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Floating leisure articles for use on and in the water —

Part 1: Classification, materials, general requirements and test methods

Articles de loisirs flottants à utiliser sur ou dans l'eau —

Partie 1: Classification, matériaux, exigences et méthodes d'essai générales

Reference number
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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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Foreword

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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

ISO 25649-1 was prepared by the European Committee Standardization (CEN) Technical Committee CEN/TC 136, *Sports, playground and other recreational facilities and equipment*, in collaboration with ISO Technical Committee TC 83, *Sports and other recreational facilities and equipment*, in accordance with the agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all the parts in the ISO 25649- series can be found on the ISO website.

Introduction

0.1 Motives, problems, risk assessment, methods

Investigations in statistical data related to drowning accidents and near-drownings create a new awareness about the enormous relevance of drownings in many countries. In particular, during childhood drowning is the second most common cause of death. Due to a lack of exactness of the available statistical data, they do not reveal details concerning the relation between drowning accidents and the involvement of certain products. Such links can be shown only for segments of the wide range of water activities related products. Consumer protection needs to rely on conclusions by risk analysis, experience and analogy to known cases. Considerations based on probability and the precautionary principle is the second access to the problem. That applies in particular for the product group "Floating leisure articles for use on and in the water" as this group is constituted here and now as a market segment to be addressed by standardization for safety reasons. Beyond the statistical deficiencies, relations between certain products and an increased risk of drowning are plausible. A risk analysis undertaken by WG 13 shows what the partial and final risks are.

Until now, standardization has addressed the risks through a wide series of standards aiming at the protection against drowning and covering a number of products used in leisure activities on and in the water. There are standards covering the relevant products for activities like playing in the water, water sports, boating, diving, learning to swim and even the emergency devices as buoyancy aids and live jackets. Beyond these typical and traditional activities and products, there is a new tendency for the creation and marketing of more and more new products. They are all aiming to increase pleasure and entertainment on the water but also more speed, action and thrill as far as the new adventurous activities as "tubing", "white water rafting" etc. is concerned. The new products are partly modified traditional core products or they are derived from them and further developed to something new. Additionally, there is a clear trend to bring more and more formerly land based playground equipment on the water. The term "amphibiation" is justified as in many cases the original function of the product is maintained, i.e. they can be used both ways. Typical examples for the first mentioned kind of new products are modifications of inflatable boats into a bathing raft in fantasy shape or the further development of the earlier swim-ring into a flotation seat. Examples for "amphibians" exist in inflatable trampolines, climbing installations being put on the water for action and fun. Inflatable floating armchairs and sun loungers including the mini bar and sun shade rather serve for more comfort and relaxation when bathing. This trend is clear and very likely to continue.

It can be shown that the nature of these new products provide an equal or even higher risk potential than the original core products. In parallel, the number of these products override the number of the core products. In cases of collective use, the frequency of use is considerably increased which in turn increases the likelihood of accidents — drownings. Drowning is the final risk of the mentioned product related activities, there are other somewhat lesser evils — partial risks — which are likely to happen too independently or in combination with the final risk.

Having in mind the existing safety related standardization, an evident discrepancy emerges. Standardization in the past was focused on the core products and has neglected the huge amount of products forming the so called "grey zone". We always were aware of this fact, but the "grey zone" was so disturbingly complicated and never really considered and investigated. The triggering incident to change this was the swim seat case, its interaction with aquatic toys and all the many related products mentioned above. The fact of negligence highlights the reason. It was due to this inconsistency, variety and complexity that these products were usually excluded from the scopes of related standards. Experts involved in this standardization work therefore invented the term "grey zone products". A systematic risk analysis or an investigation in drowning accidents was never made. What matters today is not so much the fact of a disturbing gap in the series of existing standards but the knowledge that there are a number of coincidences:

— all in all the main user groups of these products are children and adolescents who in turn are the main victims of drowning;

— the main areas where drowning happens are identical with the areas of use for such products (rivers, lakes, pools, bathing beaches);

— the risks can be easily identified partly proven, the increase in numbers and frequencies were already mentioned.

0.2 Equal risk, equal requirement

— Equality of risks shall lead to an equality of technical rules (risk-/rule-alignment);

— closing the standardization gap, completeness;

— setting of clear boundaries between the product areas in order to avoid incorrect certification (e.g. unjustified CE-Mark), "standard jumping" including escape from tougher standards into weaker ones, contributing to overcome the problems of an extremely wide and vague definition of aquatic toys according to European Directive 2009/48/EC and the distinction of shallow and deep water as dividing criterion;

— avoidance of individually established testing procedures by the various test houses in the absence of a unified technical rule.

0.3 Risks and need for prevention

— Relevance of drowning is proven (age groups, places, partly product involvement);

— new products increase frequency of use and amount of products likely to contribute to accidents;

— theoretical risk analysis shows additional risks below the final risk of drowning;

— plausibility and likelihood of harm to users is evident, so is the probability of adequate safety standards to avoid or minimize this;

— to contribute positively to the basic problem of parental supervision which is needed and claimed with regard to child activities but in many cases weak, not existing or neglected;

— safety by utmost inherent safety by design from the product in addition to this technical safety shall be supplemented through supervision it is recommended for younger children;

— we should recognize that there are new trends to bring more and more former land based products on the water, as well as trends to adventure activities increasing the thrill of water related leisure activities and entertainment;

— need for prevention.

0.4 Body dimensions by the USA-population

Body entrapment, human tests subjects and USA anthropometric data: ISO 25649-1 includes test procedures based on human test subjects. The anthropometric data for the worst case human test subject – the heaviest and biggest person representing the 95th percentile of a population – have been derived from European body measurement data. With the current internationalization of this European standard to an ISO 25649 series it is necessary to adapt these European data to international circumstances. The international worst case regarding body dimensions is constituted by the USA-population. The 95.% body weight for the USA population has to be increased from 90 kg to 110 kg and the Body Mass Index (BMI) should be specified between 35 and 40. This corresponds to a body height of 170 cm to 175 cm. Accordingly the rigid test probe has to be modified too. An amendment concerning this subject is in process and will be launched immediately after the formal vote procedure.

Floating leisure articles for use on and in the water —

Part 1:
Classification, materials, general requirements and test methods

1 Scope

This document specifies safety requirements and test methods related to materials, safety, performance for classified floating leisure articles for use on and in water in accordance with Clause 4 (see Table 1).

This document is only applicable with ISO 25649-2 and the relevant specific parts (ISO 25649-3 to ISO 25649-7).

NOTE 1 Specific safety requirements are specified in ISO 25649-3 to ISO 25649-7.

NOTE 2 The specific parts can include exclusions from the general requirements specified in this document and/or ISO 25649-2.

This document is not applicable to:

— aquatic toys according to European Directive 2009/48/EC (use in shallow waters/use under supervision);

— inflatable boats with a buoyancy > 1 800 N according to European Directive 94/25/EC;

— buoyant aids for swimming instructions according to European Directive 89/686/EEC;

— air mattresses which are not specifically designed or intended for use on the water (e.g. velour bed, self inflating mattress and rubberized cotton air mattress);

— floating seats for angling purposes;

— surf sports type devices (e.g. body boards, surf boards);

— water ski, wakeboard or kite surfing board;

— devices made from rigid materials e.g. wood, aluminium, hard or non-deformable plastic;

— devices which are kept in shape by permanent air flow;

— rings intended for use on water slides;

— wading devices.

2 Normative references

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

ISO 105-E03:2010, *Textiles — Tests for colour fastness — Part E03: Colour fastness to chlorinated water (swimming-pool water)*

ISO 105-E04, *Textiles — Tests for colour fastness — Part E04: Colour fastness to perspiration*

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

ISO 868, *Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness)*

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

ISO 3696:1995, *Water for analytical laboratory use — Specification and test methods*

ISO 4675, *Rubber- or plastics-coated fabrics — Low-temperature bend test*

ISO 25649-2, *Floating leisure articles for use on and in the water — Part 2: Consumer information*

EN 71-1:2005, *Safety of toys — Part 1: Mechanical and physical properties*

EN 13138-3:2014, *Buoyant aids for swimming instruction — Part 3: Safety requirements and test methods for swim seats to be worn*

EN 16051-1, *Inflation devices and accessories for inflatable consumer products — Part 1: Compatibility of valves and valve adapters*

EN 20105-A02, *Textiles — Tests for colour fastness — Part A02: Grey scale for assessing change in colour (ISO 105-A2:1993)*

EN 20105-A03, *Textiles — Tests for colour fastness — Part A03: Grey scale for assessing staining (ISO 105-A03:1993)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 16051-1 and the following apply.

