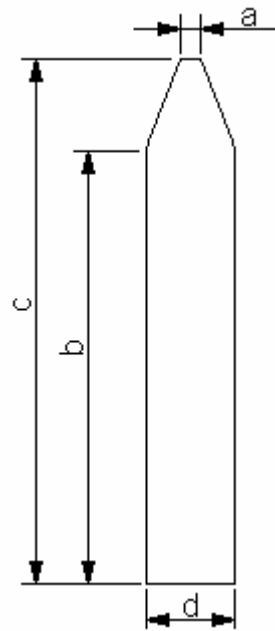
**Key**  
1 Dart

**Figure A.2 – Outer cover, front and back sections**

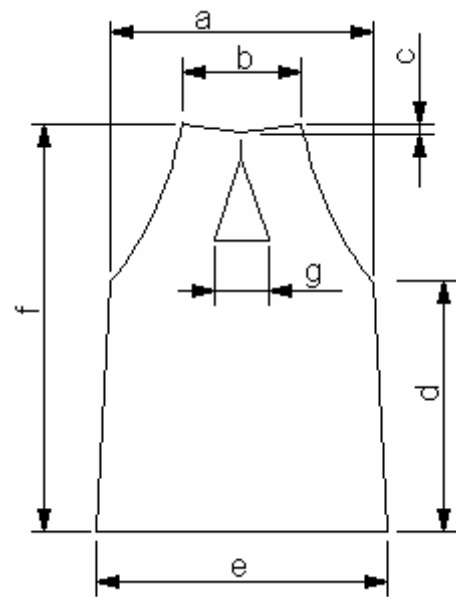


**Key**  
 1 Dart

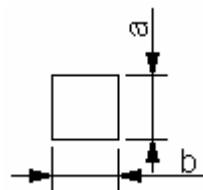
**Figure A.3 – Inside cover**



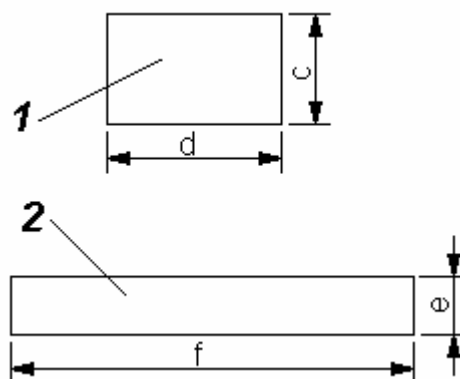
**Figure A.4 – Centre gusset**



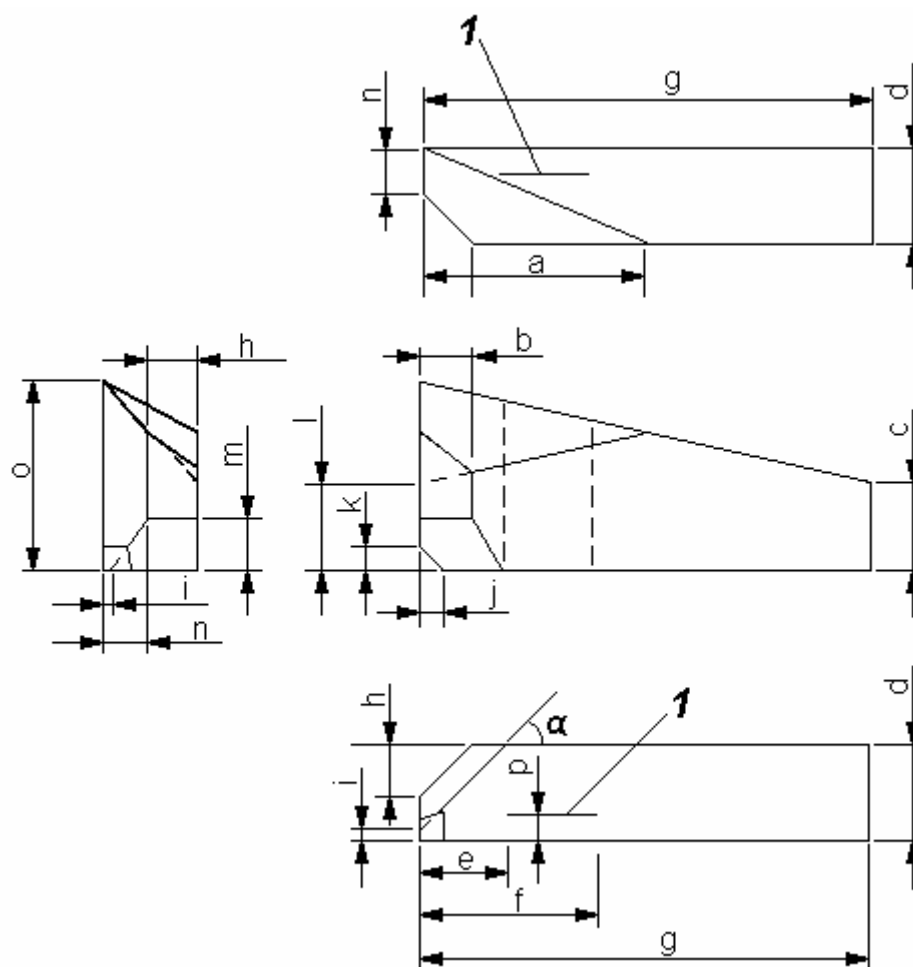
**Figure A.5 – Outer and inside cover, collar**



**Figure A.6 – Fabric reinforcement**

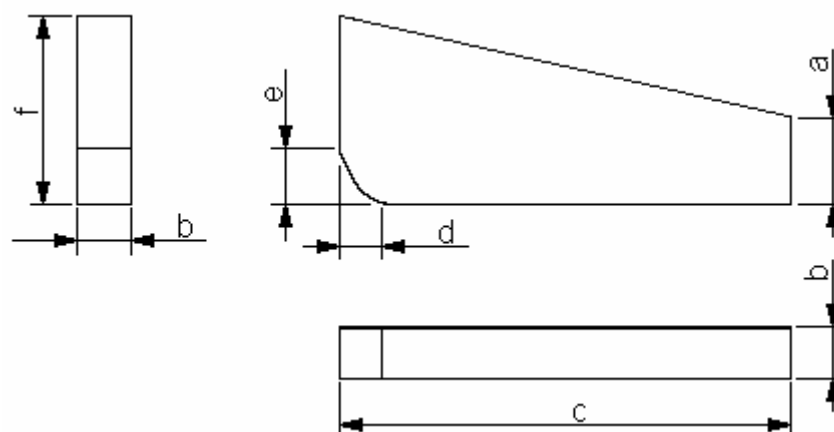


**Figure A.7 – Interior foam retainer**

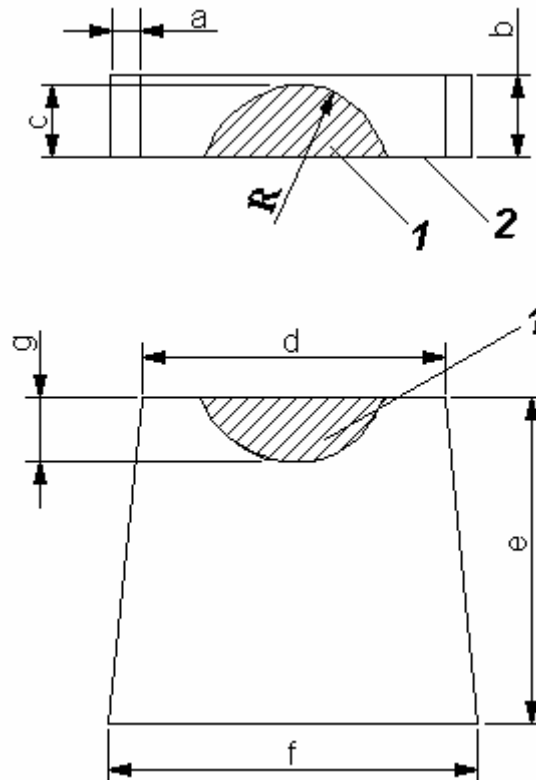


**Key**  
1 Slot  
 $\alpha$  45°

**Figure A.8 – Front foam insert**



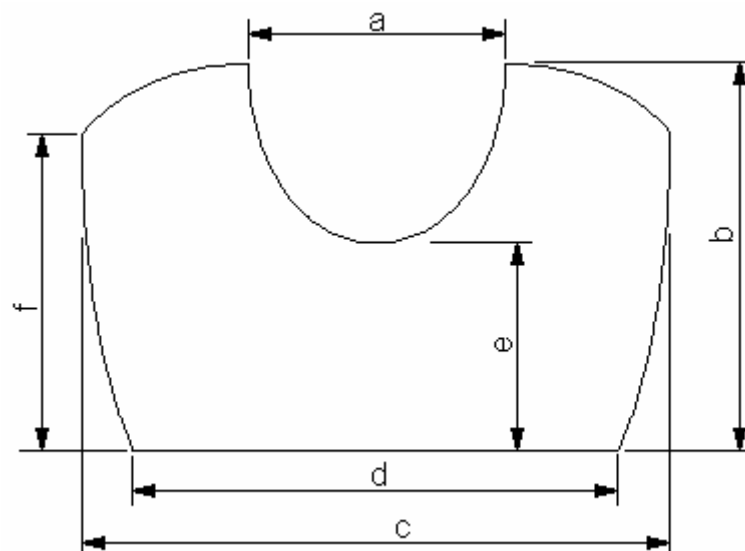
**Figure A.9 – Inside front foam insert**



