



# FINAL DRAFT International Standard

## ISO/FDIS 15027-3

### Immersion suits —

#### Part 3: Test methods

*Combinaisons de protection thermique en cas d'immersion —*

*Partie 3: Méthodes d'essai*

ISO/TC 188/SC 1

Secretariat: **AFNOR**

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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 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 document 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](http://www.iso.org/directives)).

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This document was prepared by Technical Committee ISO/TC 188, *Small craft*, Subcommittee SC 1, *Personal safety equipment*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 162, *Protective clothing including hand and arm protection and lifejackets*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 15027-3:2012), which has been technically revised.

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The main changes are as follows:

- the terms and definitions have been revised;
- in [Clause 4](#), the order of testing has been changed and clarified;
- in [4.3](#), a temperature and cycling test procedure for suits stored in sealed storage bags has been added;
- in [4.5](#), a test for tensile strength of seams has been added;
- in [4.7](#), a buoyancy test has been added;
- in [4.8](#), a suit strength test has been added;
- in [4.9](#), a lifting loop test has been added;
- in [4.12.2](#), the number and sizes of human test subjects have been revised;
- in [4.14.2](#), the use of a thermal manikin has been revised;
- [Annex B](#) “Test protocol and checklist for manikin testing” has been added;
- [Annex C](#) “Thermal manikin — Means of circulated water” has been added;
- [Annex D](#) “Correlation of thermal manikin systems” has been added;
- [Annex E](#) “Thermal insulation identification for suit material — Test methods” has been added;

## ISO/FDIS 15027-3:2024(en)

— [Annex F](#) “Medical fitness assessment for human thermal testing in cold water” has been added.

A list of all parts in the ISO 15027 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

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# Immersion suits —

## Part 3: Test methods

### 1 Scope

This document specifies the test methods for constant wear suits and abandonment suits.

Requirements for constant wear suits are given in ISO 15027-1:—.

Requirements for abandonment suits are given in ISO 15027-2:—.

### 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 188:2023, *Textiles — Determination of resistance to water penetration — Hydrostatic pressure test*

ISO 12402-9:2020, *Personal flotation devices — Part 9: Evaluation*

ISO 12894:2001, *Ergonomics of the thermal environment — Medical supervision of individuals exposed to extreme hot or cold environments*

ISO 13935-2:2014, *Textiles — Seam tensile properties of fabrics and made-up textile articles — Part 2: Determination of maximum force to seam rupture using the grab method*

ISO 15027-1:—<sup>1)</sup>, *Immersion suits — Part 1: Safety and performance requirements for constant wear suits*

ISO 15027-2:—<sup>2)</sup>, *Immersion suits — Part 2: Safety and performance requirements for abandonment suits*

ISO 15831:2004, *Clothing — Physiological effects — Measurement of thermal insulation by means of a thermal manikin*

EN 590:2022, *Automotive fuels — Diesel — Requirements and test methods*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15027-1:—, ISO 15027-2:— and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

1) Under preparation. This document, ISO 15027-1 and ISO 15027-2 are being developed together and will be published together. The date will be added just before publication.

2) Under preparation. This document, ISO 15027-1 and ISO 15027-2 are being developed together and will be published together. The date will be added just before publication.

**3.1**  
**test panel**

group of persons experienced in testing immersion suits who observe the test subject undergoing the tests

**3.2**  
**thermal manikin system**

equipment for measuring thermal insulation of immersion suit systems, including a human-shaped, instrumented (temperature sensors and heaters) manikin and a control system with a computer interface

## **4 Test methods**

### **4.1 General**

Requirements for which no special test methods are given in this document shall be tested in one of the following ways:

- a) by tests referred to in ISO 15027-1:— and ISO 15027-2:—; or
- b) by measurement; or
- c) by visual assessment; or
- d) by functional test.

Prior to testing, materials and components shall be conditioned for  $(24 \pm 0,1)$  h under standard atmosphere. The temperature cycling test and the rotating shock bin test shall be carried out as preconditioning before any other tests are carried out.

[Annex A](#) provides further information on uncertainty of measurement.

### **4.2 Sampling**

Where materials and components are common to a range of suits, it is permitted to test just one sample of each material or component, unless specified otherwise by the relevant test procedure.

Samples for testing shall be taken from the original garment or from material or materials used in the finished garment.

When the number of samples to be tested is “at least [x]” or “a minimum of [x]” that number of [x] samples shall be tested.

### **4.3 Temperature cycling test**

#### **4.3.1 General**

The temperature cycling test shall be carried out as a preconditioning before all other tests.

#### **4.3.2 Procedure**

The suit, along with any attachments, shall be subjected to the following exposures with the suit packed in accordance with the manufacturer’s instructions.

For suits supplied in a sealed storage bag, such as hermetically sealed or vacuum packed, the suit samples shall be exposed to this test in this condition, including the storage method.

The suit shall be subjected to 10 alternating cycles of 8 h continuous exposures to temperatures of  $(65 \pm 2)$  °C and  $(-30 \pm 2)$  °C. These alternating temperatures need not follow immediately after each other. On completion of the temperature cycling test, the suit shall be visually inspected for signs of degradation to the materials or construction or to any attachments.