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

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
buoyancy
resultant upthrust of a body when totally submerged in water with its uppermost part just below the water surface

Note 1 to entry: For the purpose of measuring, the buoyancy of boats (see ISO 25649-7) is measured as the volume of any chamber, which forms the inflatable hull including components which are permanently fixed to it. This buoyancy is measured by calculation or water filling and measuring the amount of water.

3.2
residual buoyancy
provision of remaining buoyancy in case of a defect of any buoyancy chamber

3.3
inflatable system
components (parts) of a device which contribute to stable floating conditions and/or safety

3.4
component
subgroup of the entire device which contributes to buoyancy, function and safety, integrated or detachable

3.5
static use
use which requires little action with regard to the user

Note 1 to entry: Product is mainly used for relaxing, sun bathing, laying, sitting, etc.

Note 2 to entry: In accordance with intended use.

3.6
dynamic use
use during which the user is in full action

Note 1 to entry: Product is mainly used for activities like jumping, climbing, rollicking (horse playing, rocking), sliding, swinging in and out from the water into or onto the inflatable, etc.

Note 2 to entry: In accordance with intended use.

3.7
positional use
product is used within a limited area

Note 1 to entry: This area is supposed to be in safe proximity to the shore, pool edge, etc.

Note 2 to entry: In accordance with intended use.

3.8
means of propulsion
devices used to generate the movements of a manually operated floating article

EXAMPLE Manually operated floating articles could be equipped with a paddle wheel, swing flipper, oar or paddle.

3.9
test panel
group of test subjects

3.10
assessment panel
group of independent experts checking process to establish compliance with the requirements specified in this document

3.11
conditioning
process to which the complete device is submitted prior to testing

3.12
load
human subjects and other items carried on or in an inflatable structure

3.13
floating stability
capability of a non-moving buoyant structure to withstand internal and external forces which tend to capsize it and maintaining a stable floating position

Note 1 to entry: Internal forces leading to capsizing can result from uneven load distribution, external forces leading to capsizing can result from wind or waves.

3.14
stable floating position
in-water position of a buoyant structure safeguarding upright floating and the on-board position of all passengers in sitting posture but in a position most likely to cause capsizing

3.15
load capacity
value stated by the manufacturer representing the maximum load on a buoyant structure under which a safe floating position is assured

3.16
permanent sealed buoyancy
sealed airtight compartment(s) filled with air, gas or inherent buoyant material

3.17
reinforced material
material which consists of a basic fabric and coated or laminated layer which ensure the air tightness

3.18
permissible maximum working pressure
permissible maximum overpressure indicated by the manufacturer which is measured immediately after the first inflation of the boat using a defined measuring device

Note 1 to entry: Where the permissible maximum working pressure is given by a range, the upper limiting value is decisive.

4 Classification and criteria to distinguish floating leisure articles from aquatic toys

Floating leisure articles shall be classified by their intended use, means of propulsion and design as set out in Table 1.

Table 1 — Classification and criteria to distinguish floating leisure articles from aquatic toys

Class	Description/Structural design criteria	Not an aquatic toy because:
A[b]	Floating leisure articles intended for quasi-static positional use on the water and position of user upon the buoyant structure. Single and collective use, mainly passive. Normally no mechanical means of propulsion, but possible. Devices may be of design that provides floating stability others do not and need to be balanced by the user. — minimum age above 36 months — the product includes use in deep water.	— provokes use in deep water; and/or due to size product is at risk to be blown into open waters and/or — labelling includes adult use; and/or — product is labelled not to be a toy; and/or — product includes a body opening inside a circumferential buoyancy system around the user's body and thus a serious entrapment risk.
B[b]	Floating leisure articles intended for quasi-static use but position of user inside a buoyant structure around the user's body (relatively tight fit). Buoyant structure fully enclosing or with openings. Devices may provide a body holding system or user is expected to hold himself by the upper arms and hands. Body holding system might be an integrated seat, straps or other means of holding regardless of the body posture (sitting, standing, laying, kneeling etc.). User's body is more or less immersed. Normally the upper part (chest upwards) is out of the water. Single or collective / passive or active use. Normally no mechanical means of propulsion but possible. — B1: use out of user's standing depth. — minimum age / body weight: variable but above 36 months / 18 kg.	— product includes a body opening inside a circumferential buoyancy system around the user's body and thus a serious entrapment risk; and/or — product needs for appropriate use a water depth beyond user's standing depth; and/or — product is labelled not to be a toy; and/or — intended use includes adults (label); and/or — use of product depends on deep water or use in deep water is foreseeable.
C[b]	Floating leisure articles for dynamic use, i.e. application at high speed. Position of user is upon or inside the buoyant structure. There may be a cockpit or seat or other means to give hold to the user. The device is towed behind external means of propulsion. Towing rope fixed to device or held by user. User is required to manage floating stability and safe course behind the towing devices. — C1: static use towable, static user. — C2: active sport use towable, active user, sport application. — C3: active extreme use towable, active user, extreme application. — use beyond user's standing depth. — minimum age variable but above 6 years.	— product is towed by non-manual means; and/or — product use exceeds a speed limit of 3 km/h; — intended use includes adult users (via labelling); and/or — product is labelled not to be a toy; and/or — use of product depends on deep water, or use in deep water is foreseeable.
D[b]	Floating leisure articles for passive (resting, relaxing on flat surface) but mainly active use i.e. climbing, jumping (more than 1 m), swinging, rotating and any related activity. No distinct position of user. Single or collective use. No mechanical means of propulsion. Shall be anchored. — minimum age variable but above 36 months. — the product includes use in deep water.	— product includes usability for jumping and climbing on or to a height of more than 1,0 m; and/or — labelling does not include the warning note according to EN 71 concerning supervision and use in shallow water only; and/or — labelling includes adult use; and/or

a Except long thin protrusions as e.g. the neck of a swan shaped inflatable.

b For typical products, see risk analysis (as described in the introduction).

Table 1 *(continued)*

Class	Description/Structural design criteria	Not an aquatic toy because:
E[b]	Inflatable boats with buoyancy less than 1 800 N and an overall length of more than 1,2 m. Single and collective use. Position of user inside the buoyant structure (wide cockpit). Propulsion: manually, motor, sail. — minimum length over all (uninflated, flat) = 1,2 m. — minimum age variable but above 36 months.	— largest uninflated dimension[a] exceeds 1,2 m; and/or — product is equipped or intended for mechanical means of propulsion; and/or — labelling does not include the warning note according to EN 71 concerning supervision and use in shallow water only; and/or — labelling includes adult use; and/or — use[a] of product depends on deep water or use in deep water is foreseeable.

a Except long thin protrusions as e.g. the neck of a swan shaped inflatable.

b For typical products, see risk analysis (as described in the introduction).

5 General safety requirements and test methods related to all classes

5.1 General

Floating leisure articles for use on and in the water shall be designed in a way that they are safe and usable for persons of a minimum age of 36 months and above, also in deep water where the user is out of its standing depth.

Via adequate labelling, it shall be made clear to the consumer and user that these articles are intended for swimmers only, that they do not provide protection against drowning and that they are not PPE (Personal Protective Equipment).

These basic requirements are deemed to be met if a product complies with the relevant parts of this series of standards.

ISO 25649-3 to ISO 25649-7 may include deviations and exclusions from the above.

5.2 Body entrapment

5.2.1 General

5.2.1.1 Introduction

Floating leisure articles shall not have accessible design features that may cause body entrapment. This requirement is deemed to be met if the following requirements are met and the specified test procedures prove that body entrapment does not occur.

Design features i.e. gaps, openings, slots etc. are categorised in design types A to E as shown in Annex A and Annex B. They include features providing fixed interior spaces and such with flexible interior components/spaces and thus variable dimensions. Design features likely to cause entrapment may be arranged in the plane but also in 3-dimensional structures providing considerable height as e.g. ladder structures, labyrinths or body enclosing structures. Testing should be undertaken according to the instructions laid out in this document.

5.2.1.2 Accessibility

Design features accessible to the test person in any stable floating position the product can take on the water.

5.2.1.3 Product categorization regarding age group and body weight of user/test persons/torso templates

Products shall be labelled with regard to their intended user groups according to ISO 25649-2. With regard to body entrapment floating leisure articles are to be distinguished in two sizes only: child use and adult use: Child use includes age group 3 years to 10 years of age/body weight 18 kg to 45 kg respectively.

