

---

---

**Immersion suits —**

**Part 3:  
Test methods**

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

*Partie 3: Méthodes d'essai*

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[ISO 15027-3:2012](https://standards.iteh.ai/catalog/standards/sist/9e0bdd0c-5702-49b2-811a-ebc00de40ad4/iso-15027-3-2012)

[https://standards.iteh.ai/catalog/standards/sist/9e0bdd0c-5702-49b2-811a-  
ebc00de40ad4/iso-15027-3-2012](https://standards.iteh.ai/catalog/standards/sist/9e0bdd0c-5702-49b2-811a-ebc00de40ad4/iso-15027-3-2012)



## iTeh STANDARD PREVIEW (standards.iteh.ai)

ISO 15027-3:2012

<https://standards.iteh.ai/catalog/standards/sist/9e0bdd0c-5702-49b2-811a-ebc00de40ad4/iso-15027-3-2012>



### **COPYRIGHT PROTECTED DOCUMENT**

© ISO 2012

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
Case postale 56 • CH-1211 Geneva 20  
Tel. + 41 22 749 01 11  
Fax + 41 22 749 09 47  
E-mail [copyright@iso.org](mailto:copyright@iso.org)  
Web [www.iso.org](http://www.iso.org)

Published in Switzerland

<b>Contents</b>	<b>Page</b>
<b>Foreword</b> .....	<b>iv</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Testing of the device</b> .....	<b>1</b>
<b>3.1 General</b> .....	<b>1</b>
<b>3.2 Sampling</b> .....	<b>2</b>
<b>3.3 Human test subjects</b> .....	<b>2</b>
<b>3.4 Fuel resistance test</b> .....	<b>3</b>
<b>3.5 Flammability test</b> .....	<b>3</b>
<b>3.6 Rotating shock bin test</b> .....	<b>4</b>
<b>3.7 Leakage measurement</b> .....	<b>5</b>
<b>3.8 Thermal test</b> .....	<b>7</b>
<b>3.9 Temperature cycling test</b> .....	<b>10</b>
<b>3.10 Ergonomic performance testing</b> .....	<b>10</b>
<b>Annex A (normative) Test results — Uncertainty of measurement</b> .....	<b>16</b>
<b>Bibliography</b> .....	<b>17</b>

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[ISO 15027-3:2012](https://standards.iteh.ai/catalog/standards/sist/9e0bdd0c-5702-49b2-811a-ebc00de40ad4/iso-15027-3-2012)

[https://standards.iteh.ai/catalog/standards/sist/9e0bdd0c-5702-49b2-811a-  
ebc00de40ad4/iso-15027-3-2012](https://standards.iteh.ai/catalog/standards/sist/9e0bdd0c-5702-49b2-811a-ebc00de40ad4/iso-15027-3-2012)

## 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 15027-3 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 162, *Protective clothing including hand and arm protection and lifejackets*, in collaboration with Technical Committee ISO/TC 188, *Small craft*, Subcommittee SC 1, *Personal safety equipment*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 15027-3:2002), which has been technically revised.

The main technical changes are:

- ITeh STANDARD PREVIEW**  
(standards.iteh.ai)
- a) clarification that test subjects are human test subjects;
  - b) addition of two sites for skin temperature measurement;
  - c) revision of field of vision test; <https://standards.iteh.ai/catalog/standards/sist/9e0bdd0c-5702-49b2-811a-ebc00de40ad4/iso-15027-3-2012>
  - d) merger of 3.10 and 3.11 into one clause and renumbering of consecutive clauses;
  - e) mean body temperature deleted;
  - f) clarification that underclothing shall be specified by the manufacturer
  - g) revision of requirements regarding the testing of a Class D suit.

ISO 15027 consists of the following parts, under the general title *Immersion suits*:

- *Part 1: Constant wear suits, requirements including safety*
- *Part 2: Abandonment suits, requirements including safety*
- *Part 3: Test methods*

# Immersion suits —

## Part 3: Test methods

### 1 Scope

This part of ISO 15027 specifies the test methods for constant wear suits, including helicopter transit suits, and abandonment suits.

Requirements for constant wear suits are given in ISO 15027-1:2012 and requirements for abandonment suits are given in ISO 15027-2:2012.

### 2 Normative references

The following referenced documents are indispensable for the application 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.