**Key**

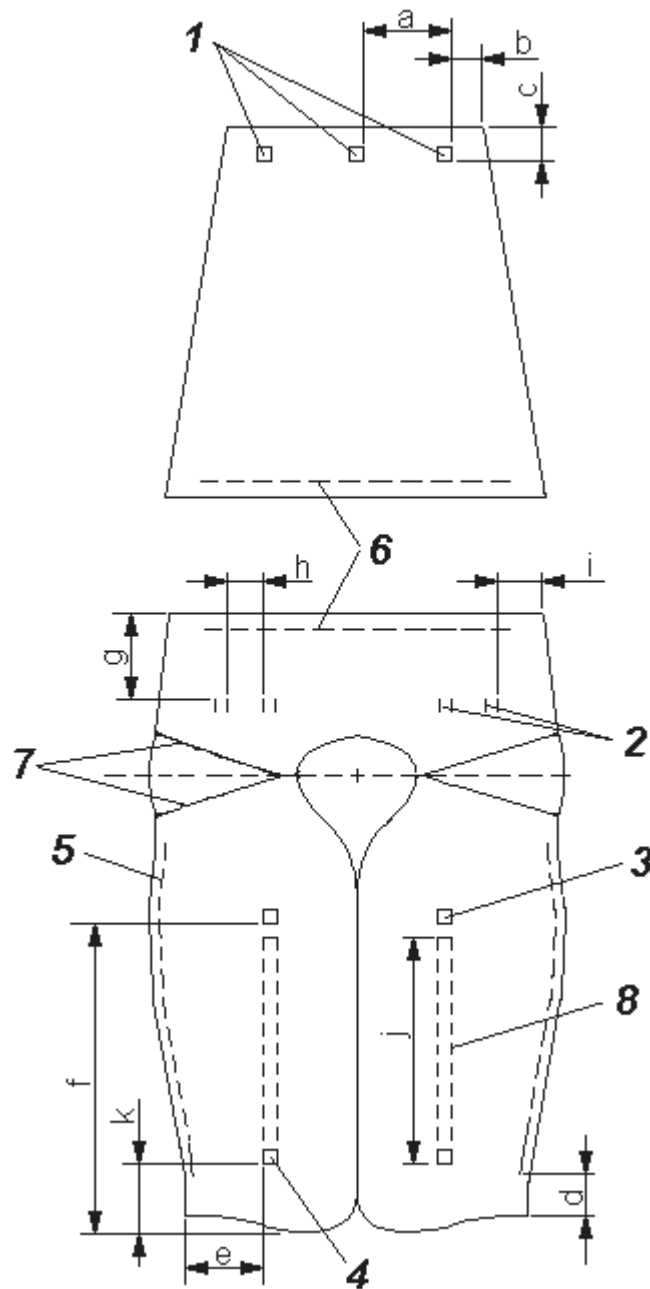
- 1 Skive
- 2 Side towards body

**Figure A.10 – Collar foam insert**



Thickness = 25 mm

**Figure A.11 – Back foam insert**

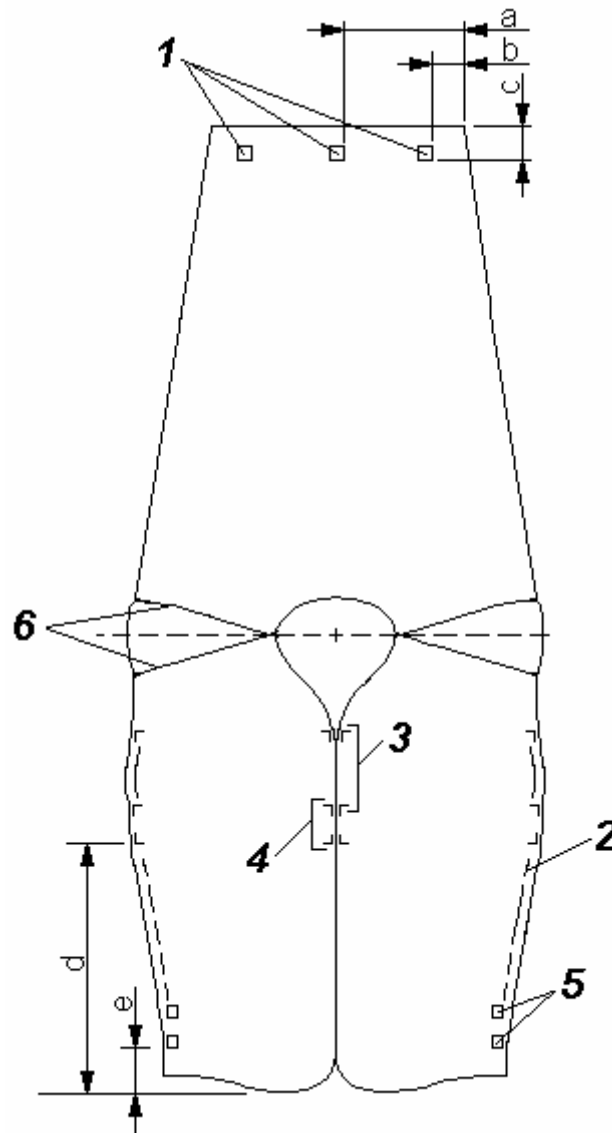


**Key**

- 1 Waist belt (1,867 mm) attachment to outside of back cover
- 2 Zipper (440 mm) attachment to front
- 3 Chest strap webbing (127 mm) attachment to outside of front cover
- 4 Waist belt (152 mm) attachment to outside of front cover
- 5 Belt loop webbing (76 mm) attachment to outside of front cover
- 6 Zipper (370 mm) attachment to the front and back covers
- 7 Dart
- 8 Collar webbing (1,384 mm) attachment to outside of front cover

**Figure A.12 – Attachments to front and back cover**

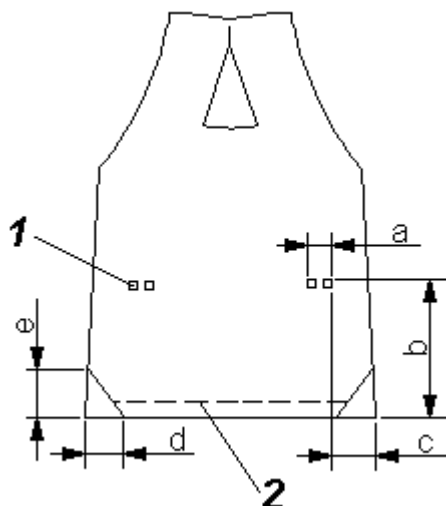




**Key**

- 1 Waist belt (1,867 mm) attachment to outside of back cover and inside cover (see figure A.12)
- 2 Zipper (440 mm) attachment
- 3 Interior fabric retainer attachment to inside front cover
- 4 Interior fabric retainer attachment to centre of inside front cover
- 5 Belt loop webbing (89 mm) attachment to outside of cover
- 6 Dart

**Figure A.13 – Attachments to inside cover**



**Key**

- 1 Collar webbing (1,384 mm) attachment on the outside of the inner cover with reinforcement fabric inside
- 2 Zipper (280 mm) attachment to the outer and inner covers

**Figure A.14 – Attachments to outer and inside collar cover**

## APPENDIX

RTD Serial number: \_\_\_\_\_

### ADULT REFERENCE TEST DEVICE – BUOYANCY TRACKING AND VERIFICATION

To achieve repeatability in human subject testing, the overall buoyancy and distribution of buoyancy between the front and back of the RTD must be maintained within a tight tolerance as specified in Table 1.

**Table 1 – SOLAS adult RTD buoyancy and tolerance**

Limit / Units	Front buoyancy <sup>1</sup>	Back buoyancy	Total buoyancy	Buoyancy distribution <sup>2</sup>
Design / N	103.5	46.5	150	69% in front
Maximum / N	107	48	155	70.5% in front
Minimum / N	100	45	145	67.5% in front

<sup>1</sup> Values at or corrected to standard temperature and pressure.

<sup>2</sup> Buoyancy distribution is calculated by dividing the front buoyancy by the total buoyancy.

The buoyancy of a new RTD may exceed the allowable tolerance range until the normal shrinkage or compression of the foam inserts stabilizes. Until the buoyancies of the foam inserts have stabilized, buoyancy and distribution should be checked at regular intervals (perhaps weekly), and then at least monthly thereafter or whenever used for testing, whichever is longer (frequent use may require more frequent checks). Only RTDs with buoyancies within tolerance should be used for certification testing. A data sheet to document the buoyancy and buoyancy distribution of the RTD is attached.

**Adjustment of buoyancy:** At the time of manufacture the left-to-right distribution of buoyancy in the front inserts was adjusted to be within 1.3 N of each other. To achieve this tolerance, thin layers of foam (“make-up” inserts) may have been inserted between the front and inside front foam inserts. The test house may need to increase the size of these make-up inserts from time to time to keep these parameters within tolerance, or may need to add buoyancy to the back or collar inserts (or trim buoyancy, if the back insert has not shrunk as anticipated). Figure 2 provides guidance for sizing of make-up inserts to adjust buoyancy. After a full sheet of 6.5 mm thick foam is required in any one of the four major areas, an inside front or back insert probably needs to be replaced. If the front buoyancy is under the minimum value, measure the buoyancy of the right and left sides so that the proper distribution of buoyancy (no more than a 1.3 N difference) between the right and left front panels can be maintained.

**Table 2 – SOLAS adult RTD insert design buoyancies**

	Combined left front and inside front <sup>1</sup>	Combined right front and inside front <sup>1</sup>	Back	Collar
Design (N)	34 + 17.75 = 51.75	34 + 17.75 = 51.75	18.5	28
S/N _____ Date: _____				

<sup>1</sup> Plus make-up inserts, if used.

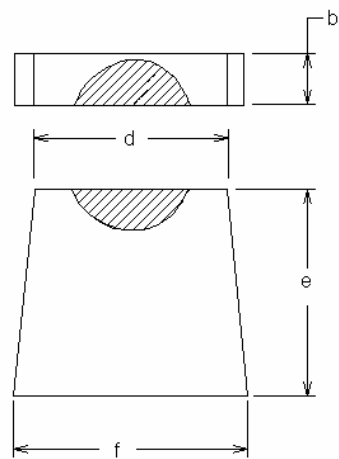
## RTD BUOYANCY DATA SHEET

RTD Serial number/identification: \_\_\_\_\_

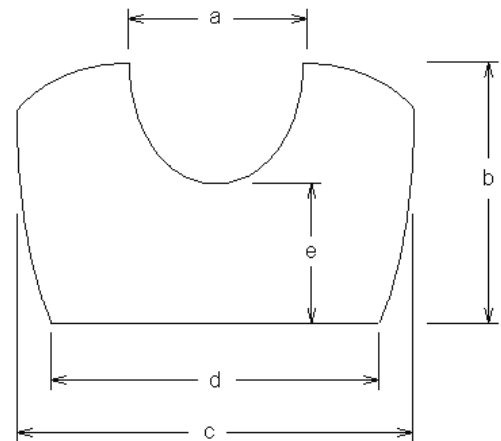
Date	Left front buoyancy (N)	Right front buoyancy (N)	Total front buoyancy (N)	Total back buoyancy (N)	Total buoyancy (N)	Buoyancy distribution (% in front)	Remarks
	(1)		(2)				

(1) Left and right front buoyancy need not be checked if distribution is within tolerance.

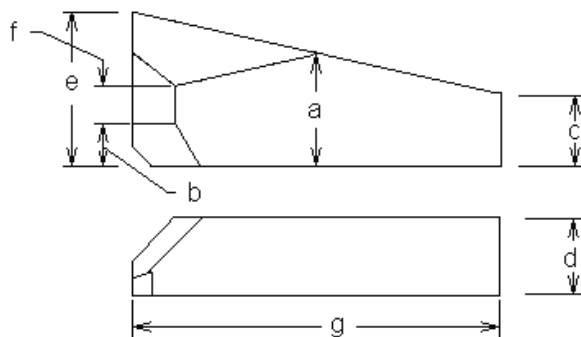
(2) If the temperature and pressure at the time of measurement is not at standard conditions, these values should be corrected to standard temperature and pressure.