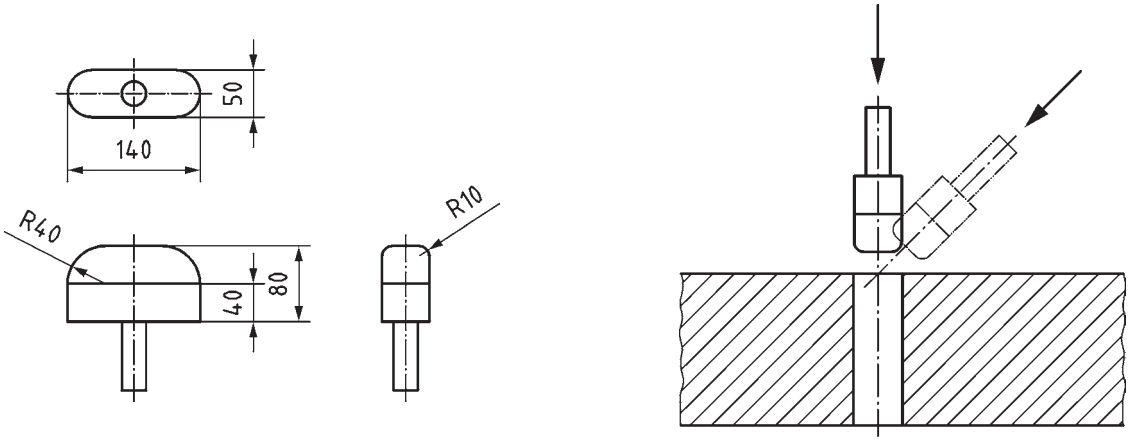
Products for combined child /adult use or adult use only include all other user groups. According to these user groups the relevant foot and torso probes or the test persons shall be applied for testing.

5.2.1.4 Probes

5.2.1.4.1 Foot probe, child

Test probe (see Figure 1), 3 years, 5th percentile (smallest foot dimension).

Dimensions in millimetres

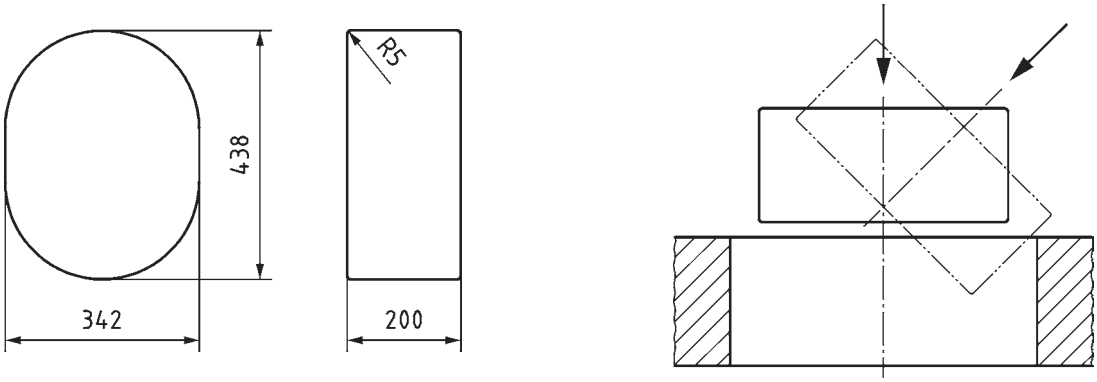


a) Dimensions of probe **b) Application of probe**

Figure 1 — Foot probe

5.2.1.4.2 Torso probes, adult and child

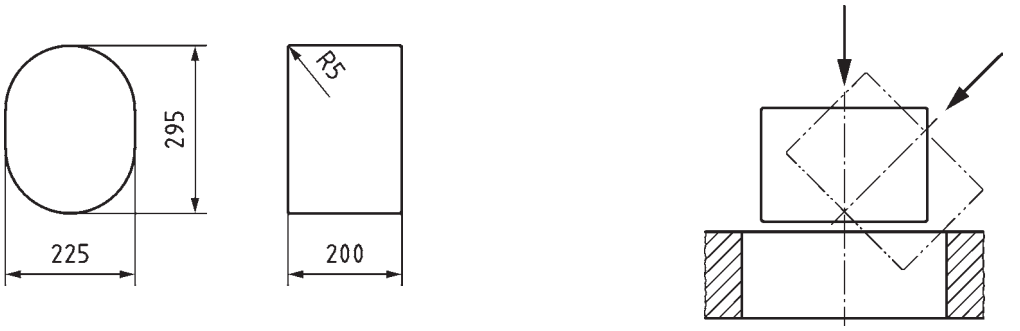
Dimensions in millimetres



a) Dimensions of probe **b) Application of probe**

Figure 2 — Adult torso probe

Dimensions in millimetres



a) Dimensions of probe **b) Application of probe**

Figure 3 — Child torso probe, 10 years of age

The material of the probe in Figure 2 and Figure 3 shall be ridged material.

5.2.1.4.3 Test subjects

Test subject representing the child of 10 years of age: test subject No. 4 according to Table 2.

Test subject representing the adult: test subject No. 1 according to Table 2.

5.2.2 Requirements on body entrapment

When tested in accordance with 5.2.3 all design features of a floating leisure article as e.g. gaps, openings, slots etc. which allow the initial ingress of the foot probe according to 5.2.1.4.1 shall prove that they subsequently allow the free passage of either the appropriate (see 5.2.1.3) test probe (adult/child) according to 5.2.1.4.2 or the relevant test subject according to 5.2.1.4.3.

For design features likely to cause body entrapment see categorization of types of openings in Annex B.

5.2.3 Test procedure

In general testing shall be performed with the probes (child/adult) as specified in 5.2.1.4 which is in cases where the design features likely to cause entrapment allow a simple dimensional check i.e. a pass or not-pass assessment of the template(s). The appropriate test probe shall be applied vertically and pushed into the gaps openings etc. with a force of 100 N.

In special cases where body entrapment depends on the flexibility of body enclosing components or where the arrangement of such hazardous design features is too complicated for a simple dimensional check testing shall be done by the appropriate test subject. The procedure shall be an in-water test and shall include access to the hazardous feature in any stable floating position the product can take. Subject tests shall include the following sub sequences:

a) appropriate test person is intentionally getting access into the potential entrapment design feature with the intent to pass through;

b) head first access, feet first access;

c) it shall be checked whether the process of intentionally and actively accessing the feature of entrapment turns itself into an opening movement and thus release of the test person (see Annex B).

5.2.4 Depths of gaps and openings

Openings, gaps, slots etc. are considered as not causing body entrapment if they have a restriction in depth which prevents the user from getting too deep into it. This depth shall not allow an entry of the

foot probe according to 5.2.1.4.1 of more than 30 cm for products intended for adult use only and not more as 20 cm for products intended for child use or combined adult and child use.

5.2.5 Method of measuring

a) The foot probe is put into the potential entrapment design feature in any direction but not more than at an angle from vertical to 45°. The force applied to the foot probe is 100 N max.

b) When the probe is blocked the depth of entry from the first contact point to the depth, which is reached after the application of 100 N shall be measured along the virtual line of entry.

5.3 Torso entrapment on safety line with regard to children

5.3.1 Requirements

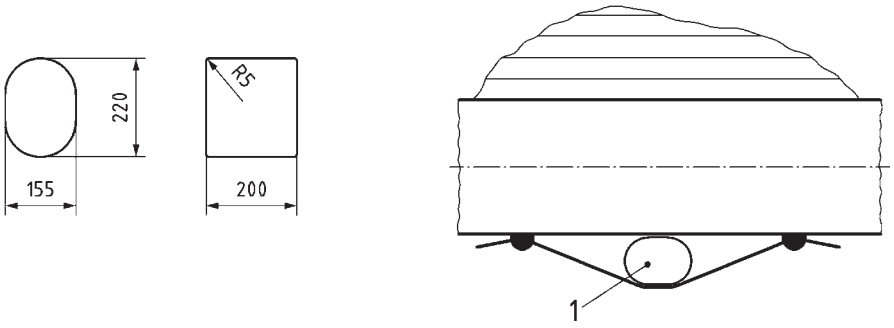
The child torso probe as shown in Figure 4 shall pass through the opening between safety line and the hull of the device at any position under the force of its own weight.

5.3.2 Test method

Put probe for torso entrapment horizontally into the gap between safety line and hull of the inflated structure. Check whether the probe becomes trapped.

Test probe, 3 years, 95th percentile (biggest torso dimension, material: pine wood or similar).