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

ISO 811, *Textile fabrics — Determination of resistance to water penetration — Hydrostatic pressure test*

ISO 12402 (all parts), *Personal flotation devices*

ISO 13935-2, *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 15027-1:2012, *Immersion suits — Part 1: Constant wear suits, requirements including safety*

ISO 15027-2:2012, *Immersion suits — Part 2: Abandonment suits, requirements including safety*

### 3 Testing of the device

#### 3.1 General

Requirements, for which no special test methods are given in this part of ISO 15027, 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 pre-conditioning before any other tests are carried out.

**3.2 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.

**3.3 Human test subjects**

**3.3.1 Instruction and selection**

All human test subjects shall be familiar with the use of the suit under test. They shall be informed and instructed on the potential hazards of the tests. The human test subjects shall have a medical check-up to prove their medical fitness for completing the test. See also 3.8.

NOTE Attention is drawn to the principles of the Declaration of Helsinki (World Medical Association, 1964) as amended at Edinburgh 2000.

**3.3.2 Number and sizes of human test subjects**

Where tests call for the use of human test subjects, unless otherwise specified, six people shall be used, each wearing a suit of a size category suitable for their build. Their body sizes shall be within the heights and masses shown in Table 1.

**Table 1 — Human test subject sizes**

Height mm	Mass kg
1 400 to 1 600	1 person under 60 1 person over 60
> 1 600 to 1 800	1 person under 70 1 person over 70
> 1 800	1 person under 80 1 person over 80

**3.3.3 Gender of human test subjects**

At least one and not more than three of the persons should be females.

**3.3.4 Fitness of human test subjects**

The persons complying with the criteria of 3.3.1 shall be capable of relaxing when in water out of their depth, be able to swim for 20 min and cover a distance of 350 m with the aid of an approved personal flotation device as recommended by the manufacturer and, after sufficient rest, board the platform specified in 3.10.6.6.

**3.3.5 Dress of human test subjects**

Throughout the following tests, unless otherwise specified, the underclothing specified by the manufacturer or, if not specified by the manufacturer, the standard underclothing according to 3.8.1.3 shall be worn by each human test subject.

**3.3.6 Pass/fail criteria**

All samples shall pass all objective tests for the entire device to meet the requirements of ISO 15027-1:2012 or ISO 15027-2:2012. However, due to the high variability between human test subjects and the difficulty in assessing some subjective measures, it is permitted that a device does not completely meet the requirements of the following subjective tests<sup>1)</sup> in a single sample and in no more than one human test subject. In these

1) For the purpose of this clause, “subjective tests” includes all tests that require the participation of human test subjects.

circumstances, two other human test subjects within the same weight category and with the same gender, wearing the same size of suit should be subjected to the same test and before the same test panel as at 3.10.3. If this additional test is still not clearly passed as required in ISO 15027-1:2012 or ISO 15027-2:2012, then the device shall be deemed to have failed, whilst if it is clearly passed by the additional two subjects, the test panel may deem that the device has passed the test overall.

### 3.4 Fuel resistance test

Place three samples each of all exterior fabrics, typical seams, apertures and components in a suitable container and submerge them under a 100 mm head of diesel according to EN 590 at a temperature of  $(20 \pm 2)$  °C for 24 h. After removal from the container, remove the surface oil by wiping. Subject the samples to a hydrostatic test according to ISO 811 with a speed of 10 cm/min until 1 000 mm water head and then carry out a tensile seam strength test according to ISO 13935-2.

### 3.5 Flammability test

#### 3.5.1 Principle

The test suit is passed over a test pan with burning test fuel to determine if the suit burns or continues to melt after removal.

#### 3.5.2 Apparatus

Test pan,  $(300 \pm 20)$  mm  $\times$   $(350 \pm 20)$  mm  $\times$   $(65 \pm 5)$  mm.

Test fuel: petrol or n-heptane.

#### 3.5.3 Sampling

One suit system shall be subjected to the flammability test.

#### 3.5.4 Procedure

Place the test pan in a draught-free area so that the suit, which is folded so that the neck part and feet are even, travels freely across the diagonal distance of the test pan.

Fill the test pan with water to a depth of 10 mm, followed by enough petrol or n-heptane to make a minimum total depth of 40 mm.

