TECHNICAL REPORT

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Shipbuilding and marine structures — Inflatable liferafts — Materials

Construction navale et structures maritimes — Radeaux pneumatiques de sauvetage — Matériaux

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 6065, which is a Technical Report of type 1, was prepared by Technical Committee ISO/TC 8, *Shipbuilding and marine structures*, Sub-Committee SC 9, *Lifesaving equipment*.

The reasons which led to the decision to publish this document in the form of a technical report type 1 are explained in the Introduction.

Annex A forms an integral part of this Technical Report.

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Introduction

It was initially intended to publish an International Standard on this subject: ISO/DIS 6065 was submitted for combined voting to the members of Technical Committee ISO/TC 8 and to all ISO member bodies, in 1989. This draft did not gain the necessary support for publication as an International Standard.

Sub-Committee ISO/TC 8/SC 9, *Lifesaving equipment*, during its meeting held in Tokyo in October 1990, studied the member bodies' comments and found that it would be impossible to achieve substantial support in view of the fact that many countries differ in the requirements for the materials of inflatable liferafts (tensile strength, tear strength, coating adhesion, etc.) stipulated in national rules or regulations.

It was then decided to stop the work and propose drawing up a Technical Report, of type 1, for the benefit of those member bodies who wish to refer to the result of the work.

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Shipbuilding and marine structures — Inflatable liferafts — Materials

1 Scope

This Technical Report specifies the fabrics and test procedures of fabrics for inflatable liferafts required by Regulation 30 of Section I, Regulations 38 and 39 of Section IV, Part C, Chapter III, and Recommendation on testing of lifesaving appliances in *1983 Amendments to the International Convention for the Safety of Life at Sea, 1974 (SOLAS 1974)*.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Technical Report. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Technical Report are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1421:1977, *Fabrics coated with rubber or plastics — Determination of breaking strength and elongation at break*

ISO 1817:1985, *Rubber, vulcanized — Determination of the effect of liquids*

ISO 2286:1986, *Rubber- or plastics-coated fabrics — Determination of roll characteristics*

ISO 2411:1991, *Rubber- or plastics-coated fabrics — Determination of coating adhesion*

ISO 3011:1981, *Rubber or plastics coated fabrics — Determination of resistance to ozone cracking under static conditions*

ISO 4674:1977, *Fabrics coated with rubber or plastics — Determination of tear resistance*

ISO 4675:1990, *Rubber- or plastics-coated fabrics — Low-temperature bend test*

1983 Amendments to the International Convention for the Safety of Life at Sea, 1974 (SOLAS 1974), Chapter III, Part C, Section I, Regulation 30, Section IV, Regulations 38 and 39, and Recommendation.

3 Fabrics

3.1 General

The fabrics used in the construction of inflatable liferafts shall be

a) waterproof (fabrics used for the inner lining of the canopy may simply be water-repellent);

b) able to withstand a tensile stress equivalent to at least four times the hoop stress which will be induced in the gas-inflated tubes at the opening pressure of the safety valves.

3.2 Base fabric

The base fabric shall be inherently rot-proof.

3.3 Coating material

Materials shall be natural or synthetic rubber or other suitable polymer proofed to meet the requirements given in table 1. They should satisfy the requirements of Regulation 30 of Section I, Regulations 38 and 39, Section IV, Part C, Chapter III, and Recommendation on testing of lifesaving appliances of *1983 Amendments to the International Convention for the Safety of Life at Sea, 1974*.

3.4 Adhesive

Adhesives used in the manufacture of liferafts shall be compatible with the material used. Where a test method requires the use of an adhesive, the method of preparation, the adhesive and its method of application shall be agreed between the liferaft manufacturer and the rubber proofer and shall be the

same as those which will be used during manufacture of the liferaft.

4 Tests and performance

The fabrics used for main buoyancy chambers, floor chambers, canopy supports, thwarts and exterior canopies shall comply with the standard values of performance as given in table 1 when type-tested in accordance with the procedures given in annex A.

5 Tests on production fabrics

5.1 The following items concerning fabrics to be used for the buoyancy chamber, floor, canopy support or thwart shall be tested on the basis of the agreement between manufacturers of fabrics and manufacturers of liferafts for quality certification and/or quality assurance purposes. Other tests defined in table 1 shall be performed at an agreed reduced frequency:

a) tensile strength and elongation;

b) tear strength;

c) ageing resistance;

d) oil resistance;

e) cold resistance;

f) coating adhesion;

g) air-tightness;

h) mass per unit area.