Dimensions in millimetres



Key

1 child's torso probe, 3 years of age

Figure 4 — Child torso probe

5.4 Accessible protruding parts causing entanglement

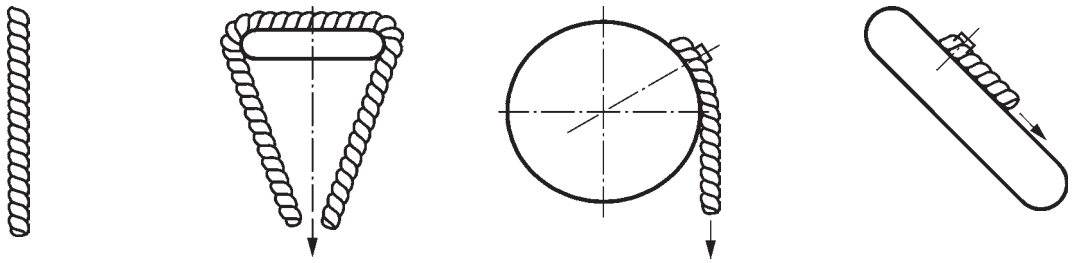
5.4.1 Requirements

To prevent the user from entanglement when unintentionally sliding out or from a device, there shall be no hazardous protrusions. The test rope shall slip of any part of the device that protrudes in the area where the user intentionally and foreseeably interacts with the product.

5.4.2 Test method

A loop of the test rope of 8 mm diameter plaited polyester rope as shown in Figure 5 shall be put around the protruding part. The pulling direction in relation to the protruding part shall be vertically to the centre line of this part. With the product in the position to simulate its intended use, apply a pulling force of 180 N either vertically downwards or in a downward direction most likely to cause failure. It

shall be checked whether the test rope disengages under any circumstances, such as capsize, slip off, protruding part breakage, etc.



a) Test rope: plaited polyester rope, 8 mm diameter, min. 600 mm in length

b) Test rope put around objects (top view)

c) Test rope put around objects (side view), vertical pulling

d) Test rope applied on objects hindering vertical pulling. Pulling direction most likely to cause failure (side view)

Figure 5 — Test rope and its application

5.5 Human subject testing

5.5.1 General

Testing for all specific parts of ISO 25649 depends highly on testing with human test subjects. Due to the very nature, diversity and disparity of the products concerned instrumental testing by using apparatuses, devices, etc. is not recommended. Also the use of rigid loads and distinct load application points should be replaced by positioning human test subjects. This approach is appropriate to adapt to the flexibility and irregularity of the products. Therefore the determination and selection of an adequate test panel is of utmost importance. The same applies consequently for the assessment panel. Standard Model Cases how to determine and select test panels exist and can be adapted to the needs of this project.

5.5.2 Test panel

Test subject 1 shall always be one time in the total number of adult male test subjects. If more than one test subject shall act, the rest shall be a mix of sex in accordance with Table 2.

Table 2 — Test panel

Test subjects	Sex	Age years	Body weight kg	Body size cm	Number of subjects	Mix[b]	Child/adult equivalence
Subject 1	male	>18	≥90	≥180	according to manufacturer's instructions	1 time	2 children = 1 adult
Subject 2	male	>18	70 – 80	≥170		50/50	
Subject 3	female	>18	65 – 70	≥160		50/50	
Subject 4[a]	female	>18	40 – 45	<150		—	

[a] Test subject 4 represents a child. In order to avoid involvement of children in testing, the child subject is substituted by the statistically smallest adult women (5th percentile).

[b] If a device is classified for an unequal number of adult users, subject 1 shall constitute the majority.

Test subjects shall be able-bodied and good swimmers. They shall be made familiar with the particularities of the product and the particularities of the inwater test procedures.

5.5.3 Assessment panel

The tests in the water shall be conducted and assessed by an assessment panel of at least three independent technical experts experienced in assessing floating leisure articles. The assessment panel directs the test subjects to take positions and to perform according to the standard's test specifications and pass/fail criteria. The responsible test house staff shall provide measures to avoid any accident during testing.

5.5.4 Positioning and posture of test subjects for testing floating stability (if applicable)

Each test subject shall be positioned:

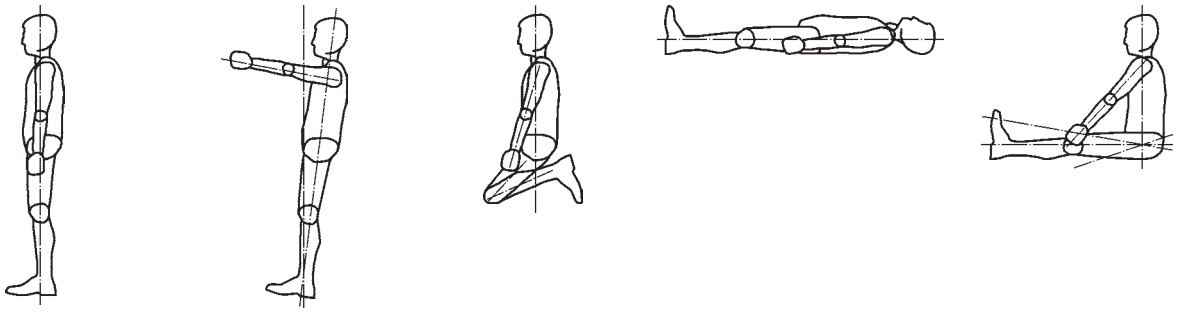
— on the intended position if there are distinct seats, sitting or laying areas or other positions for the user;

— on the position most likely to cause failure if free movement of users is possible;

— with the back leaned to the outer wall if the device provides a clear inner area surrounded by a wall.

The posture to be adopted shall be selected from the standard test postures as specified in 5.5.5 and stipulated in detail by ISO 25649-3 to ISO 25649-7. If there are various postures likely to be applied in practical use, the one most likely to cause failure shall be selected from the test postures (see 5.5.5) and applied for testing.

5.5.5 Basic test postures



a) Posture 1 **b) Posture 1.1** **c) Posture 2** **d) Posture 3** **e) Posture 4**

NOTE 1 Posture 1: upright standing, arms sideways to mid body, body centre line vertical, head upright.

Posture 1.1 upright standing, arms/hands holding a grab handle, body centre line slightly lent back (7°), feet on surface or climbing fitting.

Posture 2 kneeling position, torso rests on lower leg, arms/hands on upper legs, body centre line vertical, head upright.

Posture 3 lying position, entire body stretched out horizontally, feet, legs, torso, arms head on resting surface.

Posture 4 sitting position, legs stretched out or bent, hands on knees, torso centre line vertical, head up right.

NOTE 2 For test positions and variations of these basic test postures according to product design, see ISO 25649-3 to ISO 25649-7, Classes A to D.

Figure 6 — Basic test postures of human test subjects

5.6 Design working pressure

5.6.1 Requirements

The recommended working pressures (if applicable) shall be specified by the manufacturer for each main buoyancy chamber of the fully inflated device. These pressures shall be indicated on the device and in the operator's instruction manual (see ISO 25649-2). If for any reason working pressure is not given, inflate until full shape and functionality is achieved. Where relevant, the sequence of inflation shall be numbered next to the chamber's inflation valves.

In order that the user may ascertain that the specified working pressure has been reached, the manufacturer shall provide appropriate equipment or a pressure gauge for this purpose. Alternatively, instructions shall be included in the operator's instruction booklet, which will enable a sufficiently close estimate to be made. The working pressure shall be consistently expressed in bars.

5.6.2 Test method

Visual examination by the test panel.

5.7 Load bearing components

5.7.1 Requirements

If not otherwise stated in the specific parts all load bearing fittings, e.g. lifting and carrying handles, fittings for safety ropes, etc. shall be compatible with the material of the hull itself and shall not, when loaded as described in 5.7.2, break or result in any impairment in air tightness or water integrity.

5.7.2 Test method

Any cordage used for test purposes shall have a diameter of 8 mm.

Progressively apply a load of 500 N to all the bearing components in any direction. Maintain it during 1 min.

5.8 Towing device

5.8.1 Requirements

If not otherwise stated in the specific parts, floating articles shall be equipped with means to attach a towing rope in case of an emergency. This means shall withstand a horizontal pulling force without any damage to the fitting and the entire structure according to 5.8.2.

Not applicable if the device is marked with safety information symbol "pool use only" according to ISO 25649-2.

5.8.2 Test method

Any cordage used for test purposes shall have a diameter of 8 mm.

Progressively apply a load of 1 kN to all the pulling components in any direction. Maintain it during 15 min.

5.9 Valves and valve adapters

5.9.1 Requirements

Inflating and/or deflating valves shall be made of corrosion-resistant materials, shall be compatible with the material of the hull and shall not be capable of damaging the device. EN 16051-1 gives examples

how to achieve compatibility valves and inflating devices geometry. They should meet the requirements specified in EN 16051-1. In general, valves shall

a) not inconvenience the persons in the device in their predetermined seating positions,

b) not interfere with the operation of the device, and

c) not be damaged or torn off by moveable components of the device construction.

All valves shall enable airtight sealing by manual operation, independent of their sealing or non-return valve.