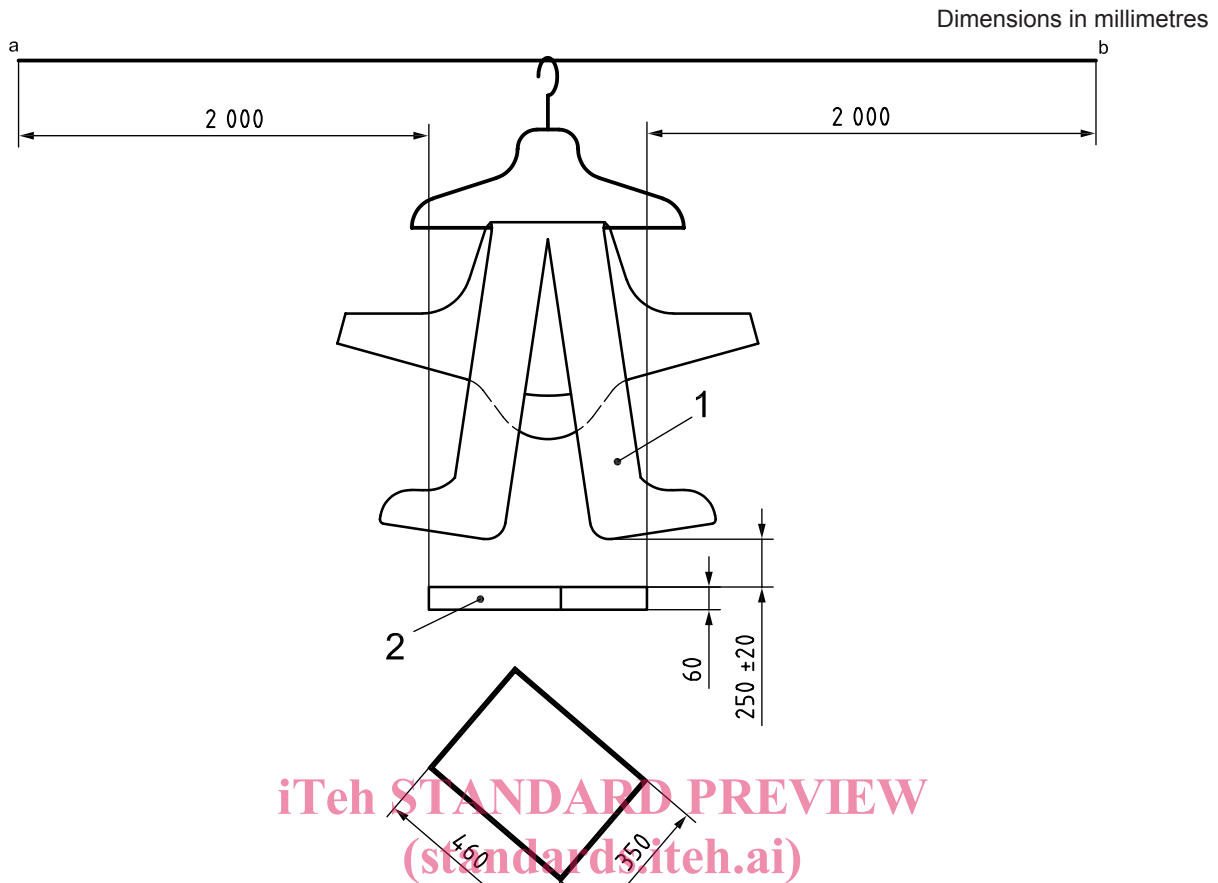
Ignite the petrol or n-heptane and allow to burn freely for 30 s.

Drape the suit over a suitable hanger, folded at the waist with the front outward. The bottom of the suit shall be  $(250 \pm 20)$  mm from the top edge of the test pan, see Figure 1. Secure loose parts above the lower part of the suit.

Then expose the suit with a constant speed of 0,29 m/s through the flames for 2 s. The suit shall start and finish the test 2 m away from the closest edge of the test pan.

#### 3.5.5 Evaluation

It shall be reported if the suit is destroyed by the flames. It shall be reported whether the suit sustains burning or continues melting 6 s after being removed from the flames.



iTeh STANDARD PREVIEW  
(standards.iteh.ai)

ISO 15027-3:2012

<https://standards.iteh.ai/catalog/standards/sist/9e0bdd0c-5702-49b2-811a-ebc00de40ad4/iso-15027-3-2012>

**Key**

- 1 suit
- 2 test pan
- a Start.
- b Finish.

**Figure 1 — Flammability test**

**3.6 Rotating shock bin test**

**3.6.1 General**

The rotating shock bin test shall be carried out as a preconditioning before all other tests.

**3.6.2 Apparatus**

The equipment used shall be that shown in Figure 2, consisting of a box of specific design made from plywood board, 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 permit the bin to be rotated freely.

**3.6.3 Procedure**

Place a test sample in the bin through a flush panel in one of the bin's faces, then close and secure it. The bin shall be operated for a total of 150 rotations at a steady rate of 6 rotations per minute.