5.2 The following items concerning fabrics to be used for the outer canopy shall be tested on the basis of the agreement between manufacturers of fabrics and manufacturers of liferafts for quality certification and/or quality assurance purposes. Other tests defined in table 1 shall be performed at an agreed reduced frequency:

a) tensile strength and elongation;

b) tear strength;

c) ageing resistance;

d) water-proofness;

e) mass per unit area.

Table 1 — Performance criteria

Quality	Performance criteria		Annex clause No.
	for main buoyancy chamber, floor, canopy support and thwart	for exterior canopy	
Tensile strength	Not less than 2 kN/5 cm width or as required by 3.1b)[1)]	Not less than 0,5 kN/5 cm width	A.2.1
Elongation	Not more than 35 %		A.2.1
Tear strength: method A.2.2.1 method A.2.2.2	Not less than 40 N For main buoyancy chamber, canopy support and thwart: — not less than 800 N in warp — not less than 750 N in weft For floor: — not less than 700N [1)] in warp and weft	Not less than 10 N Not less than 450 N in warp and weft	A.2.2
Ageing resistance	Free of stickiness, brittleness, cracks or any other deterioration Tensile strength after ageing shall be not less than 90 % of that before ageing The difference in dimensions before and after ageing shall not be more than 2 %	Free of stickiness, brittleness, cracks or any other deterioration Tensile strength after ageing shall be not less than 90 % of that before ageing —	A.2.3

Quality	Performance criteria		Annex clause No.
	for main buoyancy chamber, floor, canopy support and thwart	for exterior canopy	
Seam strength	In the tensile test, the break should occur at a part other than the seam	In the tensile test, the break should occur at a part other than the seam	A.2.4
Oil resistance	Free of tackiness or any other deterioration	—	A.2.5
Cold resistance	Free of cracking or any other deterioration	Free of cracking or any other deterioration	A.2.6
Coating adhesion	Not less than 10 N/1 cm width	Not less than 5 N/1 cm width	A.2.7
Resistance to flex cracking: method A.2.8.1 method A.2.8.2	 Free of separation between fabric and coating material Tensile strength after flexing shall be not less than 90 % of the tensile strength before cracking No cracking or deterioration after 200 000 cycles	 — — —	A.2.8
Water-proofness (Hydraulic test)	—	Free of bursting, leakage or any other deterioration	A.2.9
Air-tightness: method A.2.10.1 method A.2.10.2	 Less than 3 l/m^2/24 h using H_2 gas No bubbles after 5 min	 — —	A.2.10
Ozone resistance	Free of visible cracking	Free of visible cracking	A.2.11
Sea water resistance	Free of peeling and colour fading In the tensile test, the break should occur at a part other than the seam	—	A.2.12
Mass per unit area	As required by the specification	As required by the specification	A.2.13

1) Where two layers of floor fabric are provided to form an inflatable floor, the secondary layer may have a minimum tensile strength of 1,15 kN/5 cm width and a minimum tear strength of 450 N.

Annex A
(normative)

Tests for coated materials used for inflatable liferafts

A.1 General conditions for tests

A.1.1 Standard test atmospheres

Unless otherwise specified, the test atmospheres shall be at a temperature of 20 °C ± 2 °C and relative humidity of (65 ± 5) %. The temperature, humidity and atmospheric pressure at the time of the test shall be recorded.

A.1.2 Conditioning of test specimens

The test specimens shall have been vulcanized for not less than 24 h and not more than 3 months and shall be kept under the standard atmosphere for at least 16 h prior to test.

A.1.3 Test specimens

The required number of test specimens shall be taken from the effective width of the coated fabric well away from the selvedges and the ends, and in both directions parallel to the warp and to the weft.

A.2 Test procedures

A.2.1 Tensile test

This test shall be carried out to determine tensile strength and elongation concurrently with breaking.

The test shall be performed in accordance with the method specified in ISO 1421.

Five rectangular test specimens shall be cut parallel to the warp and five to the weft.

Test specimens shall be 50 mm wide and of such a length as to permit a free length of 200 mm between the grips.

They shall be tested at the tensile speed of 100 mm/min ± 10 mm/min.

Prior to the tensile test, the appropriate pretension shall be applied to the test specimens:

a) for fabrics up to and including 200 g/m^2: 2 N;

b) for fabrics over 200 g/m^2 up to and including 500 g/m^2: 5 N;

c) for fabrics over 500 g/m^2: 10 N.