For the buoyancy system, valves with a non-return device in accordance with EN 16051-1 should be used.

NOTE A specific European Standard dealing with compatibility of valves and valve adapters is currently under development.

Each filling valve shall enable a controlled pressure reduction.

5.9.2 Test method

Visual inspection and practical test. In house or outside test confirmation may be allowed to verify compliance.

5.9.3 Numbering of air chambers

If the sequence of air chamber inflation is relevant for function or safety of the product, the correct inflation sequence shall be indicated by numbers in close proximity to the valves.

5.10 Edges, corners and points

5.10.1 Requirements

All devices shall be of a design such that they cannot cause harm to the user. Edges and corners of hard and rigid materials shall be chamfered or rounded.

Round edges or corners shall have a minimum radius of 1 mm and where a chamfer is part of the design, it shall be of (45° ± 5) mm and at least 1 mm in width. There shall be no barbs or other sharp points or features.

5.10.2 Test method

Testing shall be by measurement and tactile assessment.

5.11 Shearing and crushing points

5.11.1 Requirements

Floating articles not specifically excluding the use by children shall meet the requirements regarding parts moving against each other as specified in EN 71-1:2005, 4.10.1 d) and 4.10.2. Floating articles for adult use only shall have no accessible shearing and/or crushing points. Shearing and crushing points exist if the distance between two rigid movable parts is less than 25 mm.

If access to shearing and crushing points is prevented by covers, none of the remaining openings shall allow a 5 mm cylindric probe to be inserted.

Not applicable for oars and oar-locks.

5.11.2 Test method

Testing shall be done by measurement and panel assessment.

5.12 Strength of the hull and test conditions

5.12.1 Requirements

If applicable, the device shall remain airtight after each of the tests below (see 5.12.2 to 5.12.5).

All tests shall be performed at a temperature of (20 ± 3) °C, unless specified otherwise.

5.12.2 Pressure test

5.12.2.1 Combined cycle pressure/static load test for devices manufactured from unsupported material

Inflate all chambers of the device to the design working pressure as instructed by the manufacturer on the product or in the instructions but not less than 0,03 bar or, if no working pressure is given for test purposes a pressure of 0,06 bar is valid and keep the device inflated for 12 h.

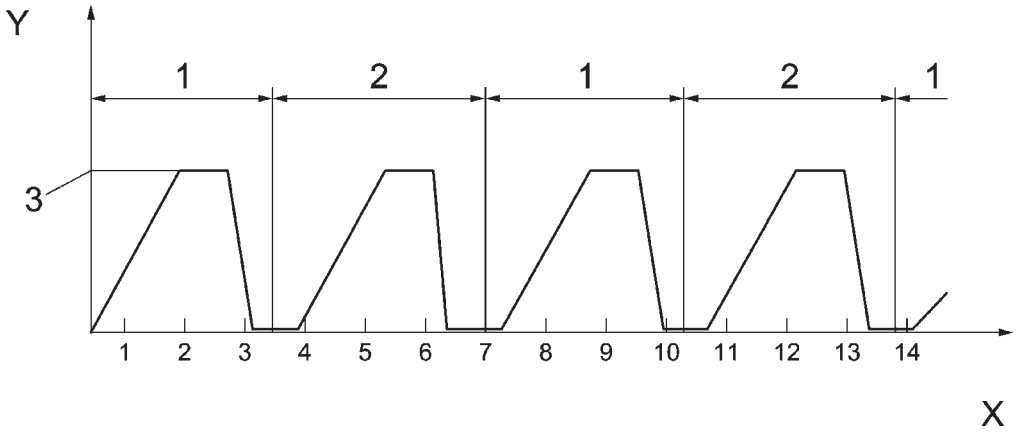
This test procedure shall be applied alternately to at least two adjoining inflated chambers (chamber 1, chamber 2) in turn as required in Figure 7 and shall comprise 50 inflation/deflation cycles.

a) Inflate chamber 1 to a pressure of 1,1 times the design working pressure and keep it for the specified time.

b) Deflate chamber 1 to zero pressure and inflate chamber 2 to 1,1 times of the design working pressure and keep it for the specified time.

c) Repeat this process for 75 times (pressure tolerance: +10 % to −0 % of applied test pressure)

Test the air tightness of all inflated air chambers in accordance with paper strip test in 5.12.4.



Key

X time, min
Y pressure, bar
1 chamber 1
2 chamber 2
3 design working pressure

Figure 7 — Cyclic pressure test for buoyancy chambers (unsupported materials)

Test durations for the inflation cycle shall be as follows:

— time to inflate to 1,1 times working pressure: 2,0 min;

— maintain at 1,1 times working pressure: 0,5 min;

— time to deflate to zero pressure: 0,5 min;

— maintain at zero pressure: 0,5 min.

Adjoining chambers shall not be tested simultaneously.

In direct succession to this cyclic pressure test the product shall be put on an even rigid floor and loaded statically with the weight of the designated user(s) for the duration of 20 min. The user(s) shall be represented by the test subjects as specified in 5.5.2 and Table 2. The test for adult users shall always include one times test subject 1, children shall be represented by test subject 4.

Alternatively corresponding dead weights or forces applied via a cushioned circular loading pad of appropriate dimension may be applied.

If dead weight is used, it shall be applied onto the product area expected/designed to carry the person/child during use.

If the product is intended for more than one user, the dead weight shall be applied over the appropriate number of loading surfaces specified for the user and for the usage position, and applied onto the areas of the product expected/designed to carry the persons/children.

For items where the inflatable components are not carrying the user but acting as buoyancy providers only, dead weight shall be applied onto the non-inflatable product areas expected/designed to carry the person/child in the water environment, and it shall be observed that the inflatable buoyancy components do not separate from the user-carrying component or otherwise burst or fail under the pull of the weight.

5.12.2.2 Overpressure test for inflatables made from reinforced or fabric covered material

Inflate each compartment of the device to 1,5 times the manufacturer's design working pressure for 30 min. If no design working pressure is given, a pressure of 0,06 bar is valid. For Class D devices, a pressure of only 1,2 times the design pressure applies. No damage or rupture shall occur and the device shall be tested for air tightness as described in 5.12.5.

NOTE Flocked film materials do not fall under the category of being "reinforced".

5.12.3 Heat test (not applicable to Class D devices)

Assemble the device in accordance with the manufacturer's instructions and inflate it to a pressure of 1,1 times the design working pressure. If no working pressure is given, a pressure of 0,06 bar shall be used. When assembled, place the device in a heat chamber, set at (60 ± 2) °C, for a period of 6 h. On completion of the test period, remove the device from the heat chamber and allow to cool down to ambient temperature. Test the air tightness of the device in accordance with the relevant test specified in 5.12.5 for devices manufactured from reinforced material or 5.12.4 for devices manufactured from unsupported material.

5.12.4 Air tightness test for inflatables made from unsupported material

The air tightness is measured indirectly as shrinkage of the material. Test all chambers for buoyancy individually with all adjacent chambers deflated.

Inflate the chamber to be tested for buoyancy to a pressure of 1,1 times the manufacturer's design working pressure. If no working pressure is given, a pressure of 0,06 bar is valid. Immediately stick a strip of paper, approximately 100 mm long, at its ends onto the outer surface of the air chamber in a

circumferential direction. Cut the strip in half horizontally. Following a test period of 2 h, there shall be no overlapping of the two cut ends.

5.12.5 Air tightness test for inflatables made from reinforced or fabric covered material

Support or insulate the device from the floor and do not expose it to any air currant and direct sunlight. Inflate the device (all air chambers) for 30 min to a pressure that is 20 % in excess of the manufacturer's design working pressure if indicated in order to pre-stretch the device. Then reset the pressures to the design working pressure for a further period of 30 min in order to stabilize conditions. Reset the pressures to the design working pressure and record the ambient temperature and atmospheric pressure. Following a test period of 24 h, the pressure drop shall not be greater than 20 % in any air chamber. Record the final ambient temperature and atmospheric pressure.

The temperature difference between the start of the test and the end of the test shall not exceed ±3 °C.

The atmospheric pressure difference between the start of the test and the test readings shall not exceed ±1 %.

For each rise or fall by 1 °C in ambient temperature, an allowance of 0,004 bar may be respectively subtracted from, or added to, the recorded device pressure.

5.13 Buckles and other fixings

5.13.1 Requirements

If buckles or other detachable fastening devices are used as parts of the entire device in order to attach or connect functional parts or components, they shall require at least two simultaneous actions for their release or opening in order to prevent unintended opening. Where one of the two sequences of buckle opening relies on pressure, it shall be necessary to apply a force of at least 50 N on this release mechanism.