## 4.4 Rotating shock bin test

### 4.4.1 General

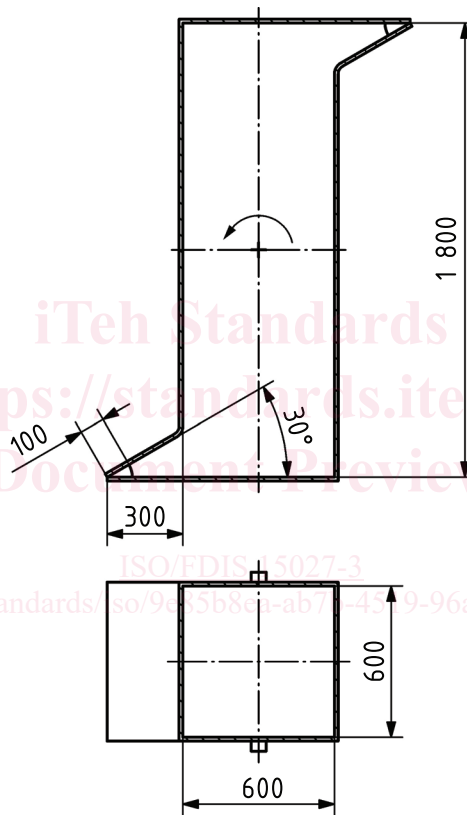
The rotating shock bin test shall be carried out as a preconditioning after the temperature cycling test in 4.3 but before all other tests.

### 4.4.2 Apparatus

The equipment used shall be as shown in [Figure 1](#).

**4.4.2.1 Box**, of specific design made from plywood board or equivalent, the inside surface of which shall be coated with hard plastic laminate or similar. The bearing of the bin shall be in the centre of the mass and shall permit the bin to be rotated freely.

Dimensions in millimetres



NOTE In this figure, dimensions are identical once rotated 180° on its central axis.

**Figure 1 — Design of rotation shock bin apparatus**

### 4.4.3 Procedure

The suit shall be placed in the bin through a flush panel in one of its faces, which shall then be closed and secured. The bin shall then be rotated for a total of 150 revolutions at a steady rate of 6 min<sup>-1</sup>.

### 4.4.4 Evaluation

On completion of the revolutions, the suit shall be removed from the shock bin and examined for signs of wear and tear, and for any signs that the thermal insulation material has migrated.

## 4.5 Tensile strength of seams

The tensile strength of seams shall be measured on separate samples using the grab method given in ISO 13935-2:2014, using specimens of at least 60 mm width and with at least 100 mm of material on each side of the test point, with four similar seams for each type of seam including the seam between fastening devices, including zip fasteners, and fabric.

## 4.6 Fuel resistance test

Three samples of all exterior fabrics, typical seams, apertures and components shall be placed in a suitable container and submerged under a 100 mm head of diesel in accordance with EN 590:2022 at a temperature of  $(20 \pm 2)$  °C for 24 h. After removal from the container, remove the surface diesel by wiping. Subject the samples to a hydrostatic test in accordance with ISO 188:2023 with a speed of 10 cm/min until 1 000 mm water head and then carry out a tensile seam strength test according to [4.5](#).

## 4.7 Buoyancy test

### 4.7.1 Principle

The buoyancy of a suit that is designed to be used without a personal flotation device (PFD) shall be measured using Archimedes' principle of weighing the submerged device in water, as specified in [4.7.3](#).

Any inflatable chambers required to meet ISO 15027-2:—, 4.11.8, shall be inflated.

The buoyancy loss of the suit shall be measured and recorded after entrapped air has been removed and 24 h after the initial buoyancy has been measured.

### 4.7.2 Apparatus

**4.7.2.1 Weighted cage**, with a submerged weight greater than 1,1 times its expected buoyancy value.

**4.7.2.2 Tank**, of fresh water, deep enough to accommodate the device horizontally with its upper surface at a depth of 100 mm to 150 mm below the water surface without contacting the sides of the tank or the bottom and supported by a calibrated load cell or balance.

### 4.7.3 Procedure

The suit shall be enclosed in a weighted cage ([4.7.2.1](#)).

The cage shall be suspended from the load cell in fresh water at a temperature of  $(20 \pm 5)$  °C so that the upper surface of the horizontally positioned suit is submerged at 100 mm to 150 mm below the surface. The combined immersed weight shall be recorded as A.

The assembly shall remain immersed for  $(24,0 + 0,5 - 0)$  h, after which time the combined immersed weight shall again be recorded as B.

The suit shall finally be removed from the cage. The weighted cage ([4.7.2.1](#)) shall again be immersed and the result again recorded as C.

The water temperature, air temperature and atmospheric pressure shall be recorded at the start of each test and then after completion of each test.

### 4.7.4 Results

The buoyancy values shall be corrected to a water temperature of 20 °C and an atmospheric pressure of 101,325 kPa.

