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Aeronavtika - Potopne obleke za posadko v rotoplanu - Zahteve, preskušanje in označevanje

Aerospace series - Rotorcraft immersion suits - Requirements, testing and marking

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European foreword

This document (prEN 4863:2021) has been prepared by the Aerospace and Defence Industries Association of Europe – Standardization (ASD-STAN).

After enquiries and votes carried out in accordance with the rules of this Association, this document has received the approval of the National Associations and the Official Services of the member countries of ASD-STAN, prior to its presentation to CEN.

This document is currently submitted to the CEN Enquiry.

Introduction

This technical document prescribes the minimum standards of design and performance for rotorcraft immersion suits, used to reduce cold shock on initial immersion and provide thermal protection following evacuation or escape from a rotorcraft.

The technical document aims to ensure that the equipment user is able to perform normal activities during flight and to carry out the necessary emergency procedures, whilst being provided with an appropriate level of protection under foreseeable conditions of use. It aims to ensure that the equipment presents a minimal hazard in relation to escape from the rotorcraft, and that the equipment has no detrimental effect on the health and safety of the user or on the performance of other equipment.

It is assumed for the purpose of this document that the immersion suit is donned prior to boarding the rotorcraft.

Rotorcraft immersion suits may be designed to be worn with an approved rotorcraft constant wear lifejacket or may be designed to incorporate the functionality of a lifejacket in which case the wearing of a separate lifejacket is not required.

This document is applicable to all rotorcraft. Rotorcraft include helicopters, tilt rotor/wing and gyroplanes. For the purpose of this document, the term helicopter is used generically hereinafter.

1 Scope

This technical document specifies requirements for immersion suits for use by helicopter crew members and passengers in the event of a ditching or water impact, to ensure minimum levels of performance. It applies to immersion suits for use by adults only.

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.

EN 4856, *Rotorcraft - Emergency Breathing Systems (EBS) - Requirements, testing and marking*

EN 4862:—,[1] *Rotorcraft - Constant Wear Lifejackets - Requirements, testing and marking*

EN 4886,[2] *Aerospace series - Rotorcraft - Liferafts for operations in hostile sea areas - Requirements, testing and marking*

EN 14225-1:2017, *Diving suits - Part 1: Wet suits - Requirements and test methods*

EN ISO 811, *Textiles - Determination of resistance to water penetration - Hydrostatic pressure test (ISO 811)*

EN ISO 1421, *Rubber- or plastics-coated fabrics - Determination of tensile strength and elongation at break (ISO 1421)*

EN ISO 2411, *Rubber- or plastics-coated fabrics - Determination of coating adhesion (ISO 2411)*

EN ISO 4674-1, *Rubber- or plastics-coated fabrics - Determination of tear resistance - Part 1: Constant rate of tear methods (ISO 4674-1)*

EN ISO 7854, *Rubber- or plastics-coated fabrics - Determination of resistance to damage by flexing (ISO 7854)*

EN ISO 9227, *Corrosion tests in artificial atmospheres - Salt spray tests (ISO 9227)*

EN ISO 11092, *Textiles - Physiological effects - Measurement of thermal and water-vapour resistance under steady-state conditions (sweating guarded-hotplate test) (ISO 11092)*

EN ISO 12402-7, *Personal flotation devices - Part 7: Materials and components - Safety requirements and test methods (ISO 12402-7)*

EN ISO 12402-8, *Personal flotation devices - Part 8: Accessories - Safety requirements and test methods (ISO 12402-8)*

EN ISO 12894, *Ergonomics of the thermal environment - Medical supervision of individuals exposed to extreme hot or cold environments (ISO 12894)*

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[1] Under preparation. Current stage is: prEN 4862:2021.

[2] Under preparation.