5.13.2 Test methods

Verification shall be executed by the test panel. In case of a locking system based on pressure, testing shall be done in accordance with EN 13138-3:2014, Annex E.

6 Material requirements and test methods

6.1 General

6.1.1 Requirements

All materials used in floating leisure articles shall be visually clean and free from contamination. They shall be selected by the manufacturer according to the stresses that are resulting from the intended service conditions and the requirements set out for shape, dimension, maximum load, etc. The use under normal conditions shall not materially impair their performance and they shall meet all the requirements specified in Clause 6 and Clause 7. To avoid rotting, all fibre materials shall not be made from natural fibres like cotton.

For conditioning, the test procedure related to immersion in chlorinated salt water (see 6.2.2) and storage in cold and hot conditions (see 6.3) shall be carried out prior to all other tests.

6.1.2 Test method

Visual inspection and manufacturer's certificate on request.

6.2 Chemical requirements for materials making up the hull, unsupported or reinforced

6.2.1 General

In house or outside test confirmation may be allowed to verify compliance.

6.2.2 Resistance to mineral oil

6.2.2.1 Requirements

After the contact during a period of (22 ± 0,25) h the change in mass per unit area shall not exceed 100 g/m^2.

6.2.2.2 Test method

Carry out the test on the external side of the material in contact with the ambient environment as specified in ISO 1817 but with a sample size of 100 mm x 100 mm or a disc of 100 mm diameter by using mineral oil 15W40HD for diesel engines at a temperature of (40 ± 1) °C.

6.2.3 Resistance to chlorinated salt water

6.2.3.1 Water absorption

After the contact during a period of minimum 36 h the change in mass per unit area shall not exceed 100 g/m^2.

6.2.3.2 Test method

Carry out the test on the external side of the material in contact with the ambient environment as specified in ISO 1817 by using salt water composed of distilled water and 30 g of sodium chloride per litre at a temperature of (40 ± 1) °C.

6.3 Physical requirements

6.3.1 Resistance to cold

6.3.1.1 Requirements

After an exposure for 4 h and the following treatment, there shall be no signs of cracking when the test sample is examined under a magnification of ×10.

6.3.1.2 Test method

In accordance with ISO 4675, a sample with a size of (100 × 250) mm shall be kept in a suitable cooling chamber at a temperature of –5 °C. Then the sample shall be folded through 180° and kept under a weight of 5 kg for another 10 min in the cooling chamber. After removal the sample is examined for fractures or cracking.

6.3.2 Resistance to heat

6.3.2.1 Requirements

The test sample shall give neither evidence of blocking nor show damages of the surface after unfolding when the sample is examined under a magnification of ×5.

6.3.2.2 Test method

A test piece with a size of (100 × 250) mm shall be folded at its centre line, with the external sides laid together, and stored for 2 h in a heating chamber at a temperature of (60 ± 2) °C under a load of 50 N/50 cm^2. After removal from the heating chamber the sample is allowed to cool down for 2 h under standard atmosphere, then unfolded and examined for blocking or surface damages.

6.4 Mechanical requirements of unsupported hull materials

6.4.1 General

Unless otherwise specified, the standard environmental conditions for the tests shall be a temperature of (20 ± 2) °C and a relative humidity of (65 ± 5) %.

NOTE See specific requirements in ISO 25649-3 to ISO 25649-7.

6.4.2 Resistance to puncturing

6.4.2.1 Requirements

Air filled buoyancy chambers shall remain air tight when tested according to the procedure given in 6.4.2.2.

6.4.2.2 Test method

Apply a force of 5 N to any part of the external surface of the device when inflated to the designed working pressure or until full shape and functionality is achieved if no working pressure is given through a steel needle tip with a radius of 0,5 mm. Apply the force gradually over a period of 5 s. Maintain the force for further 5 s. Upon completion of the procedure, submerge the device or the tested part of it in a bath of cold water and examine for leakage of air.

6.5 Mechanical requirements for reinforced hull materials

6.5.1 General

Specific requirements according to ISO 25649-3 to ISO 25649–7 apply.

6.5.2 Adhesion of coatings (if applicable)

6.5.2.1 Requirements

Where the hull of a floating leisure article consists of coated reinforcing materials (e.g. cloths), the adhesion between the coating and the substrate (base cloth) shall be sufficiently strong, so as to exclude any unintentional separation of the coating from the substrate during the intended use of the floating leisure article.

The separating force between the coating and the reinforcing material shall be at least 20 N/cm^2.

6.5.2.2 Test method

Carry out the test in accordance with ISO 2411.

6.6 Other materials

6.6.1 Wood

6.6.1.1 Requirements

The exposed types of timber and plywood used shall be suitable for the application and the marine environment and shall be given weatherproof protection, such as paint, varnish or preservative, when exposed to the marine environment. All plywood used shall incorporate hardwoods for both internal and external veneers and the bonding adhesive shall be waterproof and boil-proof. The timber used shall be seasoned and free from sapwood, decay, insect attack, splits and other imperfections likely to adversely affect the performance of the material. The timber shall be generally free from knots but an occasional sound intergrown knot is acceptable. Adjoining edges and/or surfaces, including any end-grain, shall be effectively sealed.

The legal regulations of the country or region of application shall be met.

For the European region the selection of preservatives, relevant regulations shall be considered. Restrictions on the marketing and use of certain dangerous substances and preparations are addressed in the European Directive 76/769/EEC and its amendments, e.g. the restriction of organostannic compounds for crafts.

6.6.1.2 Test method

Verification through visual examination by test panel.

6.6.2 Metal and synthetic material parts

6.6.2.1 Requirements

Materials used shall be of a type, strength and finish, suitable for the intended purpose of the components and compatible with the marine environment.

6.6.2.2 Testing

In house or outside test confirmation may be allowed to verify compliance.

6.7 Threads

6.7.1 Requirements

To sew load bearing components, only threads manufactured from synthetic materials whose properties correspond to polyester or polyamide fibres shall be used.

6.7.2 Test method

Visual inspection and/or manufacturer's certificate on request.

7 Durability of warnings and markings

7.1 Resistance to perspiration

7.1.1 Requirements

When tested in accordance with the procedure in 7.1.2, the change in colour of the warnings and markings shall be 3 or better on the grey scale.

7.1.2 Test method

The test shall be carried out in accordance with the procedures in ISO 105-E04. The assessment shall be carried out in accordance with EN 20105-A02.

7.2 Resistance to chlorinated salt water

7.2.1 Colour fastness

When tested in accordance with the test methods in 7.2.4 the change in colour of the warnings and markings shall be 3 or better on the grey scale according to EN 20105-A03.

7.2.2 Test liquid

The chlorinated salt water is prepared by dissolving 30 g of sodium chloride (NaCl) in one litre of an aqueous solution of sodium hypochlorite (NaOCl) containing 50 mg of active chlorine at pH (7,5 ± 0,05). The sodium hypochlorite solution is prepared in accordance with ISO 105-E03:2010, 5.2. The solution shall always be prepared immediately prior to use, using grade 3 water as specified in ISO 3696:1995, Clause 3.

7.2.3 Apparatus

A suitable apparatus for the conditioning procedure should consist of a glass or stainless steel container that is big enough to hold the necessary volume of chlorinated salt water for a liquor ratio of 100:1 and a motor driven stirrer rotating at a frequency of 40 min^{-1}. In order to maintain the whole arrangement at room temperature, the procedure should be undertaken in a climate controlled room. Refer to ISO atmosphere according to ISO 554:1976, 2.1 (designation 20/65).

7.2.4 Test method

Material samples showing the warnings/markings shall be submerged in agitated chlorinated salt water for 12 h, in darkness and at room temperature (20 ± 2) °C. Ensure that the test samples are thoroughly wetted. After removal from chlorinated salt water, the samples shall be rinsed in distilled water and dried by hanging in air at room temperature.

7.3 Adhesion of markings

7.3.1 Requirements

When tested in accordance with the procedures in 7.3.2, the markings shall not be damaged and shall remain legible in all details when assessed by the assessment panel. The requirements do not apply where the warnings or markings are embossed onto or moulded into the device.

7.3.2 Test method

The product shall be tested in accordance with the procedures set down in ISO 105-X12 (wet and dry) and for 100 cycles.

7.4 Provision of repair means

Each floating leisure article shall be supplied with a repair kit, together with instructions for use, suitable for repairing small punctures of limited extent.