### 3.6.4 Evaluation

On completion of the rotations, the test sample shall be removed from the bin and examined by the panel for signs of wear and tear, and for any signs that the thermal insulation material has migrated.

Dimensions in millimetres

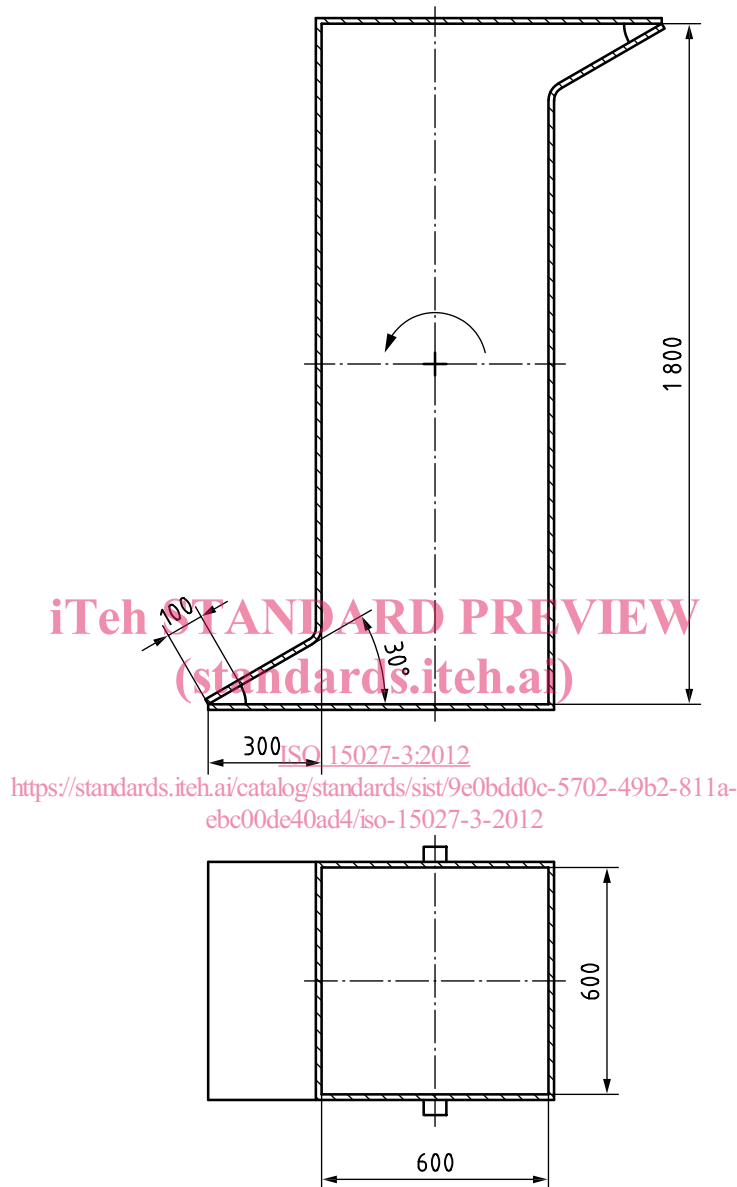


Figure 2 — Design of rotation shock bin apparatus

## 3.7 Leakage measurement

### 3.7.1 Leakage measurement for jumping

**3.7.1.1** Clean the suit samples in accordance with the manufacturer's cleaning instructions to condition them prior to leakage measurement and thermal testing. The number of cleaning cycles recommended by the manufacturer or five cleaning cycles shall be undertaken.

NOTE The amount of leakage will be used as the threshold value for the thermal test.

**3.7.1.2** Each human test subject shall wear the suit system with the standard underclothing as specified by the manufacturer or, if not specified by the manufacturer, the standard underclothing according to 3.8.1.3. The human test subject shall carefully enter the pool using the pool ladder and remain there for 2 min in order to completely pre-wet the suit. The suit shall be vented of excess air prior to this test according to the instructions of the manufacturer. If a PFD is not required and there is an inflatable element on the suit, it shall not be inflated for this test.

**3.7.1.3** The human test subject shall then climb out using the pool ladder, crouch, stretch, shake limbs and then stand to permit excess water to run off the exterior of the suit and to remove the water from all trapped areas. After 1 min the human test subject shall be weighed, in order to establish the human test subject's gross weight before the leak test starts. The weighing scales shall have a capacity up to 150 kg, and a resolution of 0,02 kg or better.