EN ISO 13934-1, *Textiles - Tensile properties of fabrics - Part 1: Determination of maximum force and elongation at maximum force using the strip method (ISO 13934-1)*

EN 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 13935-2)*

EN ISO 13937-4, *Textiles - Tear properties of fabrics - Part 4: Determination of tear force of tongue-shaped test specimens (Double tear test) (ISO 13937-4)*

ISO 105-A02, *Textiles — Tests for colour fastness — Part A02: Grey scale for assessing change in colour*

ISO 105-E02, *Textiles — Tests for colour fastness — Part E02: Colour fastness to sea water*

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

ISO 188, *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

ISO 3801, *Textiles — Woven fabrics — Determination of mass per unit length and mass per unit area*

ASTM D1655, *Specification for aviation turbine fuels*

CIE 015, *Colorimetry*

DEF STAN 91-091, *Turbine Fuel, Kerosine Type, Jet A-1; NATO Code: F-35; Joint Service Designation: AVTUR*

EASA, *Certification Specifications and Acceptable Means of Compliance for Large Aeroplanes, CS-25, Book 1 – Appendix F*

EASA, ETSO-C85b, *Survivor locator lights*

IATA, *Guidance material (Kerosene Type), NATO Code F-35*

IMO, Resolution A.658(16), *Use and fitting of retro-reflective materials on life-saving appliances*

IMO, International Life-Saving Appliance (LSA) Code, adopted by Resolution MSC.48(66), (as amended)

IMO, Resolution MSC.81(70), (adopted on 11 December 1998) *Revised recommendation on testing of life-saving appliances*

MIL-STD-3009, *Lighting, aircraft, night vision imaging system (NVIS) compatible*

SAE ARP5825, *Design requirements and test procedures for dual mode exterior lights*

SAE AS 4492A, *Survivor locator lights*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

3.1
lifejacket
garment or device which, when correctly worn and used in water will provide the user with buoyancy positioned to provide protection from drowning and increase the likelihood of survival and rescue

3.2
helicopter constant wear lifejacket
lifejacket worn on the body throughout a helicopter flight over water, provided to protect the user in the event of a ditching or water impact

3.3
buoyancy chamber
inflatable component of a lifejacket or integrated immersion suit

3.4
immersion suit
garment designed to protect the user's body from the cooling effects of unintended immersion in water

Note 1 to entry: Cooling effects include cold shock and hypothermia.

Note 2 to entry: An immersion suit may be integrated or worn with a separate constant wear lifejacket.

3.5
integrated immersion suit
immersion suit that incorporates the functionality of a lifejacket

3.6
buoyancy element
inflatable chamber incorporated into an integrated immersion suit that, when inflated, provides the suit with the functionality of a lifejacket

3.7
helicopter immersion suit
immersion suit worn on the body throughout a helicopter flight, provided to protect the user in the event of a ditching or water impact

3.8
immersion suit system
helicopter immersion suit (with or without thermal insulation) and its components and accessories including either a constant wear lifejacket or buoyancy element and/or emergency breathing system, as applicable

3.9
hood
covering for the head and neck with an opening for the face, worn for protection against cold

3.10
glove
covering for the hand which may have separate parts for each finger and the thumb, worn for protection against cold

3.11
thermal insulation
material layer used in an immersion suit to reduces heat flow, thus provided protection against cold

3.12
underclothing
clothes worn under a helicopter immersion suit

3.13
emergency breathing system
EBS
system that allows a person to breathe underwater, overcoming the need to breath-hold for the complete duration of an underwater escape from a helicopter, that can be deployed under emergency conditions

3.14
rotorcraft
heavier-than-air aircraft that depends principally for its support in flight on the lift generated by one or more rotors

3.15
helicopter
rotorcraft that, for its horizontal motion, depends principally on its engine-driven rotors

3.16
ditching
controlled emergency landing on water, deliberately executed in accordance with Rotorcraft Flight Manual procedures, with the intent of abandoning the rotorcraft as soon as practical

3.17
water impact
helicopter contact with water that is unintentional or exceeds the ditching capability of the helicopter for water entry

3.18
crew member
person assigned by an operator to perform duties on board an aircraft

3.19
hardware
lifejacket components such as structural closures and adjusters and multi-eyelet guides used with lacing

3.20
manual inflation system
means of inflation achieved by a person operating a mechanism that actively releases stored gas into the buoyancy chamber(s)

3.21
fully inflated
inflation achieved by using the manual inflation system (stored gas) with no subsequent deflation

3.22
oral inflation system
means of inflation achieved by a person blowing expired air into the buoyancy chamber(s)