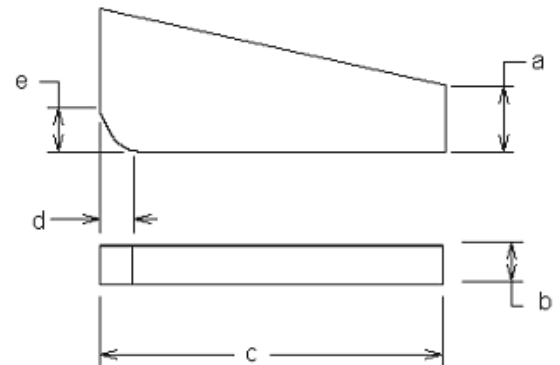
**COLLAR INSERT**



**BACK INSERT**



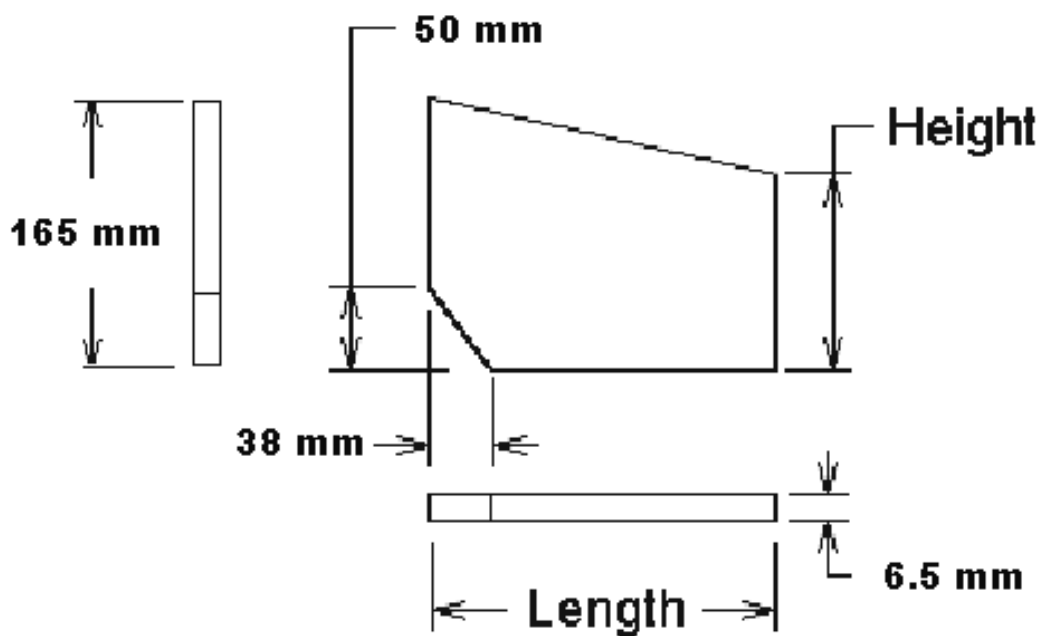
**FRONT INSERT**



**INSIDE FRONT FOAM INSERT**

**Figure 1 – Adult RTD foam insert nomenclature**

Buoyancy (N)	Length (mm)	Height (mm)
0.9	84	146
1.3	126	137
1.8	172	126
2.2	222	114
3.1	394	76



**Figure 2 – Adult RTD “make-up” foam insert sizes**

## APPENDIX 2

### CHILD REFERENCE TEST DEVICE (RTD) DESIGN AND CONSTRUCTION

1 **General.** The RTD is intended for use only as a test reference standard to represent the desired level of in-water performance of a lifejacket required by the 1974 SOLAS Convention, and is not considered representative of any other required lifejacket performance. The child RTD is for persons weighing approximately 15 to 43 kg, or 100 to 155 cm in height. The device is designed to fit persons with chest sizes from 50 cm to 70 cm. This RTD is made with layers of buoyant foam in a bib-style design using a heavy nylon shell cover fabric secured to the body with a waist belt with quick and positive closure and adjustment, along with a chest strap at the neck for closure and adjustment. The shell is made with slide fasteners (zippers) in place of closing seams to hold the foam within, in order that the foam inserts can be easily removed to check their buoyancy and renew or supplement them if they are out of tolerance. The RTD is designed to be reasonably comfortable to wear as a non-reversible device.

2 **Materials.** All materials used should comply with ISO 12402-7.

2.1 **Foam requirements.** The performance of the RTD is dependent on using plastic foam of the proper stiffness, shape and buoyancy.

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

2.1.2 **Shape.** The shape of each foam layer is identified in figures B.2 and B.3. Dimensions are in tables B.1, B.2 and B.3.

2.1.3 **Buoyancy.** The total design buoyancy of the device is 88 N. Table B.4 specifies foam characteristics, the buoyancy for each insert and its tolerances, and the overall buoyancy distribution to be verified when using the RTD for certification testing.

2.2 **Other component requirements.** See table B.1.

3 **Construction.** The construction and assembly of the device should be in accordance with tables B.1 and B.5 and figures B.1 through B.9. A tolerance of  $\pm 6$  mm is used throughout for fabric cutting and stitching assembly. A tolerance of  $\pm 6$  mm is also used for foam cutting, however, the buoyancy requirements of table A.3 should be met.

3.1 **Seams.** Seam allowances are 13 mm, unless otherwise specified. All structural seams use a lock type stitch so that the seam will not unravel when a force is applied in the direction of the seam on any of the threads forming the stitch. Stitching should have a density of 7 to 12 stitches per 25 mm of stitch length. Box-x stitching on the webbing is 30 x 15 mm for the waist belt and 15 x 13 mm for the belt loop and chest strap, unless otherwise specified. The bar-tack stitching on webbing is 30 x 2 mm for the waist belt and 15 x 2 mm for the belt loop and chest strap.

3.1.1 The fabric reinforcements for the waist belt, belt loop and chest strap should be attached to the inside surface of the outside cover before attaching any of these items. On the closing seam of the top and bottom sections of the outside and inside cover, the cut ends of the fabric is turned under and stitched when installing the zippers so that the fabric will not ravel and so that the folds are flush with the line where the zipper teeth mesh (zippers installed to be hidden by cover fabric when closed).

**Table B.1 – Parts, quantity and assembly**

Component	Description	Quantity	See figure	Construction notes
<b>1 Cover fabric</b>	420 denier nylon, with ravel resistant coating, orange		B.1, B.4, and B.9	
1.1 Outside cover		1	B.1, B.4, and B.9	
1.2 Inside cover		1	B.1, B.4, and B.9	
1.3 Fabric reinforcement, chest strap)		2	B.5 and B.9	Attach one each to inside left and right outside covers for the chest strap. Use lock stitches on three sides each (see figure B.9 for locations).
1.4 Fabric reinforcement, belt, and belt loop		2	B.5 and B.9	Attach to inside left and right outside covers for the waist belt and belt loop. Use lock stitches on three sides (see figure B.9 for location).
<b>2 Foam</b>	7 mm thickness, polyethylene (PE) foam, except for one layer as needed to achieve required buoyancy		B.2 and B.3	Layers stacked per figures B.2 and B.3.
2.1 Front foam insert, left		13 layers	B.2	Trim corner of layers A and B only per figure B.2.
2.2 Front foam insert, right		13 layers	B.2	Trim corner of layers A and B only per figure B.2.
2.3 Back foam insert		11 layers	B.3	
<b>3 Webbing</b>				All cut ends heat-sealed.
3.1 Waist belt webbing	38 mm, black, polypropylene, with easy adjustment and no significant slippage when used with the specified hardware.	1,285 mm cut length	B.1, B.8 and B.9	On left side attach waist belt with fixed part of buckle. Tab on the end of belt formed by turning under 40 mm of material twice and stitching 19 mm from the end of the fold with a bar-tack stitch. For location see figure B.9.
3.2 Belt loop webbing	19 mm, black, polypropylene.	80 mm cut length	B.1 and B.9	Attach webbing to front outside cover with two sets of double bar tack stitches to form a belt loop. For location see figure B.9.



Component	Description	Quantity	See figure	Construction notes
3.3 Chest strap webbing	19 mm, black, polypropylene.	235 mm and 80 mm cut length	B.1, B.7 and B.9	Attach webbing with female buckle to right outside cover. Attach webbing with male buckle to left outside cover. For location see figure B.9. Tab formed 75 mm from the free end of the male section of chest strap by folding in "Z" pattern 30 mm apart and stitching 15 mm from the fold with a bar-tack stitch. See figure B.7.
<b>4 Thread</b>	Generic synthetic	AR		
<b>5 Hardware</b>				
5.1 Buckle	38 mm, plastic (male and female sections)	1	B.1 and B.8	Used in waist belt assembly
5.2 Buckle	19 mm, plastic (male and female sections)	1	B.1 and B.7	Used in chest strap assembly
5.3 Zipper	380 mm, plastic (zipper chain length)	1	B.1 and B.9	
5.4 Zipper	150 mm, plastic separating (zipper chain and box/pin length)	2	B.1 and B.9	

**Table B.2 – List of dimensions shown in figure B.2**

Dimension	Insert layer dimensions (mm)				
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>
<i>a</i>	145	140	125	115	95
<i>b</i>	305	300	285	275	255
<i>c</i>	30	30	0	0	0
<i>d</i>	30	30	0	0	0

**Table B.3 – List of dimensions shown in figure B.3**

Dimension	Insert layer dimensions (mm)				
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>
<i>a</i>	343	335	325	315	305
<i>b</i>	140	133	120	108	95
<i>c</i>	9	5	3	0	-5*
<i>R</i>	46	50	52	55	55

\* measured in direction opposite to that shown in figure.