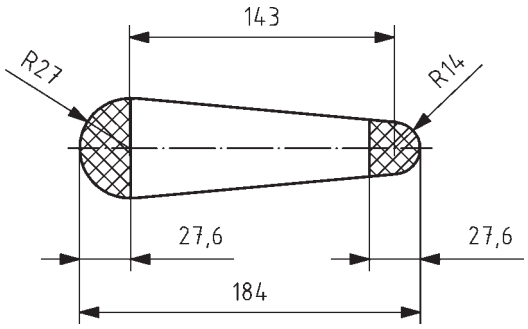
Annex A
(normative)

Templates

A.1 Space per person, templates for lying/sitting; adult/child

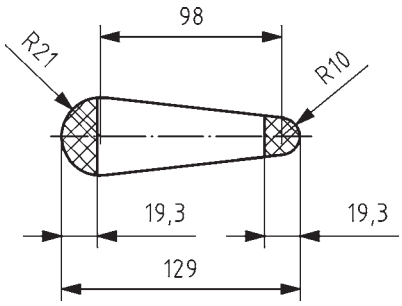
A.1.1 Lying

Dimensions in centimetres



NOTE Shaded area = allowed overhang.

Figure A.1 — Body length/shoulder width template adult average 95th percentile, male

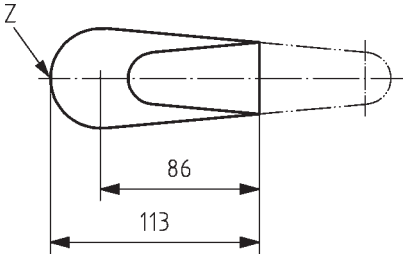


NOTE Shaded area = allowed overhang.

Figure A.2 — Body length/shoulder width template child 6 years, 95th percentile, male

A.1.2 Sitting

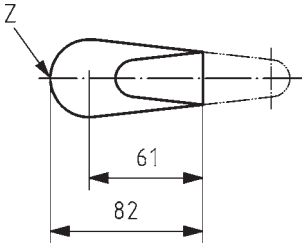
Dimensions in centimetres



Key

Z reference point for application/positioning underneath overhanging walls/components

Figure A.3 — Sitting (legs stretched out) length/shoulder width template adult average 95th percentile, male

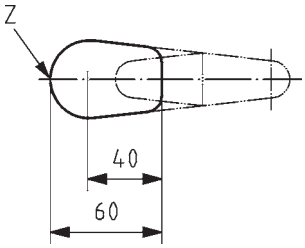


Key

Z reference point for application/positioning underneath overhanging walls/components

Figure A.4 — Sitting (legs stretched out) length/shoulder width template child 6 years, 95th percentile, male

Dimensions in centimetres



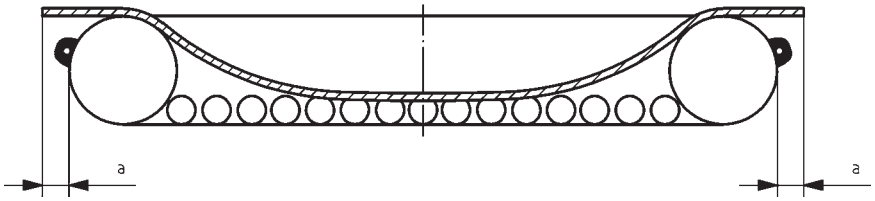
Key

Z reference point for application/positioning underneath overhanging walls/components

Figure A.5 — Sitting (legs tuck up) length/shoulder width template child 6 years, 95th percentile, male

A.1.3 Template application and overhang

See Figure A.6.



a 15 % overhang max.

Figure A.6 — Application of template and overhang

A.2 Template material

The templates shall be made from foam sheet (e.g. polychloroprene) with a shore A hardness of (80 ± 10) and a thickness of 15 mm.

The shore A hardness shall be determined according to ISO 868.

Annex B
(informative)

Examples of openings

B.1 Rationale

This entrapment related collection and categorization of typical and known design features shall provide a survey which facilitates the assessment of entrapment hazards to be either avoided or designed in a way to make these features safe.

Safety of products shall be achieved by design. The user shall not be forced to cope with hazards through permanent care to avoid them or to free him out of an entrapment if something went wrong. This applies in particular for those hazards which - under the given circumstances of floating structures - can lead to drowning accidents, e.g. entrapment in combination with capsizing.

Therefore floating articles shall not provide accessible places of entrapment or entanglement.

In cases where for functional reasons gaps, opening protrusions etc. cannot be completely avoided they shall meet the relevant safety requirements as specified in this document.

Safety can be achieved by absence of hazardous points (entrapment/entanglement), by making them not accessible or – as an exception - by warnings.

In deviation of assessing entrapment hazards of rigid structures the approach of ISO 25649-1 takes into consideration the nature of low pressure inflatable structures which provide or create flexible, yielding and shape changing openings, gaps etc. It also considers that depending on the inflation pressure or a change in material towards more rigid materials the structure to be assessed behaves increasingly as a rigid structure.

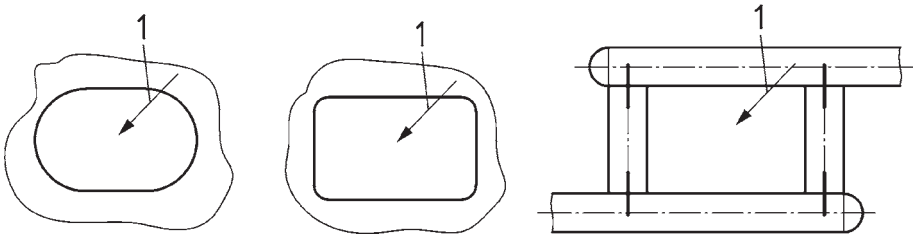
For the reason of clarity and simplification entrapment requirements relate to the relevant smallest part of the human body (foot) and the entire body itself in a way that the relevant smallest part shall not pass or the entire body of the biggest user shall pass.

B.2 Common types of design features to be verified for entrapment

B.2.1 Openings and gaps

B.2.1.1 Type A, Openings closed and fixed in size

Openings of type A are characterized by circumferential fixed length.



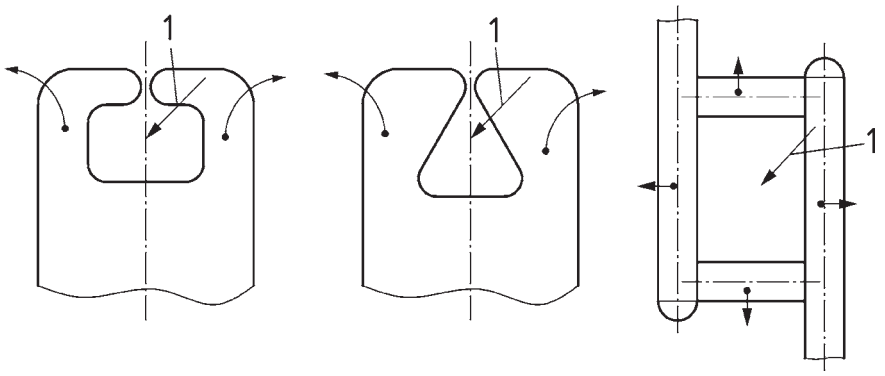
Key

1 access point (in and/or out)

Figure B.1 — Type A, Openings closed and fixed in size

B.2.1.2 Type A1, closed openings but yielding walls

A1-Type openings yield under load to a certain degree. Their flexibility depends on the pressure and or rigidity of the material.



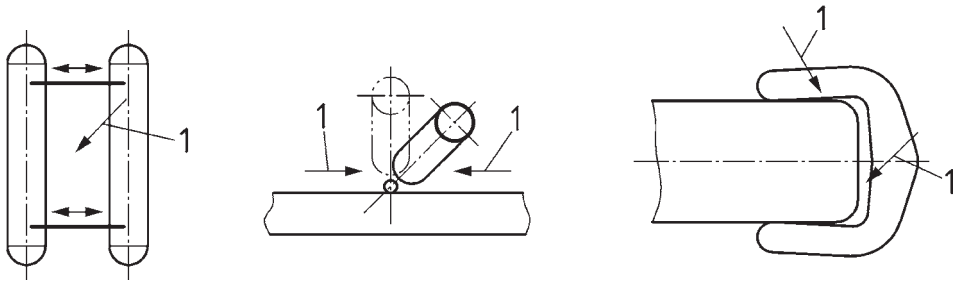
Key

1 access point (in and/or out)

Figure B.2 — Type A1, closed openings but yielding walls

B.2.1.3 Type B, closed gaps fixed in size

Gaps of type B include movable components varying the inner space in dependence of their position.