3.23
overpressure relief valve
safety device used to limit the pressure in an inflatable system, to avoid the likelihood of destruction caused by excessive pressure

3.24
sprayhood
cover that can be brought in front of the face, incorporating an area of transparent material, used to protect the airways from water and wave splash, intended to increase the likelihood of survival in rough water conditions

3.25
survivor locator light
device which emits light intended to aid in the location of the user in an emergency

3.26
whistle
device which, when blown by mouth, produces an audible sound intended to aid in the location of the user

3.27
lifting loop
device which facilitates manual recovery of a person from water

3.28
buddy line
length of cord or webbing which can be tied or otherwise fixed to another person or to that person's lifejacket or other objects, so as to keep the user in the vicinity of that person or object, aiding in the location of the user

3.29
retroreflective material
material that reflects light beams back to their point of origin with a low level of scattering

3.30
infrared
IR
electromagnetic radiation at the red end of the spectrum at wavelengths from 800 nm to 1 mm (longer than those of visible red light but shorter than microwaves)

3.31
personal locator device
PLD
device carried on the body that is able to transmit a signal to enable electronic detection and location of a person in the water

Note 1 to entry: In the maritime environment a PLD may be known as an Autonomous Maritime Rescue Device (AMRD).

3.32
escape buoyancy
buoyancy of an equipment combination, with the lifejacket or buoyancy element uninflated, that must be overcome when escaping from an immersed helicopter

Note 1 to entry: It includes the inherent buoyancy of the components of the immersion suit system and entrapped air but excludes the inflated buoyancy elements.

3.33
hypothermia
condition where body core temperature is below 35 °C

3.34
cold shock
short transitory phase lasting about 2 min to 3 min upon sudden immersion in cold water and characterized by reduced breath-holding ability and an uncontrollable hyperventilation accompanied by other cardio-respiratory distress

3.35
heat strain

increase of body temperature induced by sustained heat stress which cannot be fully compensated by temperature regulation or activation of thermoeffective activities in response to heat stress, which cause sustained changes in the state of other, non-thermal, regulatory systems

3.36
thermal resistance
insulation
R_{ct}
temperature difference between the two faces of a material divided by the resultant heat flux per unit area in the direction of the gradient

Note 1 to entry: The dry heat flux may consist of one or more conductive and radiant components. Thermal resistance R_{ct}, expressed in square metres kelvin per watt, is a quantity specific to textile materials or composites, which determines the dry heat flux across a given area in response to a steady applied temperature gradient.

4 Classification

There are four categories of immersion suit system with different thermal insulation, defined in Table 1.

Table 1 — Helicopter immersion suit system categories

	Category 1	Category 2	Category 3	Category 4
Insulation level	Immersion suit system without inherent insulation	Immersion suit system with low inherent insulation	Immersion suit system with medium inherent insulation	Immersion suit system with high inherent insulation
Sea temperatures relating to intended use (°C)	≥ 12	≥ 7	≥ 2	< 2

NOTE Helicopter immersion suits are hereinafter referred to as immersion suits.

Protection from drowning is provided either by the use of a helicopter constant wear lifejacket worn with the immersion suit, or by the immersion suit incorporating a buoyancy element that has the functionality of a lifejacket (integrated immersion suit).

Guidance and background relating to the use of immersion suits and the different categories of protection is provided in Annex A (informative).

5 Requirements

5.1 General

5.1.1 Immersion suits may be designed for dedicated use by crew members only, for dedicated use by passengers only, or for use by crew members and passengers.

5.1.2 The immersion suit system shall not adversely affect the health or hygiene of the user.

5.2 Design

5.2.1 The immersion suit shall comprise at least the following:

- a dry coverall garment;
- wrist seals;
- neck and/or face seal;
- a closure system;
- integral socks or boots.

5.2.2 A combination of an immersion suit and accessories shall not impair the performance of the system. This shall be established by testing the immersion suit and accessories in combination, in accordance with 6.1, 6.10, 6.11, 6.12 and 6.13 as applicable.

The requirements for accessories are identified in Table 2.

5.2.3 The immersion suit shall include an integral or separate hood to provide thermal insulation to the head. Testing shall be carried out in accordance with 6.1.