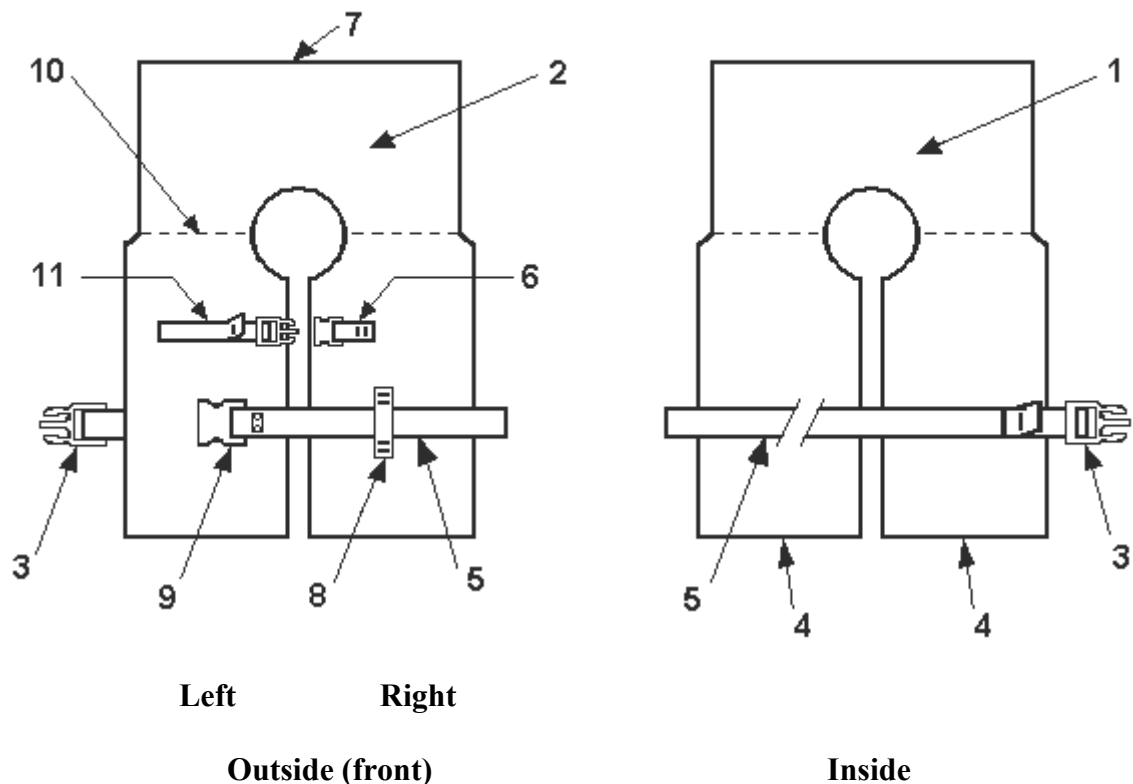
**Table B.4 – Foam insert specifications**

	Left front insert	Right front insert	Back insert
Density	$29 \pm 5 \text{ kg/m}^3$	$29 \pm 5 \text{ kg/m}^3$	$29 \pm 5 \text{ kg/m}^3$
Compressive strength at 25% (ISO 3386-1)	$35 \pm 10 \text{ kPa}$	$35 \pm 10 \text{ kPa}$	$35 \pm 10 \text{ kPa}$
Buoyancy <sup>a, b</sup>	$31.5 \pm 1.2 \text{ N}$	$31.5 \pm 1.2 \text{ N}$	$25 \pm 1.2 \text{ N}$
<sup>a</sup> The buoyancy of most foams will change over time with the greatest change occurring in the first several months after manufacture. The exact kind of foam selected with need to be evaluated to determine the amount of additional buoyancy needed at the time of manufacture to achieve the values specified. <sup>b</sup> Buoyancy distribution: 71.5% front $\pm$ 1.5 percentage points			

**Table B.5 – List of dimensions shown in figures B.4 - B.9**

Dimension	Dimensions (mm)						
	Figure B.4	Figure B.5		Figure B.6	Figure B.7	Figure B.8	Figure B.9
		Key-1	Key-2				
<i>a</i>	420	75	80	75	90	1,150 <sup>*</sup>	45
<i>b</i>	210	105	110		40		135
<i>c</i>	92						85
<i>d</i>	210						45
<i>e</i>	356						25
<i>f</i>	230						33
<i>g</i>	460						115
<i>h</i>	375						25
<i>i</i>	580						265

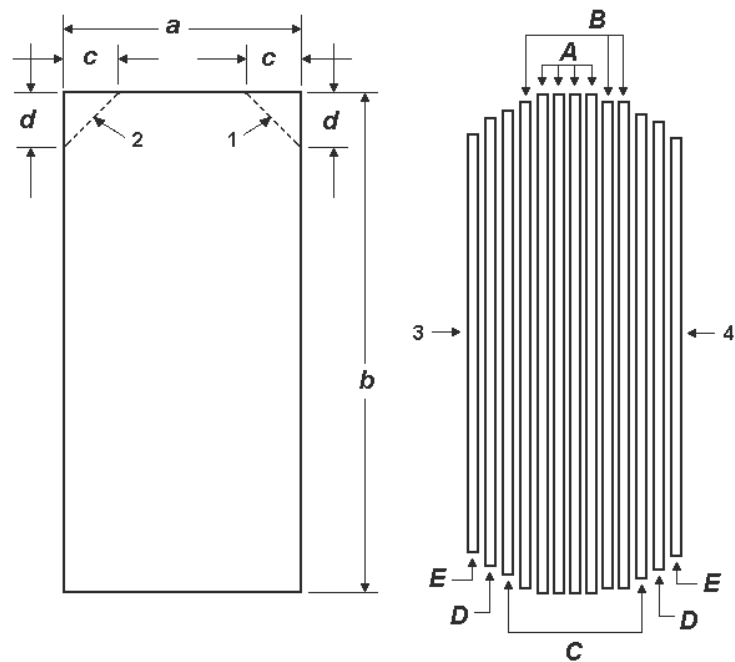
\* With webbing assembly fully extended.



**Key**

- 1 Inside cover fabric
- 2 Outside cover fabric
- 3 Adjustable part of waist belt closure
- 4 Zippers for access to front right and left foam compartment
- 5 Waist belt
- 6 Fixed part of chest strap
- 7 Zipper for access to back foam compartment
- 8 Belt loop
- 9 Fixed part of waist belt closure
- 10 Lockstitch to provide foam compartment separation
- 11 Adjustable part of chest strap

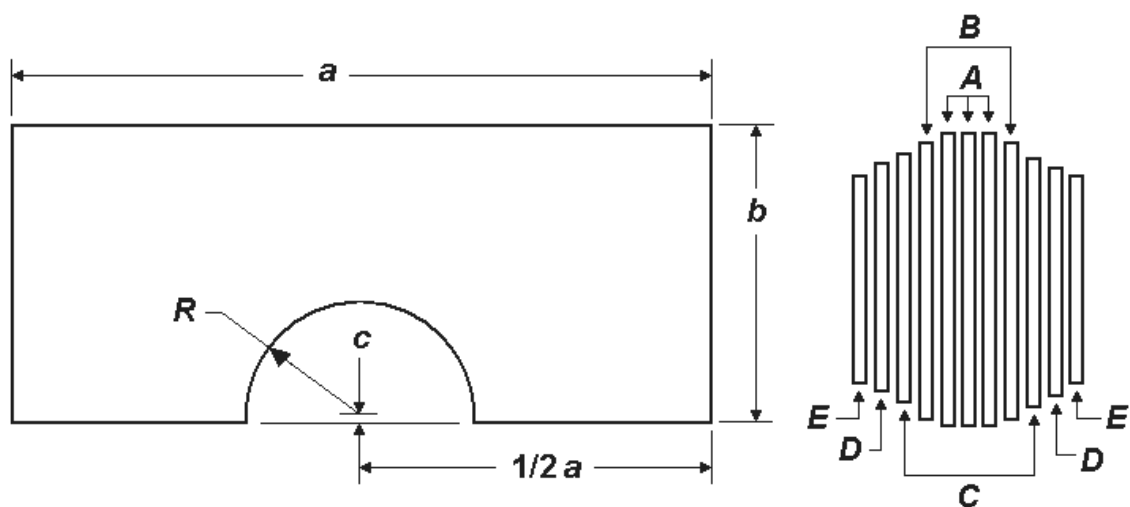
**Figure B.1 – General arrangement, right side out (outside and inside)**



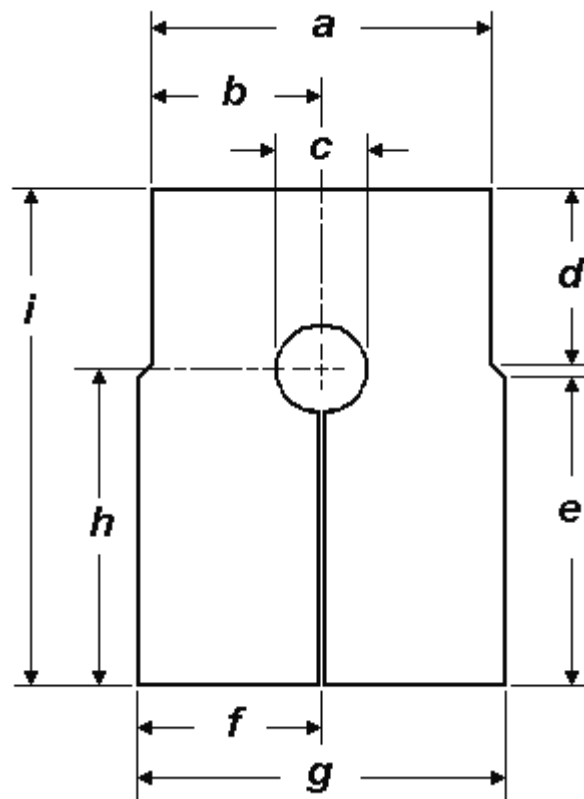
**Key**

- 1 Trim upper right corner only for left insert layers per table B.2
- 2 Trim upper left corner only for right insert layers per table B.2
- 3 Outside
- 4 Inside

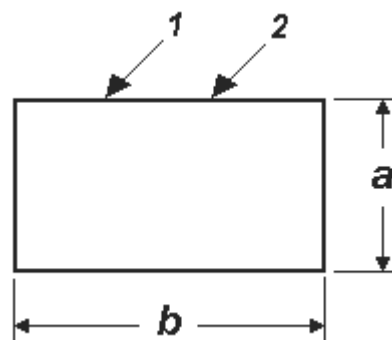
**Figure B.2 – Front foam inserts (right and left sides)**



**Figure B.3 – Back foam insert**



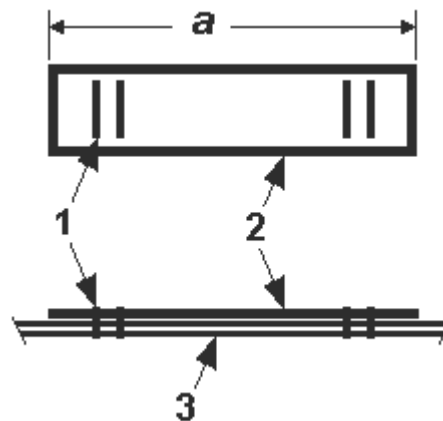
**Figure B.4 – Cover cut pattern (outside and inside covers)**



**Key**

- 1 Fabric reinforcements for chest strap attachments
- 2 Fabric reinforcement for waist belt and belt loop attachments