The test reports shall be recorded as the arithmetical average of five specimens each for warp and weft.

A.2.2 Tear test

Two alternative test methods, the constant rate of traverse method (see A.2.2.1) or the wound test method (A.2.2.2) may be used for the tear test at the discretion of the national administration.

A.2.2.1 Constant rate of traverse method

The test shall be performed in accordance with Method A — Constant rate of tear, specified in ISO 4674.

Five test specimens shall be cut parallel to the warp and five to the weft.

The test specimens shall be the so-called trouser-shaped test pieces of Method A2 in ISO 4674: a rectangular strip 225 mm by 75 mm ± 0,5 mm wide, with a longitudinal slit 80 mm long beginning from the middle of the width.

Place the test specimens symmetrically in the grips with one tongue in each of the grips, with the uncut end of the test specimen remaining free.

Ensure that each tongue is fixed in a grip so that the beginning of the tear is parallel to the direction in which the tearing force is applied.

The test shall be carried out at a tensile speed of 100 mm/min ± 10 mm/min for both warp and weft directions up to breaking point.

The test reports shall be recorded as the arithmetical average of five specimens each for warp and weft.

A.2.2.2 Wound test method

A.2.2.2.1 Apparatus

The apparatus shall be an approved strength-testing machine complying with clause 5 of ISO 1421:1977 except that

a) the constant rate of traverse method may be used, the rate being not more than 70 mm/min ± 10 mm/min grip separation;

b) the load indicated at any part of the range used is correct within 1 % of the actual load.

A.2.2.2.2 Test specimens

From the test sample, cut three rectangular specimens each 75 mm ± 0,5 mm wide and 300 mm to 400 mm long as convenient, with the length closely parallel to the direction of the warp threads and also three specimens with the length closely parallel to the direction of the weft threads.

Space the selection across the full width and full length of the sample. Make a 12,5 mm cut across the middle of each specimen at right angles to the length.

A.2.2.2.3 Test procedures

Grip the specimen under test accurately and evenly in the grips so that they are 200 mm apart and so that the specimen length is virtually in the pull direction.

Operate the machine in accordance with A.2.2.2.1.

As the load is applied, the specimen yields by tearing outward from both ends of the 12,5 mm cut and in the case of two-ply fabric by parting of the plies.

Record the maximum load sustained as the wound tearing strength; calculate the average of the results for the three specimens; measure the maximum elongation at break; and express the results as a percentage of the original 20 mm gauge length.

A.2.3 Ageing test

Three separate tests are involved: dimensional stability (see A.2.3.3.1), folding (see A.2.3.3.2) and tensile strength (see A.2.3.3.3).

A.2.3.1 Test specimens

For the dimensional stability and folding tests, cut four specimens of at least 100 mm square from the test sample.

For the tensile strength test, cut a total of 12 specimens — three pieces each for warp for dry condition and wet condition and three pieces each for weft for dry condition and wet condition — as for the tensile test in A.2.1.

A.2.3.2 Ageing of specimens

Freely suspend half the samples in an oven for 7 days at 70 °C ± 1 °C.

Suspend the other half of the samples over water in a loosely closed vessel for the same period of time at 70 °C ± 1 °C.

A.2.3.3 Test procedures

A.2.3.3.1 Dimensional stability test

Measure the overall dimensions of the specimens before and after ageing and report the percentage change in warp and weft directions.

A.2.3.3.2 Folding test

Remove the specimens and after 15 min at room temperature, fold them consecutively in two directions parallel to the edges and at right angles to each other so as to reduce the exposed area of each specimen to one quarter of its original size. Unfold and again fold the specimens along the same creases but with each fold reversed in direction.

After each folding, press the fold by rubbing fingers and thumb along it.

Inspect the specimens for cracks, separation of plies, stickiness or brittleness.

A.2.3.3.3 Tensile strength test

Follow the procedure in A.2.1.

A.2.4 Seam test

Test specimens shall be 50 mm wide by 300 mm long, having a seam lapped by 25 mm wide across the centre. Five test specimens each shall be prepared parallel to warp and to weft.

The tensile test specified in A.2.1 shall be carried out to determine the breaking resistance.

This test shall also be carried out after 7 days ageing at a temperature of 70 °C ± 1 °C as specified in A.2.3.2.