5.2.4 The immersion suit shall include gloves to protect the hands. Gloves shall be either permanently attached or tethered to the immersion suit. Testing shall be carried out in accordance with 6.1.

5.2.5 The immersion suit shall not contain any component nor use any method of component attachment which in normal use is likely to cause injury to the user or damage the suit when tested in accordance with 6.10, 6.11, 6.12 and 6.13.

Table 2 — Immersion suit accessories

Accessory	Mandatory	Optional	Requirement
Inherent thermal insulation layer		x[a]	5.11.6, 5.11.7
Hood	x		5.2.3
Gloves	x		5.2.4
Sprayhood	x[b]		5.12.11
Survivor locator light	x[b]		5.12.1
Whistle	x[b]		5.12.2
Lifting loop	x[b]		5.12.3
Buddy line	x[b]		5.12.4
Retroreflective material	x		5.8.2
EBS		x[c]	5.9, 5.13
Other		x	5.10, 5.13

[a] Dependent upon the category of immersion suit system.

[b] Mandatory for immersion suits with integral lifejacket functionality.

[c] EBS are only mandatory for helicopter offshore operations [European Commission Regulation (EU) No 965/2012, amended by Commission Regulation (EU) 2016/1199, SPA.HOFO.165(c)]. EBS may or may not be attached to the immersion suit.

5.3 Size and fit

The design of the immersion suit shall allow tailoring to fit the individual user or, where suits are not individually tailored, the size range shall be satisfactory to at least fit the test subject size range defined in 6.10.2.

Testing shall be carried out in accordance with 6.1, 6.10.4.

5.4 Materials and components

5.4.1 General

The choice of materials used shall be such that, when stowed in accordance with the relevant instructions, neither the immersion suit nor its attached equipment shall be liable to become unserviceable through material deterioration or chafing, or from any other cause. All materials used shall be compatible with the complete immersion suit system.

All fabric samples including seam samples shall be pre-conditioned by temperature cycling in accordance with 6.6.

5.4.2 Fuel resistance

All exterior structural materials, fabrics, typical seams, seals and components of the immersion suit shall be resistant to the damaging effects of aviation fuel (Jet A1 in accordance with DEF STAN 91-091, ASTM D1655 and IATA Guidance material (Kerosene Type), NATO Code F-35).

Testing shall be carried out in accordance with the fuel resistance test (6.4). There shall be no leakage during the hydrostatic test and the tensile seam strength shall be at least 150 N per 50 mm width using the grab method given in EN ISO 13935-2.

5.4.3 Fabric flammability

The outer fabric used in the construction of the immersion suit shall as a minimum meet the vertical test of EASA CS-25 Appendix F Part 1 (a)(1)(ii) (or as amended).

The test shall be conducted on new fabric without any pre-treatment.

5.4.4 Fabric thermal conductivity

5.4.4.1 Outer fabrics

Where required in accordance with 5.11.6.2, the thermal conductivity of the outer fabrics used in the construction of the immersion suit shall be measured in fresh water.

Testing shall be carried out in accordance with the test method described in EN 14225-1:2017, Annex A.

Measurements shall be carried out on three samples of each material. Each sample shall be in the form of a cylindrical sleeve 210 mm high and 150 mm diameter, to give a surface area exposed to the heat flow of 0,1 m^2.

The tank in which the apparatus is immersed shall be at a uniform water temperature between 10 °C and 15 °C and the difference between the water temperature within the apparatus and the external water temperature shall be between 25 °C and 30 °C.

Each sample shall be tested at a pressure of 1 bar absolute only.

5.4.4.2 Insulating material

Where required in accordance with 5.11.6.2, the thermal conductivity of any insulating material that is not an outer fabric shall be tested in accordance with the thermal resistance requirements of EN ISO 11092.

Measurements shall be carried out on three samples of each material.

5.4.5 Tensile strength of seams

The tensile strength of seams shall be of at least 200 N per 50 mm width. The seam shall not leak when samples are subjected to a hydrostatic test according to EN ISO 811 at a rate of 100 mm/min up to a 1 000 mm water head. Then carry out a tensile seam strength test according to EN ISO 13935-2. The tensile strength shall be measured on separate samples 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.