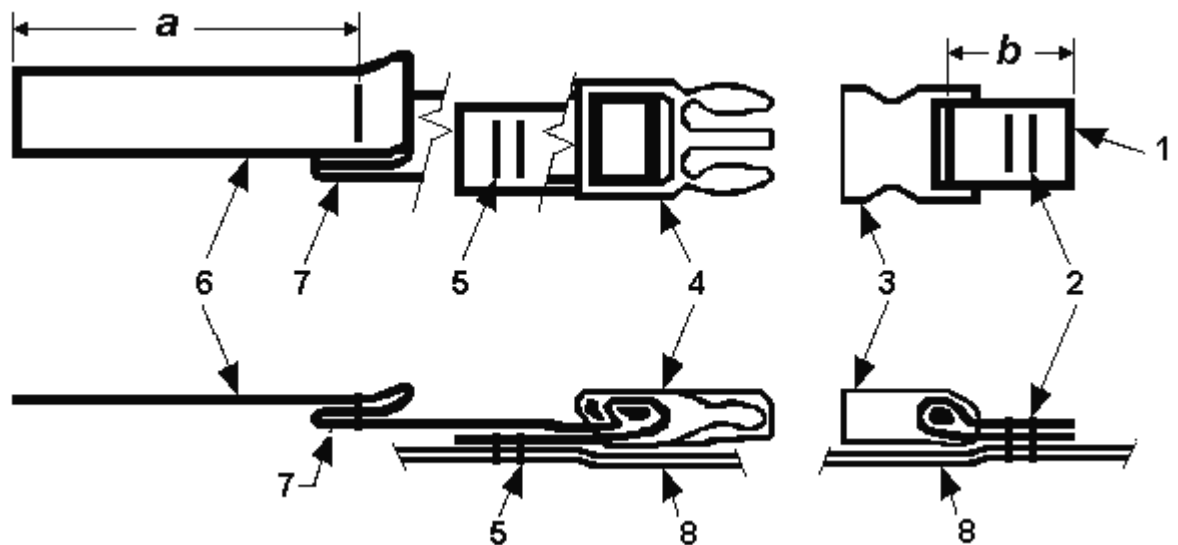
**Figure B.5 – Fabric reinforcements**



**Key**

- 1 Bar-tack
- 2 Webbing
- 3 Outer cover and reinforcement (shown on lower view only)

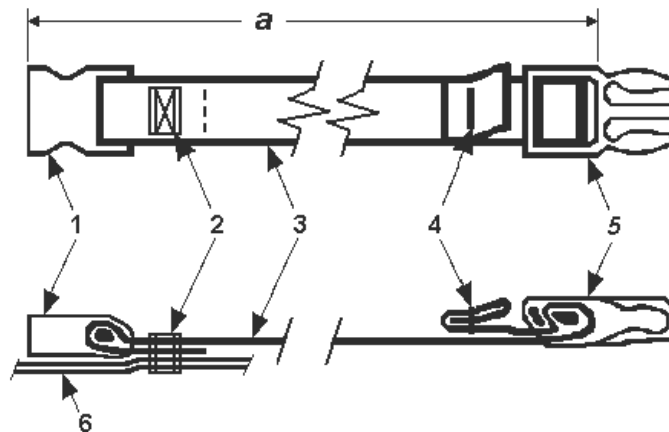
**Figure B.6 – Belt loop**



**Key**

- 1 Webbing
- 2 Double bar-tack (or Box-x) stitch
- 3 Fixed part of closure
- 4 Adjustable part of closure
- 5 Double bar-tack (or Box-x) stitch
- 6 Webbing
- 7 Tab
- 8 Outer cover and reinforcement (shown on lower view only)

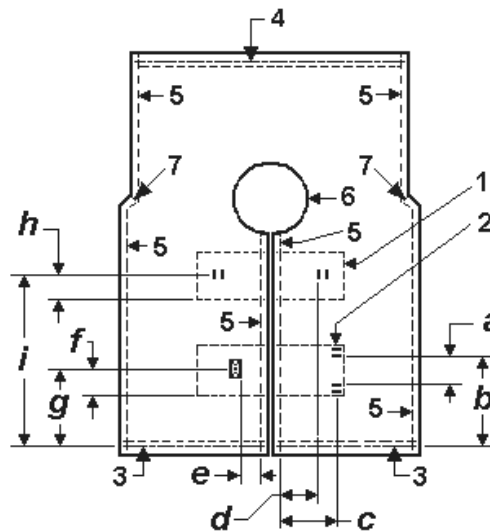
**Figure B.7 – Chest strap assembly (adjustable part left and fixed part right)**



**Key**

- 1 Fixed part of closure
- 2 Box-x (or double bar-tack) stitch
- 3 Webbing
- 4 Tab, double fold webbing and secure with a bar-tack stitch
- 5 Adjustable part of closure
- 6 Outer left cover and reinforcement (shown on lower view only)

**Figure B.8 – Waist belt assembly**



**Key**

- 1 Stitching on interior fabric reinforcement for chest strap on right and left sides of the outside cover
- 2 Stitching on interior fabric reinforcement for waist belt and belt loop on right and left sides of the outside cover
- 3 Fabric fold and zipper teeth line of engagement when zipper is attached to outside and inside covers
- 4 Fabric fold and zipper teeth line of engagement when zipper is attached to outside and inside covers
- 5 Lockstitch seams (with fabric face to face)
- 6 Lockstitch with 5 mm seam allowance and over-edge stitch (with fabric face to face)
- 7 After stitching cut relief

**Figure B.9 – Initial assembly (shown right side out, except as noted)**

## APPENDIX

**RTD Serial number:** \_\_\_\_\_

### **CHILD REFERENCE TEST DEVICE – BUOYANCY TRACKING AND VERIFICATION**

To achieve repeatability in human subject and manikin testing, the overall buoyancy and distribution of buoyancy between the front and back of the RTD should be maintained within a tight tolerance as specified in Table 1.

**Table 1 – SOLAS child RTD buoyancy and tolerance**

Limit / Units	Front buoyancy <sup>(1)(2)</sup>	Back buoyancy <sup>(1)</sup>	Total buoyancy <sup>(1)</sup>	Buoyancy distribution <sup>(3)</sup>
Design / N	63	25	88	71.5% in front
Maximum / N	65.4	26.2	91.6	73% in front
Minimum / N	60.6	23.8	84.4	70% in front

<sup>(1)</sup> Values at or corrected to standard temperature and pressure.

<sup>(2)</sup> The left-to-right buoyancy distribution in the front inserts is to be within 1.3 N of each other.

<sup>(3)</sup> Buoyancy distribution is calculated by dividing the front buoyancy by the total buoyancy.

The buoyancy of a new RTD may exceed the allowable tolerance range until the normal shrinkage or compression of the foam inserts stabilizes. Until the buoyancies of the foam inserts have stabilized, buoyancy and distribution should be checked at regular intervals (perhaps weekly), and then at least monthly thereafter or whenever used for testing, whichever is longer (frequent use may require more frequent checks). Only RTD's with buoyancies within tolerance should be used for certification testing. A data sheet to document the buoyancy and buoyancy distribution of the RTD is attached.

To check buoyancy tolerances, foam inserts need to be removed from the device. Take care that all trapped air is removed when checking buoyancy and that layers are maintained in their proper sequence when reinstalled (considerable effort would be needed to remove entrapped air if testing the intact device).

**Adjustment of buoyancy:** At the time of manufacture the left-to-right distribution of buoyancy in the front inserts was adjusted to be within 1.3 N of each other. To achieve this tolerance, the layers were individually selected to achieve the cumulative insert buoyancy. If buoyancy of a new device exceeds the upper limits, one layer per compartment may be altered or replaced to bring the unit into compliance. The test house may need to add make-up layers (see figure 3) from time to time to maintain the front-to-back and side-to-side insert tolerances. If the front buoyancy is under the minimum value, measure the buoyancy of the right and left sides so that the proper distribution of buoyancy (no more than a 1.3 N difference) between the right and left front panels can be maintained.

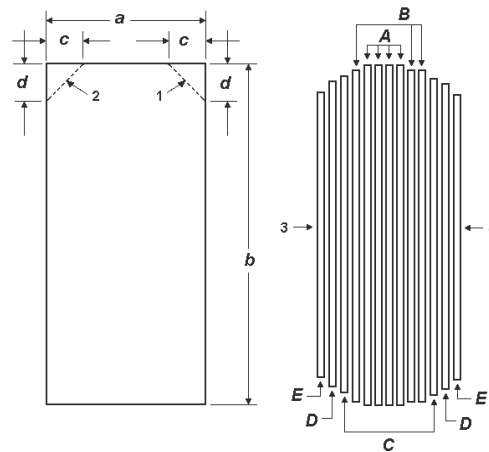


	Combined left front insert (13 layers)	Combined right front insert (13 layers)	Combined back insert (11 layers)
Design (N)	31.5	31.5	25
S/N _____ Date:			

## RTD Serial number/identification: \_\_\_\_\_

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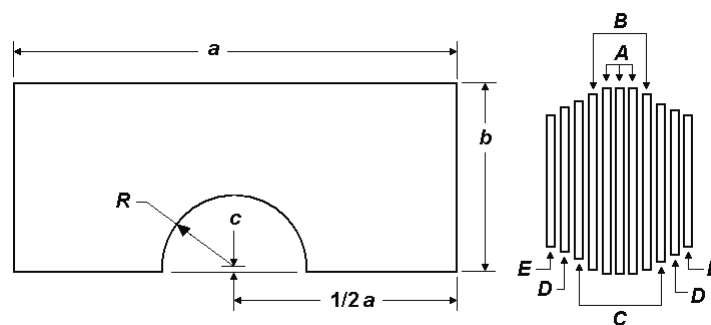


**Key**

- 1 Trim upper right corner only for left insert layers A and B.
- 2 Trim upper left corner only for right insert layers A and B.
- 3 Outside
- 4 Inside

Insert layer	Buoyancy (approx.) (N)	Insert layer dimensions (mm)			
		<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>
A	2.8	145	305	30	30
B	2.7	140	300	30	30
C	2.3	125	285	0	0
D	2.0	115	275	0	0
E	1.6	95	255	0	0

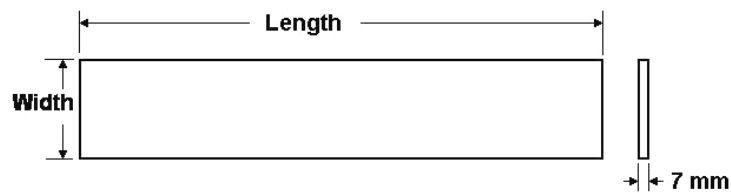
**Figure 1 – Front foam insert specifications**



Insert layer	Buoyancy (approx.) (N)	Insert layer dimensions (mm)			
		<i>a</i>	<i>b</i>	<i>c</i>	<i>R</i>
A	2.8	343	140	9	46
B	2.6	335	133	5	50
C	2.2	325	120	3	52
D	1.9	315	108	0	55
E	1.6	305	95	-5*	55

\* measured in direction opposite to that shown in figure.