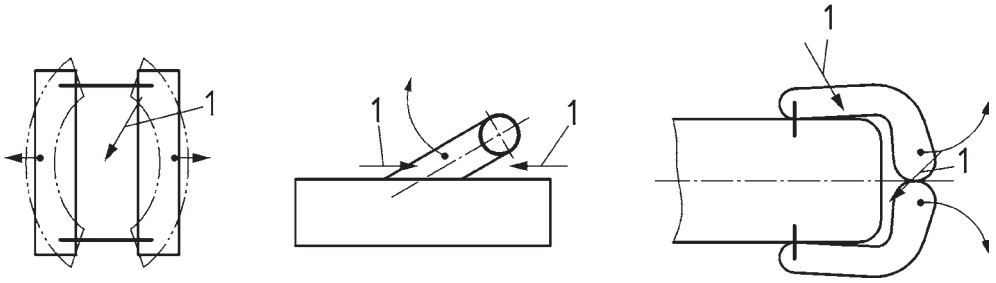
Key

1 access point (in and/or out)

Figure B.3 — Type B, closed gaps fixed in size

B.2.1.4 Type B1, closed gaps but yielding walls or components

B1-openings yield due to their slotted components or due to the flexibility of the components itself.



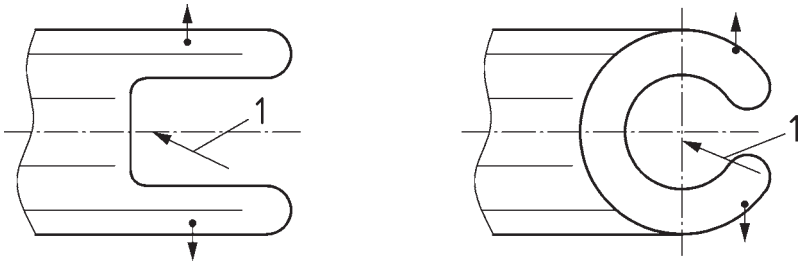
Key

1 access point (in and/or out)

Figure B.4 — Type B1, closed gaps but yielding walls or components

B.2.1.5 Type B2, open gaps

B2-Type gaps are characterized by their relatively wide gap between the enclosing components.



Key

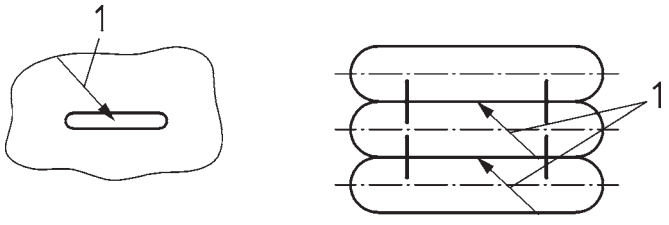
1 access point (in and/or out)

Figure B.5 — Type B2, open gaps

B.2.2 Slots

B.2.2.1 Type C, Closed slots

Openings of type A slots are characterized by nearly fully gapless initial positions opening under force only.



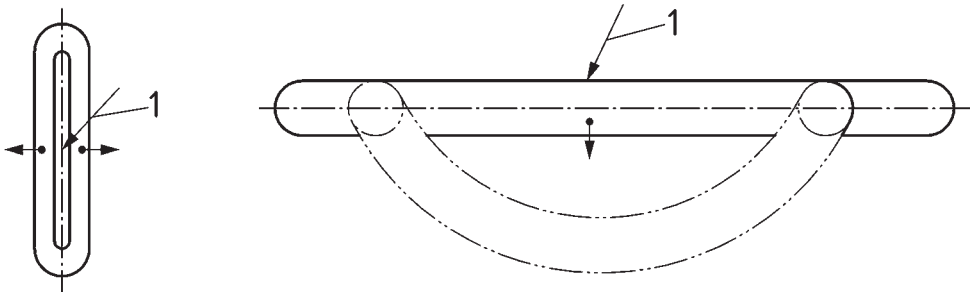
Key

1 access point (in and/or out)

Figure B.6 — Type C, Closed slots

B.2.2.2 Type C1, Closed slots, but yielding walls or components

C1-Type Openings are characterized by yielding side wall or elements forming side walls yielding vertically when under load.



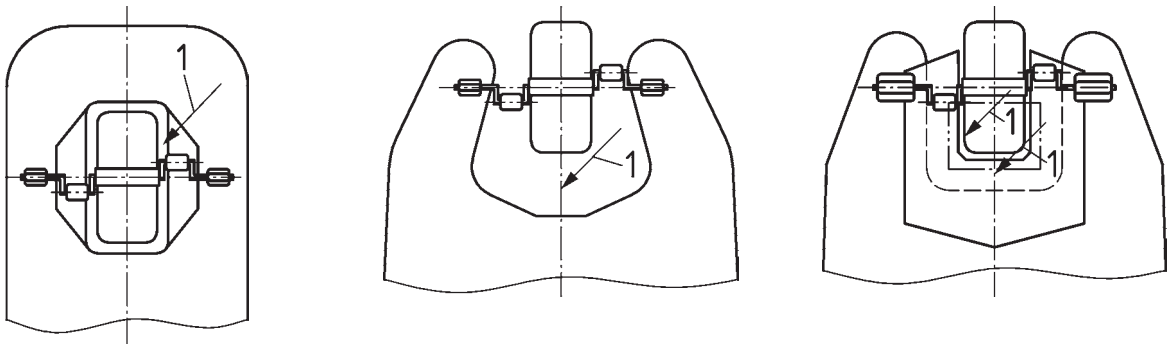
Key

1 access point (in and/or out)

Figure B.7 — Type C1, Closed slots, but yielding walls or components

B.2.3 Type D, Functional openings, gaps etc

Functional openings are characterized by their property to be arranged around another fixed or movable component for space and support should be given.



a) Minimized gap around paddle wheel

b) Gap wide enough to allow passage of body allow passage of body of biggest designated user

c) Flat cover on top or underneath floating structure in order to minimize gab around movable part or part hood above movable part and gab in order to make hazardous point inaccessible

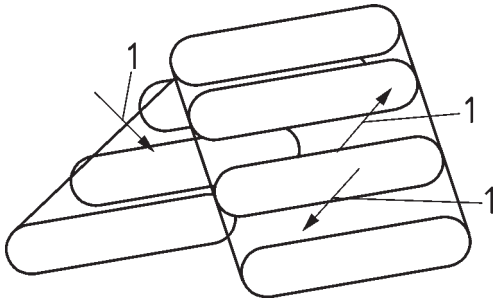
Key

1 access point (in and/or out)

Figure B.8 — Type D, Functional openings, gaps, etc

B.2.4 Type E, Three dimensional arrangements

Characterized by openings arranged in the plane and the height. Passage through one opening ends in the water.



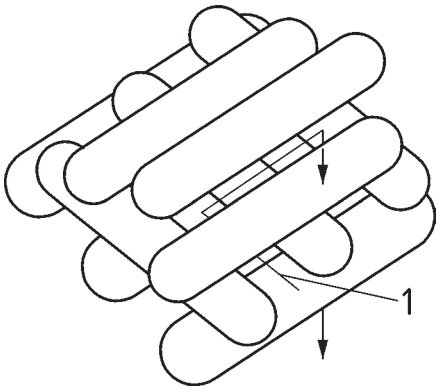
Key

1 access point (in and/or out)

Figure B.9 — Type E, Three dimensional arrangements

B.2.5 Type E, Labyrinths

Characterized by openings arranged in the plane and the height. Passage through one opening leads to another one. Arrangement of openings form horizontal /vertical zic-zac passages.



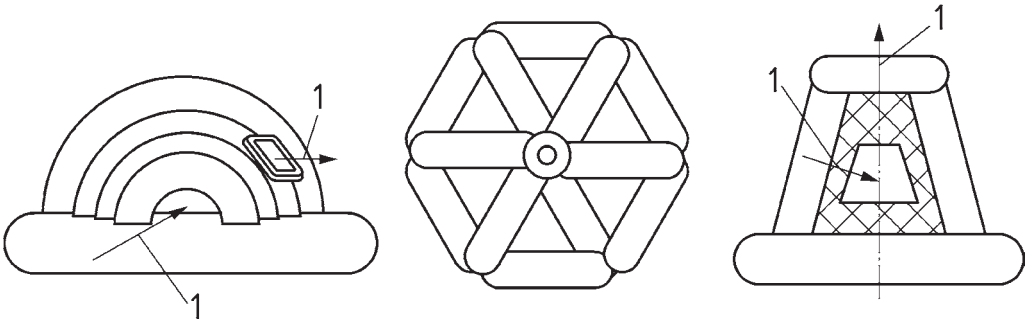
Key

1 access point (in and/or out)

Figure B.10 — Type E, Labyrinths

B.2.6 Type E, Enclosing spaces (inflatable caverns)

Enclosing spaces are characterized by their property to provide access of the entire human body. Big entrance and small outlets.



Key

1 access point (in and/or out)

Figure B.11 — Type E, Enclosing spaces (inflatable caverns)

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