A.2.5 Oil resistance test

The disc specimen for testing shall be at least 70 mm in diameter. The typical apparatus required is shown in figure A.1. It consists of a base-plate (A) and an open-ended cylindrical chamber (B) which is held tightly against the test specimen (C) by wing nut (D), with the wing nuts mounted on bolts (E).

A hole of approximately 30 mm diameter may be made in the base-plate to examine the surface that is not in contact with the liquid. During the test, the opening in the top of the chamber is closed by a close-fitting plug (P).

Condition test specimens in the "as-received" condition for not less than 3 h at 20 °C ± 2 °C immediately before testing.

Place the test specimens in the apparatus as indicated in figure A.1. Fill the chamber of the apparatus with the test liquid to a depth of approximately 20 mm and insert the plug (P). Maintain the apparatus at the required temperature of 20 °C ± 2 °C for the duration of the liquid contact of 22 h.

At the end of the contact period, remove the test liquid and release the test specimen. Remove any surplus liquid from the surface of the test specimen by blotting with filter paper or a textile fabric which does not deposit lint.

Fold the test specimen over so that the surfaces are pressed together to see if there are any signs of residual tackiness.

With the test specimen opened out, a single pass of the finger over the exposed surface shall not produce smearing.

The liquid to be used as a standard test oil shall be oil No. 1 specified in ISO 1817.

A.2.6 Cold resistance test

The cold resistance test shall be carried out in accordance with ISO 4675.

Test specimens shall be kept at a temperature of −30 °C $^{0}_{-5}$ °C for 1 h prior to test.

In the case of a coated fabric for the main buoyancy chamber, an additional test shall be performed after exposure of specimens to a temperature of −60 °C $^{0}_{-5}$ °C for 10 min: other temperatures and times may be specified by the national administration.

A.2.7 Coating adhesion test

Adhesion between the coating and the fabric shall be tested in accordance with the method specified in 5.1, 5.2 and 5.3 of ISO 2411:1991 at a speed of 100 mm/min.

A.2.8 Flex cracking test

Two alternative test methods, the Scott (see A.2.8.1) or the De Mattia method (see A.2.8.2) may be used for the flex cracking test, at the discretion of the national administration.

A.2.8.1 Scott method

This test shall be carried out to examine the resistance to crack growth caused by repeated bend flexing.

Dimensions in millimetres

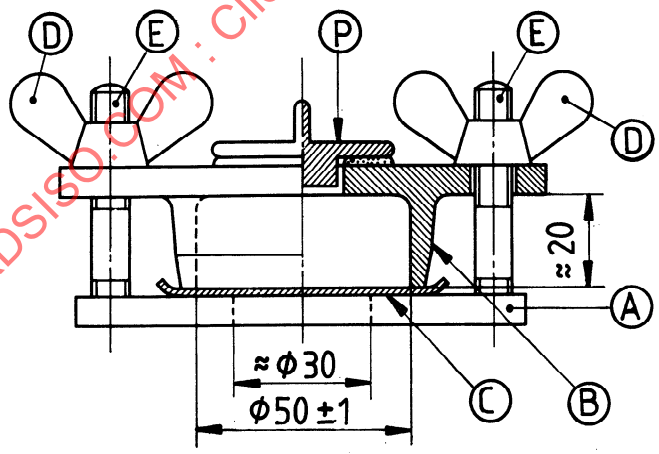

Figure A.1 — Apparatus for test with liquid on one surface only

A.2.8.1.1 Apparatus

The test apparatus shown diagrammatically in figure A.2 shall be used for this test; the machine has a pair of grips for holding the specimens.

One grip is stationary, and the other is mobile and capable of reciprocating. The stationary grip can be compressed by spring loading at right angles to the mobile grip.

A.2.8.1.2 Test specimens

Five test specimens, 25 mm wide and 300 mm long, shall be cut parallel to the warp and five to the weft.

A.2.8.1.3 Test procedure

Place the test specimen between the test machine grips, keeping the grip distance at 30 mm.

Gradually narrow the grip distance until one end of the coated surface is slightly in contact with the other end of it. Apply a load of 10 N to the test specimen.

Subject the test specimen to 500 cycles of flexing operation at a rate of 2 Hz and a grip traverse distance of 50 mm, and then to the tensile test specified in A.2.1.

The test report, including visual inspection, shall be recorded as an arithmetical average of five specimens each for warp and weft.