**Figure 2 – Back foam insert specifications**



- 1 Any thickness of foam up to 7 mm is acceptable for a make-up layer.
- 2 For 7 mm thick foam, 15,300 mm<sup>2</sup> surface area equals approximately 1 N of buoyancy.

Make-up layer <sup>(1)</sup>	Buoyancy (approx.) (N)	Make-up layer dimensions (mm)	
		Length (mm) <sup>(2)</sup>	Width (mm)
Front	1.0	300	51
	1.5		76
Back	1.0	340	45
	1.5		67

<sup>(1)</sup> For 7 mm thick foam.

<sup>(2)</sup> The length for make-up layer is fixed to maintain proper placement within the lifejacket, but the width may vary to obtain desired buoyancy.

**Figure 3 – Child RTD “make-up” foam insert sizes**

## APPENDIX 3

### INFANT REFERENCE TEST DEVICE (RTD) DESIGN AND CONSTRUCTION

1 **General.** The RTD is intended for use only as a test reference standard to represent the desired level of in-water performance of a lifejacket required by the 1974 SOLAS Convention, and is not considered representative of any other required lifejacket performance. The infant RTD is for persons weighing less than 15 kg, or less than 100 cm in height. The device is designed to fit persons with a chest size of less than 50 cm. This RTD is made with layers of buoyant foam in a bib-style design using a heavy nylon shell cover fabric secured to the body with a waist belt with quick and positive closure and adjustment, along with a chest strap at the neck for closure and adjustment. The shell is made with slide fasteners (zippers) in place of closing seams to hold the foam within, in order that the foam inserts can be easily removed to check their buoyancy and renew or supplement them if they are out of tolerance. The RTD is designed to be reasonably comfortable to wear as a non-reversible device.

2 **Materials.** All materials used should comply with ISO 12402-7.

2.1 **Foam requirements.** The performance of the RTD is dependent on using plastic foam of the proper stiffness, shapes, and buoyancy.

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

2.1.2 **Shape.** The shape of each foam layer is identified in figures C.2 and C.3. Dimensions are in tables C.1, C.2 and C.3.

2.1.3 **Buoyancy.** The total design buoyancy of the device is 71 N. Table C.4 identifies foam characteristics, the buoyancy for each insert and its tolerances, and the overall buoyancy distribution to be verified when using the RTD for certification testing.

2.2 **Other component requirements.** See table C.1.

3 **Construction.** The construction and assembly of the device should be in accordance with tables C.1 and C.5 and figures C.1 to C.9. A tolerance of  $\pm 6$  mm is used throughout for fabric cutting and stitching assembly. A tolerance of  $\pm 6$  mm is also used for foam cutting, however, the buoyancy requirements of table C.4 should be met.

3.1 **Seams.** Seam allowances are 13 mm, unless otherwise specified. All structural seams use a lock type stitch so that the seam will not unravel when a force is applied in the direction of the seam on any of the threads forming the stitch. Stitching should have a density of 7 - 12 stitches per 25 mm of stitch length. Box-x stitching on the webbing is 30 x 15 mm for the waist belt and 15 x 13 mm for the belt loop and chest strap, unless otherwise specified. The bar-tack stitching on webbing is 30 x 2 mm for the waist belt and 15 x 2 mm for the belt loop and chest strap.

3.1.1 The fabric reinforcements for the waist belt, belt loop and chest strap should be attached to the inside surface of the outside cover before attaching any of these items. On the closing seam of the top and bottom sections of the outside and inside cover, the cut ends of the fabric are turned under and stitched when installing the zippers so that the fabric will not ravel and so that the folds are flush with the line where the zipper teeth mesh (zippers installed to be hidden by cover fabric when closed).

**Table C.1 – Parts, quantity and assembly**

Component	Description	Quantity	See figure	Construction notes
<b>1 Cover fabric</b>	420 denier nylon, with ravel resistant coating, orange		C.1, C.4, and C.9	
1.1 Outside cover		1	C.1, C.4, and C.9	
1.2 Inside cover		1	C.1, C.4, & C.9	
1.3 Fabric reinforcement, chest strap		2	C.5 and C.9	Attach one each to inside left and right outside covers for the chest strap. Use lock stitches on three sides each (see figure C.9 for locations).
1.4 Fabric reinforcement, belt and belt loop		2	C.5 and C.9	Attach to inside left and right outside covers for the waist belt and belt loop. Use lock stitches on three sides (see figure C.9 for location).
<b>2 Foam</b>	7 mm thickness, polyethylene (PE) foam, except for one layer as needed to achieve required buoyancy		C.2 and C.3	Layers stacked per Figures C.2 and C.3.
2.1 Front foam insert, left		15 layers	C.2	Trim corners per figure C.2, except outside layers B to G.
2.2 Front foam insert, right		15 layers	C.2	Trim corners per figure C.2, except outside layers B to G.
2.3 Back foam insert		12 layers	C.3	
<b>3 Webbing</b>				All cut ends heat-sealed.
3.1 Waist belt webbing	38 mm, black, polypropylene, with easy adjustment and no significant slippage when used with the specified hardware.	1,085 m m cut length	C.1, C.8 and C.9	On left side attach waist belt with female buckle. Tab on the end of belt formed by turning under 40 mm of material twice and stitching 19 mm from the end of the fold with a bar-tack stitch. For location see figure C.9.

3.2 Belt loop webbing	19 mm, black, polypropylene.	80 mm cut length	C.1, C.6, and C.9	Attach webbing to front outside cover with two sets of double bar tack stitches to form a belt loop. For location see figure C.9.
3.3 Chest strap webbing	19 mm, black, polypropylene.	235 mm and 80 mm cut length	C.1, C.7 and C.9	Attach webbing with female buckle to right outside cover. Attach webbing with male buckle to left outside cover. For location see figure C.9. Tab formed 75 mm from the free end of the male section of chest strap by folding in “Z” pattern 30 mm apart and stitching 15 mm from the fold with a bar-tack stitch. See figure C.7.
<b>4 Thread</b>	Generic synthetic	AR		
<b>5 Hardware</b>				
5.1 Buckle	38 mm, plastic (male and female sections)	1	C.1 and C.8	Used in waist belt assembly.
5.2 Buckle	19 mm, plastic (male and female sections)	1	C.1 and C.7	Used in chest strap assembly
5.3 Zipper	350 mm, plastic (zipper chain length)	1	C.1 and C.9	Installed to be hidden by cover fabric when closed.
5.4 Zipper	180 mm, plastic separating (zipper chain and box/pin length)	2	C.1 and C.9	Installed to be hidden by cover fabric when closed.

**Table C.2 – List of dimensions shown in figure C.2**

Dimension	Insert layer dimensions (mm)						
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>	<i>G</i>
<i>a</i>	140	133	127	120	108	95	83
<i>b</i>	190	184	178	172	165	160	140
<i>c</i>	28	28	28	28	28		

**Table C.3 – List of dimensions shown in figure C.3**

Dimension	Insert layer dimensions (mm)				
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>
<i>a</i>	310	303	290	275	255
<i>b</i>	165	160	140	120	95
<i>c</i>	3	3	3	3	-3*
<i>R</i>	44	44	44	44	44

\* measured in direction opposite to that shown in figure.

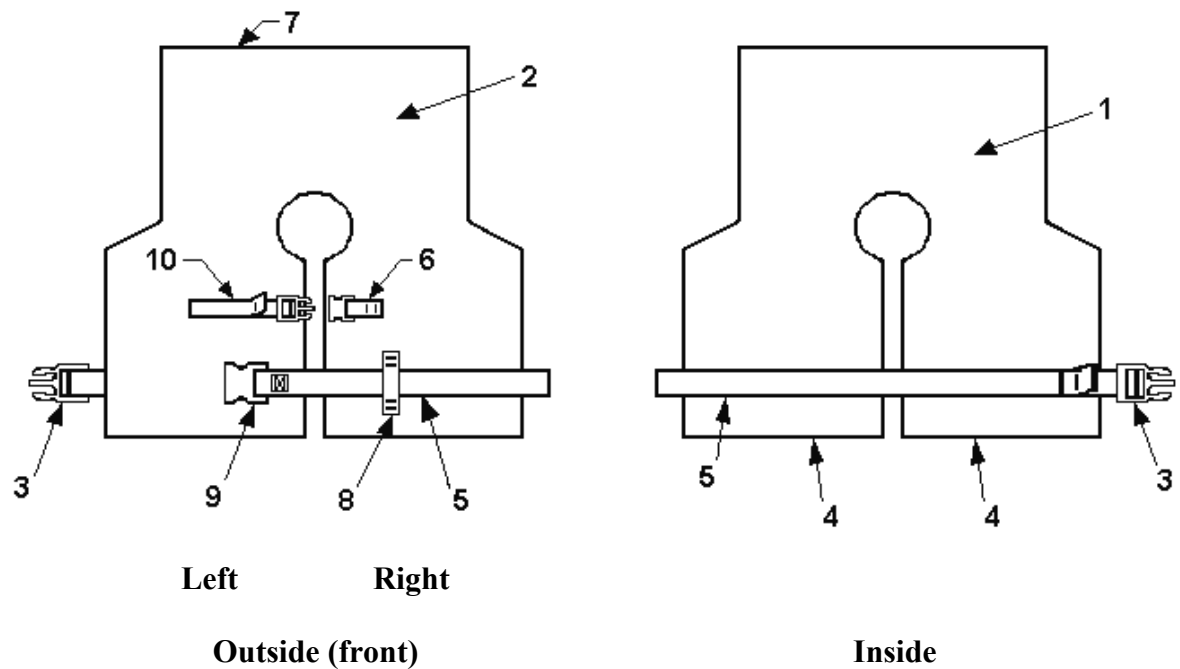
**Table C.4 – Foam insert specifications**

	Left front insert	Right front insert	Back insert
Density	$29 \pm 5 \text{ kg/m}^3$	$29 \pm 5 \text{ kg/m}^3$	$29 \pm 5 \text{ kg/m}^3$
Compressive strength at 25% (ISO 3386-1)	$35 \pm 10 \text{ kPa}$	$35 \pm 10 \text{ kPa}$	$35 \pm 10 \text{ kPa}$
Buoyancy <sup>a, b</sup>	$21 \pm 1.2 \text{ N}$	$21 \pm 1.2 \text{ N}$	$29 \pm 1.2 \text{ N}$
<sup>a</sup> The buoyancy of most foams will change over time with the greatest change occurring in the first several months after manufacture. The exact kind of foam selected will need to be evaluated to determine the amount of additional buoyancy needed at the time of manufacture to achieve the values specified. <sup>b</sup> Buoyancy distribution: 59.2 % front $\pm$ 1.5 percentage points			

**Table C.5 – List of dimensions shown in figures C.4 - C.9**

Dimension	Dimensions (mm)						
	Figure C.4	Figure C.5		Figure C.6	Figure C.7	Figure C.8	Figure C.9
		Key-1	Key-2				
<i>a</i>	390	75	80	75	90	950*	45
<i>b</i>	195	105	110		40		115
<i>c</i>	85						140
<i>d</i>	220						45
<i>e</i>	245						25
<i>f</i>	241						33
<i>g</i>	482						95
<i>h</i>	260						25
<i>i</i>	490						160

\* With webbing assembly fully extended.