The initial buoyancy is obtained by subtracting A from C. The final buoyancy is obtained by subtracting B from C. The buoyancy lost during immersion is obtained by subtracting the final buoyancy from the initial buoyancy.

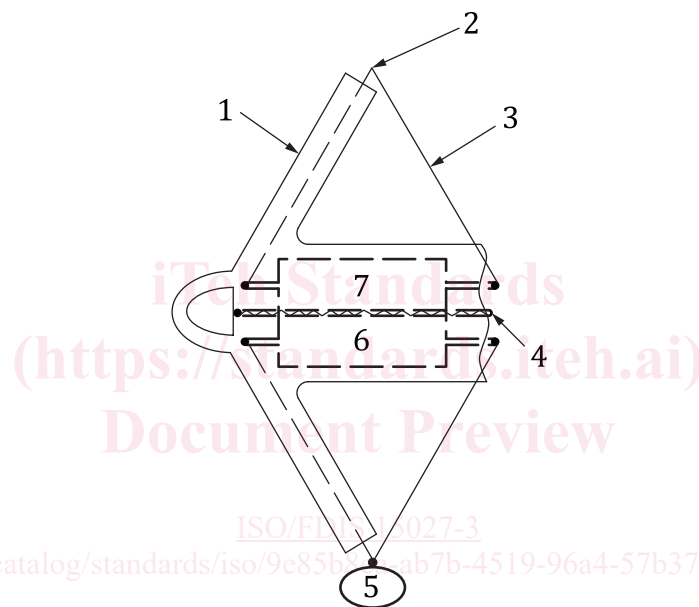
## 4.8 Suit strength test

### 4.8.1 Principle

The suit shall be subject to tension via its integral structure, such as waist belt or harness arrangement, by means of a specified load.

### 4.8.2 Apparatus

**4.8.2.1 Horizontally suspended upper cylinder**, of diameter  $(50 \pm 5)$  mm for child suits, or of diameter  $(125 \pm 10)$  mm for adult suits. The length of the test cylinder shall be sufficient to accommodate the full width of the portion of the suit under test, as shown in [Figure 2](#).



#### Key

1	immersion suit	5	weight
2	suspension point	6	bottom cylinder
3	rope or cable	7	top cylinder
4	suit closure (closed)		

**Figure 2 — Suit strength test**

### 4.8.3 Procedure

The suit shall withstand a load of 1 350 N for 30 min, without tearing, seams ripping, parts breaking or other damage that permits water entry or otherwise affects the intended performance of the suit. One sample of the suit shall be tested. Prior to the application of the load, the suit shall be immersed in water for at least 2 min. The suit shall be placed in the test apparatus immediately after the immersion.

The load shall be applied by means of two cylinders ([4.8.2.1](#)), as illustrated in [Figure 2](#).

With the suit supported by the top cylinder and the primary suit closures closed and adjusted to simulate use, a weight shall be attached to the bottom cylinder by means of ropes or cables to apply the required load

to the suit. When required, to accommodate the test apparatus, the suit shall be cut at the wrists or waist, or holes shall be cut into the suit.

**4.8.4 Results**

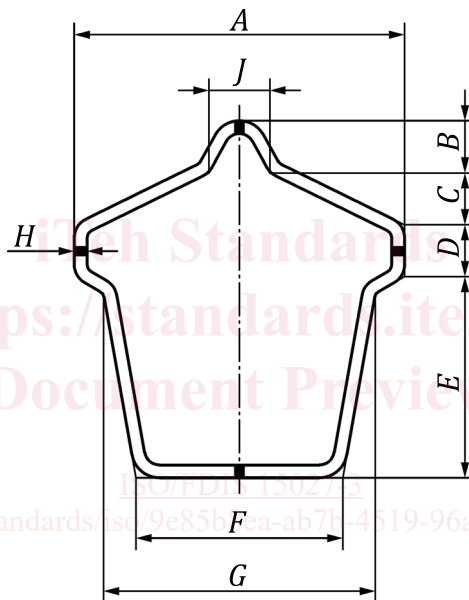
The suit shall be examined for any failures resulting in functional damage of the suit.

**4.9 Lifting loop test**

**4.9.1 Procedure**

The suit shall be fitted to the appropriately sized dummy such as that shown in ISO 12401:2009, 5.2.2.2, or the appropriately sized test form (see [Figure 3](#)) according to the manufacturer’s donning and adjustment instructions.

A cylinder, (50 ± 5) mm in diameter, shall be put through the loop and a load of 3 200 N shall be applied steadily until the suit is hanging freely. The load shall be maintained for 30 min and shall include the mass of the dummy or test form (see [Figure 3](#)).



**Key**

Size	Dimensions in millimetres								
	A	B	C	D	E	F	G	H	I
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

NOTE General tolerances ISO 2768-1:1989, tolerance level “v”.

**Figure 3 — Test form for vertical load test, lifting loop and buddy lines**

**4.10 Results**

The suit and lifting loop shall be examined for any failures resulting in functional damage of the suit.