A.2.8.2 De Mattia method

A.2.8.2.1 Apparatus

The De Mattia flex-testing machine consists of pairs of flat grips, one grip of each pair being positioned vertically above the other.

One of the grips of each pair is capable of vertical reciprocating motion, with a stroke of 57 mm; the rate of movement of the reciprocating grip is 5 Hz.

Each pair of the grips is so positioned that they are 70 mm apart when in the "open" position and 13 mm apart when in the "closed" position. The machine may be stopped at evenly spaced intervals for examination of the specimens.

A.2.8.2.2 Test specimens

Cut three strips 37,5 mm $\pm$ 1 mm wide and 125 mm long from the sample with the length parallel to the longitudinal direction.

Cut two further strips with the length parallel to the cross direction.

Select strips evenly spaced from the full usable length and width of the sample but not within 50 mm of a selvedge.

If assessment is to be by use of the hydrostatic head test, the test specimen size should be increased as required.

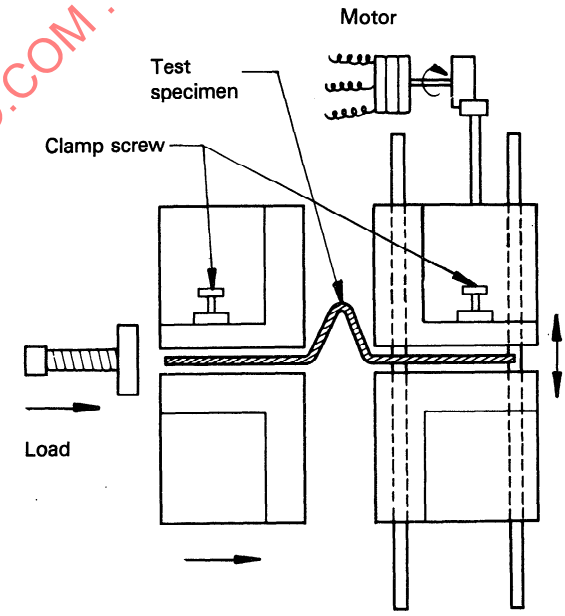

Figure A.2 — Scott type test machine (plan)

A.2.8.2.3 Test procedure

Fold each test specimen with the coating outwards along lines 12,5 mm from each of the longer sides and to a width of 12,5 mm. Mount each folded test specimen between a pair of grips of the flexing apparatus, so that the coating on the centre section will be subjected to an outward fold.

Mount the specimens while the grips are in the open position and so that they are slightly taut. Then move the grips together by hand and guide the specimen into a fold at approximately its midpoint.

Set the apparatus in motion and stop it after 200 000 cycles.

Then examine the test specimens under × 2 magnification.

A.2.9 Water-proofness test (hydraulic test)

Three test specimens 200 mm × 200 mm shall be taken from the outer canopy fabric for the hydraulic test.

Mount a test specimen on a typical test apparatus as shown in figure A.3 having a 100 mm bore so that the rubber surface is subjected to the hydraulic pressure and the other side placed by disc screen plate with 45 holes each 3 mm diameter, evenly distributed.

Perform a hydraulic test at 0,02 MPa for 3 min, and then examine for any leakage or other fault.

A.2.10 Air-tightness test

Two alternative test methods — the hydrogen gas method (see A.2.10.1) or the air twist porosity test (see A.2.10.2) — may be used for the air-tightness test at the discretion of the national administration.

A.2.10.1 Hydrogen gas method

A.2.10.1.1 Apparatus

The apparatus shall consist of the Cambridge fabric permeameter or its equivalent.

The essential components, properly assembled for the tests, are shown diagrammatically in figure A.4.

A.2.10.1.2 Test specimens

Seal a test specimen 150 mm in diameter at the periphery on both surfaces and edge with wax to leave a wax-free central area approximately 120 mm in diameter.

A.2.10.1.3 Test procedure

Subject the apparatus to a preliminary balancing period, to bring the operation onto the straight line portion of a curve of permeability plotted against time. Clamp the specimen between the test plates, start the hydrogen flow and allow it to continue for the duration of the balancing period.

Take the exact moment that the galvanometer spot crosses the zero line as the start of the actual test. Then allow the galvanometer to deflect for the specified period without further balancing; at the end of the specified period, read the permeability directly from the galvanometer scale.

A.2.10.1.4 Report

The permeability shall be expressed in litres of hydrogen per square metre per 24 h as an arithmetical average of the results obtained from the three specimens tested.