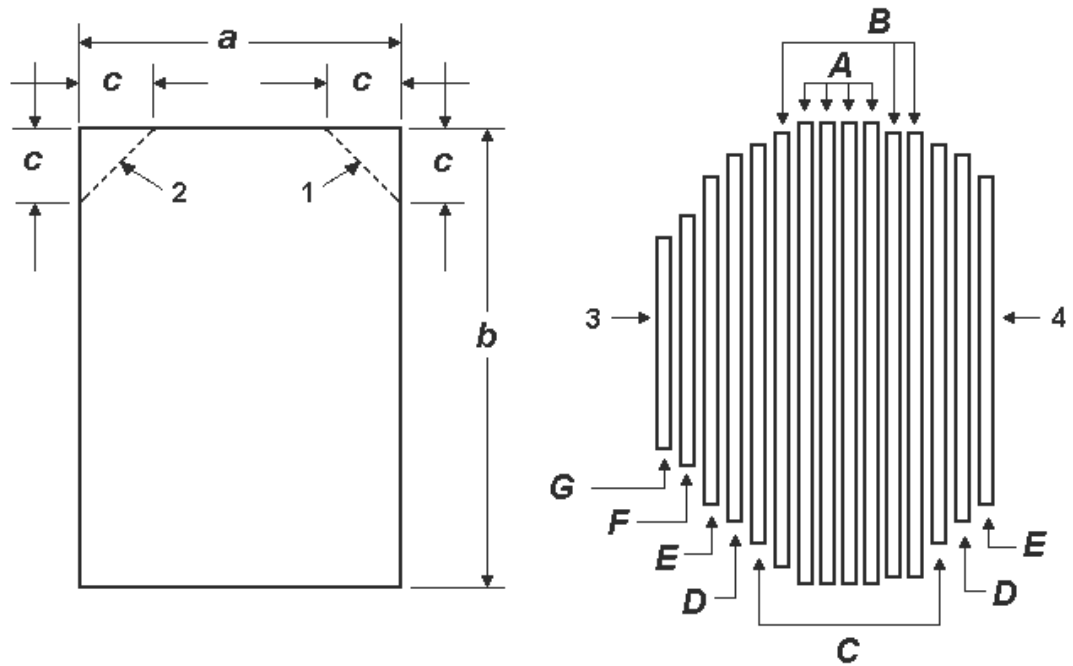


**Key**

- 1 Inside cover fabric
- 2 Outside cover fabric
- 3 Adjustable part of closure
- 4 Zippers for access to front right and left foam compartment
- 5 Waist belt
- 6 Fixed part of chest strap
- 7 Zipper for access to back foam compartment
- 8 Belt loop
- 9 Fixed part of closure
- 10 Adjustable part of chest strap

**Figure C.1 – General arrangement, right side out (outside and inside)**

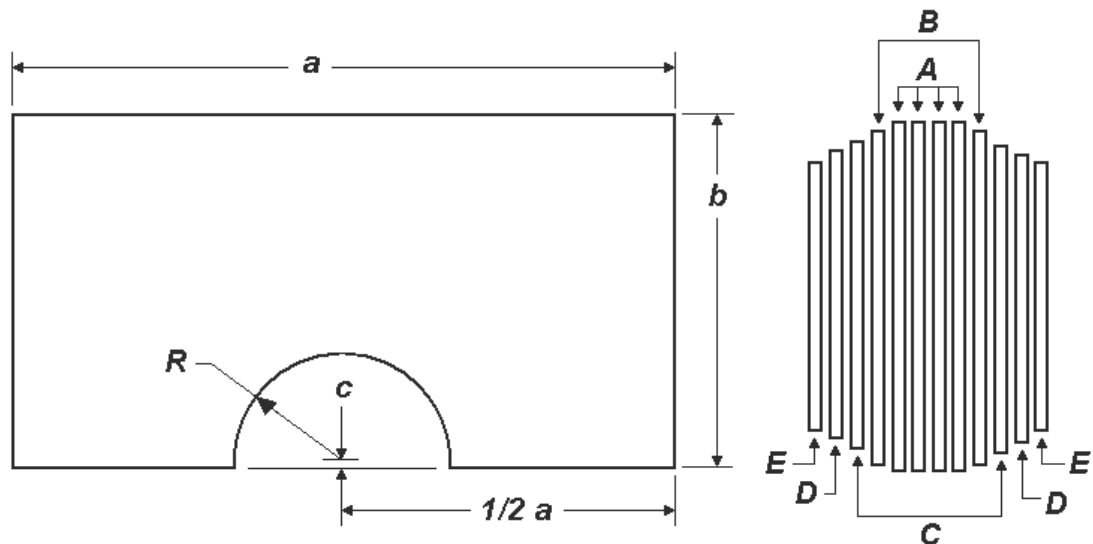




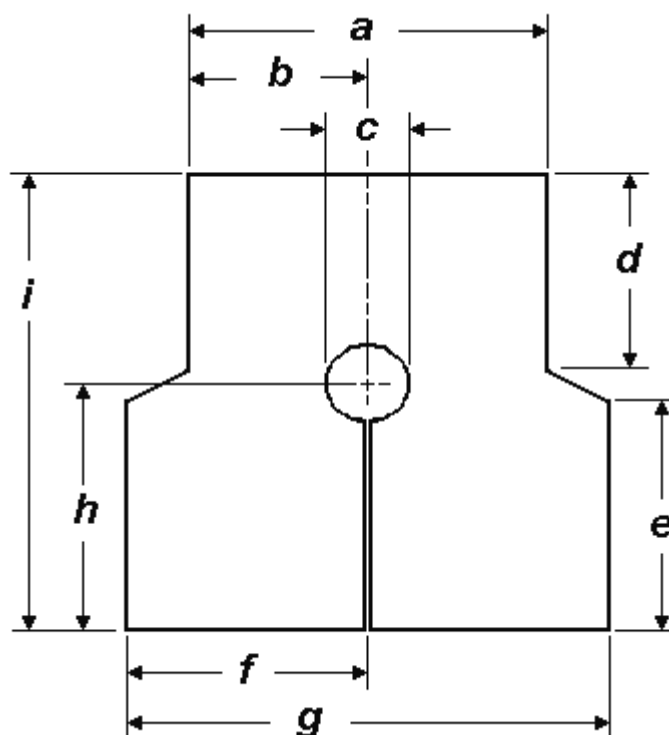
**Key**

- 1 Trim upper right corner only for left insert layers per table C.2
- 2 Trim upper left corner only for right insert layers per table C.2
- 3 Outside
- 4 Inside

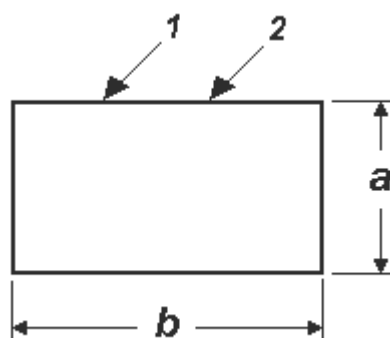
**Figure C.2 – Front foam inserts (right and left sides)**



**Figure C.3 – Back foam insert**



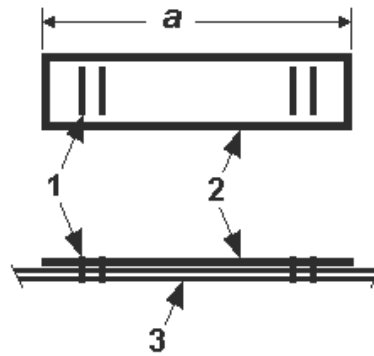
**Figure C.4 – Cover cut pattern (outside and inside covers)**



**Key**

- 1 Fabric reinforcements for chest strap attachments
- 2 Fabric reinforcement for waist belt and belt loop attachments

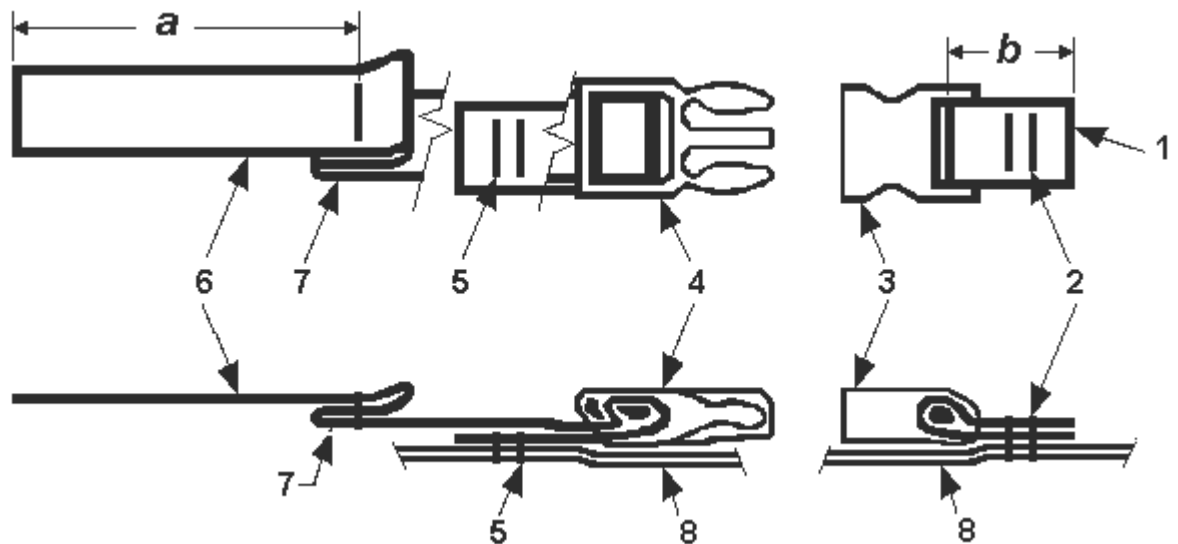
**Figure C.5 – Fabric reinforcements**



**Key**

- 1 Bar-tack
- 2 Webbing
- 3 Outer cover and reinforcement (shown on lower view only)