**3.7.1.4** Immediately after the "pre-wetting" and weighing, a PFD shall be donned and inflated if required. The human test subject shall then cover the mouth and nose with one hand and cross the other arm over the top, grasping the shoulder of the suit or of the PFD. The human test subject shall then jump vertically, feet first, into the pool from a height of  $(4,5 \pm 0,5)$  m .

**3.7.1.5** After the jump, the human test subject shall climb out using the pool ladder, remove the PFD if used, crouch, stretch, shake limbs and then stand to remove free water from all trapped areas. After 1 min the human test subject shall be weighed again. The increase in weight shall be recorded, to be used together with the amount of leakage from swimming (see 3.7.2.4) as the amount of leakage for the thermal test according to 3.8. The suit shall then be removed to record the location of leakage in the suit and the areas of wetted underclothing.

iTeh STANDARD PREVIEW  
(standards.iteh.ai)

**3.7.2 Leakage measurement for swimming**

**3.7.2.1** Following the leakage measurement for jumping, the human test subject shall re-don the suit system using a dry set of underclothing and vent the suit. The human test subject shall then carefully enter the pool using the pool ladder and remain there for 2 min in order to completely pre-wet the suit.

**3.7.2.2** The human test subject shall then climb out using the pool ladder, crouch, stretch, shake limbs and then stand to permit excess water to run off the exterior of the suit and to remove the water from all trapped areas. After 1 min the human test subject shall be weighed in order to establish the human test subject's gross weight before the swim starts.

**3.7.2.3** Immediately after the "pre-wetting" and weighing, any hand protection provided with the suit shall be donned and a PFD shall be donned and inflated if required. The human test subject shall then carefully re-enter the pool using the pool ladder and swim on the back for 20 min, covering a distance of at least 350 m in this time. The hands and arms shall be kept in the water even if not being used for propulsion.

**3.7.2.4** After the swim, the human test subject shall climb out using the pool ladder, remove the hand protection and PFD if used, crouch, stretch, shake limbs and then stand to remove free water from all trapped areas. After 1 min the human test subject shall be weighed again. The increase in weight shall be recorded, to be used together with the amount of leakage from jumping (see 3.7.1.5) as the amount of leakage for the thermal test according to 3.8. The suit shall then be removed to record the location of leakage in the suit and the areas of wetted underclothing.

## 3.8 Thermal test

### 3.8.1 Using a thermal manikin

#### 3.8.1.1 General

The test house shall validate that the thermal manikin used is able to provide thermal insulation values for immersion suits which are within  $\pm 10\%$  of the values obtained from human subject testing of the suits.

**NOTE** The validation should be accompanied by an exchange of experience between the manikin testing laboratories, round robin testing, and the correlation of results between the tests with human subject and manikin.

#### 3.8.1.2 Apparatus

A thermal manikin shall be constructed so that it

- a) has a surface area and shape similar to that of a 50th percentile man and at least 9 segments representing the head, upper torso, right and left arms, hip, right and left thigh, and right and left lower legs;
- b) can be dressed in the underclothing specified by the manufacturer or in standard underclothing according to 3.8.1.3;
- c) is capable of being heated to and controlled at a programmable uniform temperature in each segment;
- d) can control and measure temperatures and power inputs and calculate, record and present the parameters;
- e) can be immersed to the neck in water without causing failure in the electrical system if water leaks inside the outer clothing;
- f) can be calibrated both in and out of the water;
- g) shows reproducible results with less than  $\pm 4\%$  variance for three tests on the same suit system.

#### 3.8.1.3 Standard underclothing

The underclothing to be worn in connection with the suit system shall be specified by the manufacturer. If not specified by the manufacturer, the following standard underclothing shall be used for testing.

- a) For class A suit systems:
  - underwear (short-sleeved, short-legged);
  - long-sleeved shirt;
  - trousers (not woollen);
  - woollen socks;
  - appropriate footwear (if the suit is used with footwear).

The thermal insulation of the dry standard underclothing shall be no more than 1 clo measured with the thermal manikin in air.

- b) For class B, C and D suit systems: as for class A, with the addition of two woollen long-sleeved pullovers.

The underclothing shall be in good condition and shall not be altered by use or otherwise damaged. The size of each piece of underclothing shall be suitable for the individual human test subject.

#### 3.8.1.4 Procedure

The thermal protection provided by a suit system shall be assessed by measurement of the effective insulation of the whole suit system and associated underclothing placed on a thermal manikin and immersed in calm but