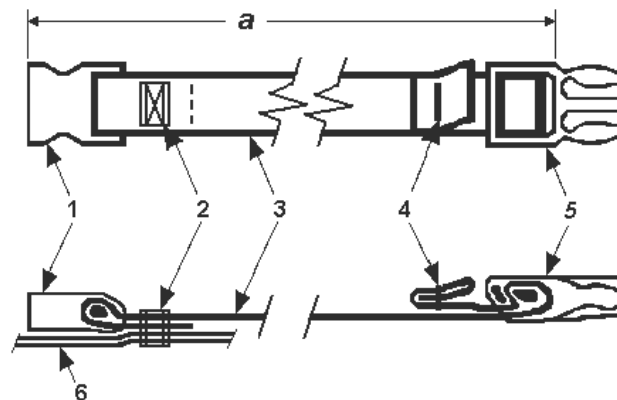
**Figure C.6 – Belt loop**



**Key**

- 1 Webbing
- 2 Double bar-tack (or Box-x) stitch
- 3 Fixed part of closure
- 4 Adjustable part of closure
- 5 Double bar-tack (or Box-x) stitch
- 6 Webbing
- 7 Tab
- 8 Outer cover and reinforcement (shown on lower view only)

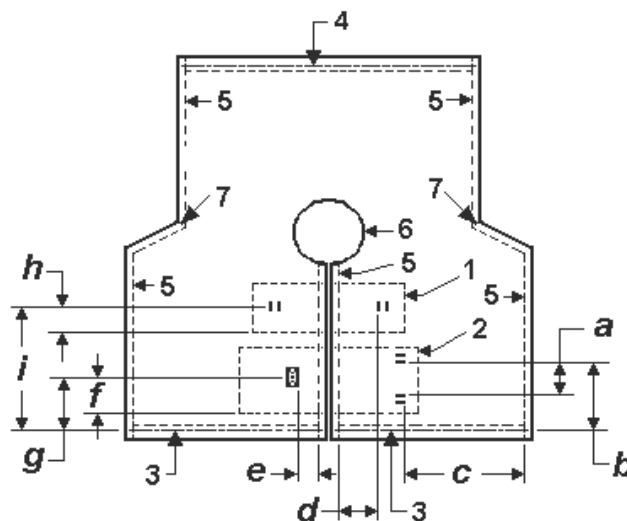
**Figure C.7 – Chest strap assembly (adjustable part left and fixed part right)**



**Key**

- 1 Fixed part of closure
- 2 Box-x (or double bar-tack) stitch
- 3 Webbing
- 4 Tab, double fold webbing and secure with a bar-tack stitch
- 5 Adjustable part of closure
- 6 Outer left cover and reinforcement (shown on lower view only)

**Figure C.8 – Waist belt assembly**



**Key**

- 1 Stitching on interior reinforcement for chest strap on right and left sides of outside cover only
- 2 Stitching on interior reinforcement for waist belt and belt loop on right and left sides of outside cover only
- 3 Fabric fold and zipper teeth line of engagement when attached to outside and inside covers
- 4 Fabric fold and zipper teeth line of engagement when attached to outside and inside covers
- 5 Lockstitch seams (with fabric face to face)
- 6 Lockstitch with 5 mm seam allowance and over-edge stitch (with fabric face to face)
- 7 After stitching seams cut relief

**Figure C.9 – Initial assembly (shown right side out, except as noted)**

## APPENDIX

RTD Serial number: \_\_\_\_\_

### INFANT REFERENCE TEST DEVICE – BUOYANCY TRACKING AND VERIFICATION

To achieve repeatability in human subject and manikin testing, the overall buoyancy and distribution of buoyancy between the front and back of the RTD should be maintained within a tight tolerance as specified in table 1.

**Table 1 – SOLAS infant RTD buoyancy and tolerance**

Limit / Units	Front buoyancy <sup>(1) (2)</sup>	Back buoyancy <sup>(1)</sup>	Total buoyancy <sup>(1)</sup>	Buoyancy distribution <sup>(3)</sup>
Design / N	42	29	71	59.2% in front
Maximum / N	44.4	30.2	74.6	60.7% in front
Minimum / N	39.6	27.8	67.4	57.7% in front

(1) Values at or corrected to standard temperature and pressure.

(2) The left-to-right buoyancy distribution in the front inserts is to be within 1.3 N of each other.

(3) Buoyancy distribution is calculated by dividing the front buoyancy by the total buoyancy.

The buoyancy of a new RTD may exceed the allowable tolerance range until the normal shrinkage or compression of the foam inserts stabilizes. Until the buoyancies of the foam inserts have stabilized, buoyancy and distribution should be checked at regular intervals (perhaps weekly), and then at least monthly thereafter or whenever used for testing, whichever is longer (frequent use may require more frequent checks). Only RTD's with buoyancies within tolerance should be used for certification testing. A data sheet to document the buoyancy and buoyancy distribution of the RTD is attached.

To check buoyancy tolerances, foam inserts need to be removed from the device. Take care that all trapped air is removed when checking buoyancy and that layers are maintained in their proper sequence when reinstalled (considerable effort would be needed to remove entrapped air if testing the intact device).

**Adjustment of buoyancy:** At the time of manufacture the left-to-right distribution of buoyancy in the front inserts was adjusted to be within 1.3 N of each other. To achieve this tolerance, the layers were individually selected to achieve the cumulative insert buoyancy. If buoyancy of a new device exceeds the upper limits, one layer per compartment may be altered or replaced to bring the unit into compliance. The test house may need to add make-up layers (see figure 3) from time to time to maintain the front-to-back and side-to-side insert tolerances. If the front buoyancy is under the minimum value, measure the buoyancy of the right and left sides so that the proper distribution of buoyancy (no more than a 1.3 N difference) between the right and left front panels can be maintained.

**Table 2 – SOLAS infant RTD insert design buoyancies**

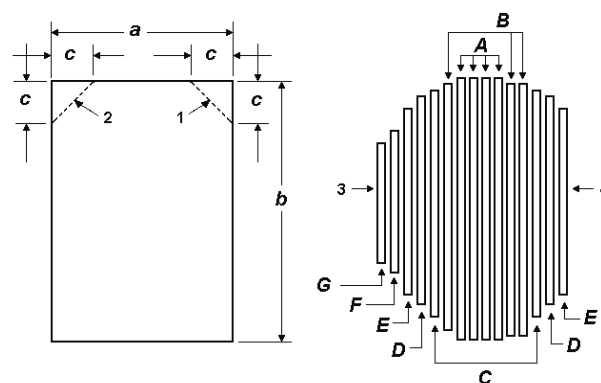
	Combined left front inserts (15 layers)	Combined right front inserts (15 layers)	Combined back inserts (11 layers)
Design (N)	21	21	29
S/N _____			
Date:			

**RTD BUOYANCY DATA SHEET**

RTD Serial number/identification: \_\_\_\_\_

Date	Left front buoyancy (N)	Right front buoyancy (N)	Total front buoyancy (N)	Total back buoyancy (N)	Total buoyancy (N)	Buoyancy distribution (% in front)	Remarks
	(1)		(2)				

- (1) Left and right front buoyancy need not be checked if distribution is within tolerance.  
(2) If the temperature and pressure at the time of measurement is not at standard conditions, these values should be corrected to standard temperature and pressure.

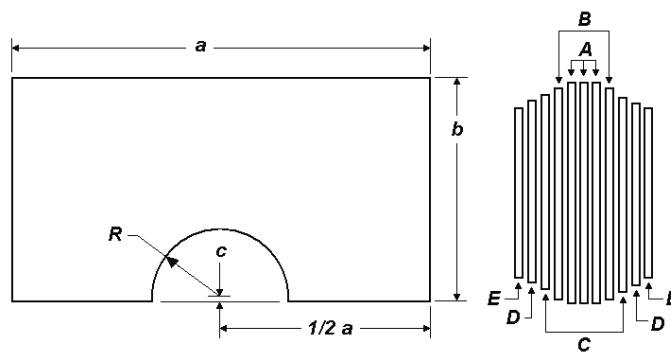


**Key**

- 1 Trim upper right corner only for left insert layers A to E
- 2 Trim upper left corner only for right insert layers A to E
- 3 Outside
- 4 Inside

Insert layer	Buoyancy (N)	Insert layer dimensions (mm)		
		<i>a</i>	<i>b</i>	<i>c</i>
A	1.7	140	190	28
B	1.6	133	184	28
C	1.4	127	178	28
D	1.3	120	172	28
E	1.1	108	165	28
F	1.0	95	160	0
G	0.8	83	140	0

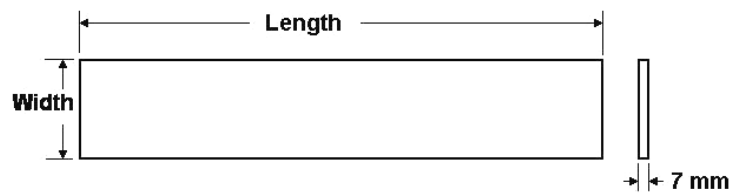
**Figure 1 – Front foam insert specifications**



Insert layer	Buoyancy (N)	Insert layer dimensions (mm)			
		<i>a</i>	<i>b</i>	<i>c</i>	<i>R</i>
A	3.1	310	165	3	44
B	2.9	303	160	3	46
C	2.4	290	140	3	48
D	1.8	275	120	3	50
E	1.3	255	95	-3 <sup>*</sup>	52

\* measured in direction opposite to that shown in figure.

**Figure 2 – Back foam insert specifications**



- 1 Any thickness of foam up to 7 mm is acceptable for a make-up layer.
- 2 For 7 mm thick foam, 15,300 mm<sup>2</sup> surface area equals approximately 1 N of buoyancy.

Make-up layer <sup>(1)</sup>	Buoyancy (approx.) (N)	Make-up layer dimensions (mm)	
		Length (mm) <sup>(2)</sup>	Width (mm)
Front	1	185	82
	1.5		123
Back	1	305	50
	1.5		75

<sup>(1)</sup> For 7 mm thick foam.

<sup>(2)</sup> The length for make-up layer is fixed to maintain proper placement within the lifejacket, but the width may vary to obtain desired buoyancy.

**Figure 3 – Child RTD “make-up” foam insert sizes”**

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RESOLUTION MSC.200(80)  
(adopted on 13 May 2005)  
ADOPTION OF AMENDMENTS TO THE REVISED  
RECOMMENDATION ON TESTING OF  
LIFE-SAVING APPLIANCES