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Small craft — Personal watercraft — Construction and system installation requirements

Petits navires — Véhicules nautiques à moteur — Exigences de construction et d'installation des systèmes

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: 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).

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For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 188, *Small craft*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 464, *Small craft*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 13590:2003), which has been technically revised.

The main changes are as follows:

— in Clause 1, it has been clarified that outboard powered personal watercraft and jet powered surfboards are outside the scope of this document;

— comparing all values to SAE and industry standards;

— using the single term "craft's ground" for both "earthed" and "ground";

— requirements for watercraft identification have been added in new Clause 5;

— requirements for cellular plastic used to encase metallic fuel tanks have been removed (former 5.2.2);

— requirements for plastic-encased metallic fuel tanks have been removed (former 5.3.2);

— requirements for carburettors have been removed (former 5.6);

— the fuel fill system grounding value in 6.13 has been corrected;

— requirements for propulsion engine cut-off device have been added in new Clause 13;

— requirements for off throttle steering when underway have been added in Clause 16;

— requirements for the owner's manual have been added in Clause 18;

— off-throttle steering testing methods have been added in new Annex A.

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.

Small craft — Personal watercraft — Construction and system installation requirements

1 Scope

This document specifies construction and system installation requirements for personal watercraft. It addresses the builder's plate, watercraft identification, permanently installed petrol fuel systems, electrical systems, steering systems, ventilation, hull structure and floatation, stability, mooring and towing, flooding, off-throttle steering and the owner's manual.

This document does not apply to outboard powered personal watercraft and jet powered surfboards.

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 1817:2022, *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*

ISO 7326:2016, *Rubber and plastics hoses — Assessment of ozone resistance under static conditions*

ISO 7840:2021, *Small craft — Fire-resistant fuel hoses*

ISO 8469:2021, *Small craft — Non-fire-resistant fuel hoses*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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/

3.1
personal watercraft
watercraft intended for sports and leisure purposes, of less than 4 m in hull length, which uses a propulsion engine having a water jet pump as its primary source of propulsion and is designed to be operated by a person or persons sitting, standing, or kneeling on, rather than within the confines of a hull

Note 1 to entry: The measurement methodology for the length of hull is defined in ISO 8666.

3.2
fuel system
entire assembly of the fuel fill, vent, tank and distribution components, including but not limited to pumps, valves, strainers, and filters

3.3
static floating position
condition in which a personal watercraft floats in calm water, with each fuel tank filled to its rated capacity, but with no person or items of portable equipment on board

3.4
conduit
any type of rigid plastic or metal piping or tubing that supports the conductors contained within

3.5
sheath
material used as a continuous protective covering, such as electrical tape, moulded rubber, moulded plastic or flexible tubing, around one or more insulated conductors

3.6
open to the atmosphere
space or compartment that has at least 0,34 m^2 of open area directly exposed to the atmosphere for each cubic metre of net compartment volume

3.7
engine compartment
space where the engine is permanently installed

3.8
bilge
area, excluding *engine compartments* (3.7), in the personal watercraft, below a height of 100 mm measured from the lowest point in the personal watercraft, where liquid can collect when the personal watercraft is in its *static floating position* (3.3)

3.9
engine compartment bilge
space in the *engine compartment* (3.7) or a connected compartment, below a height of 300 mm measured from the lowest point, where liquid can collect when the personal watercraft is in its *static floating position* (3.3)

3.10
builder's plate
label or plate to display basic user information related to the personal watercraft

3.11
handlebar
mechanical means for applying manual steering effort into the connected *helm* (3.12), normally a horizontal configuration with hand grips at each end

3.12
helm
mechanism, exclusive of *handlebars* (3.11) or other means for manual application of a controlling force, by which the controlling force is fed into a personal watercraft steering system

3.13
craft's ground
ground that is established by a conducting connection (intended or accidental) with the common ground (potential of the earth's surface), including any conductive part of the wetted surface of the hull

Note 1 to entry: "Ground" is also known as "earth".

[SOURCE: ISO 10088:—[1)], 3.12]

1) Under preparation. Stage at the time of publication: ISO/FDIS 10088:2021.

3.14
normal accumulation of bilge water
minor amounts of water collecting in the *bilge* (3.8) from spray, rain seepage and spillage that can be removed by bilge pumps

Note 1 to entry: The height of the normal accumulation of bilge water is below the lowest part of the engine, or measured at the top of the bilge pump inlet or the bilge pump automatic float switch.

3.15
accessible
capable of being reached for inspection, removal or maintenance without removal of permanent craft structure

3.16
readily accessible
capable of being reached for use, inspection, removal or maintenance without the use of tools

3.17
propulsion engine cut-off device
switch or other system that, when activated in an emergency, provides the means to shut off the mechanical propulsion system

3.18 Terms related to the off-throttle testing (see Annex A)

3.18.1
advance
distance travelled along an extension of a previous straight line course measured from the completion of steer input

3.18.2
apex marker
test triangle (3.18.7) marker closest to the *turn markers* (3.18.9)

3.18.3
entrance chute
area of the test course between the *gate markers* (3.18.4) and the *turn markers* (3.18.9)

3.18.4
gate marker
marker at the beginning of the *entrance chute* (3.18.3)

3.18.5
off throttle condition
condition where the forward thrust throttle is completely released by the operator and the engine returns to idle

3.18.6
off throttle steering
any means provided with the personal watercraft that allows manoeuvring of the craft in an *off throttle condition* (3.18.5)

3.18.7
test triangle
area, outlined by markers, that the personal watercraft is not meant to enter during the test

3.18.8
transfer
perpendicular distance from an extension of a previously straight line course

3.18.9
turn marker
marker at the end of the *entrance chute* (3.18.3)

4 Builder's plate

Personal watercraft shall display a permanently installed builder's plate.

NOTE Requirements for builder's plate are found in ISO 14945.

5 Watercraft identification

Personal watercraft shall display a permanent identification number.

NOTE 1 The identification number is subject to certain international as well as national regulations.

NOTE 2 Requirements for the identification number are found in ISO 10087.

6 Fuel system

6.1 General

6.1.1 Each fuel system fitting, joint and connection shall be accessible.

6.1.2 The fuel system shall be designed not to leak liquid fuel into the personal watercraft when

a) the personal watercraft is overturned through 180° of roll in either direction, or

b) the personal watercraft is overturned through 90° of pitch in either direction.

6.1.3 The fuel system shall be designed not to leak liquid fuel into the personal watercraft when subjected to the greater of the following two values: 20 kPa or 1,5 times the highest hydrostatic pressure to which the component can be subjected in service.

6.1.4 The fuel system shall be designed to supply fuel to the engine within 10 s of the engine being energized and automatically stop the supply of fuel within 10 s of the engine being de-energized.

6.2 Fuel tanks

6.2.1 Materials prohibited for fuel tanks

6.2.1.1 A fuel tank shall not be constructed of terneplate.

6.2.1.2 Unless it has an inorganic sacrificial galvanic coating on the inside and outside of the tank, a fuel tank shall not be constructed of black iron or steel.

6.2.1.3 A metallic fuel tank encased in cellular plastic or in fibre-reinforced plastic shall not be constructed from a ferrous alloy.

6.2.2 Fuel level indication

A means shall be provided to check the fuel level, or a reserve fuel supply shall be provided.

6.2.3 Tank pressure limitation

With the personal watercraft in its static floating position, a fuel tank, when filled, shall have an air-expansion volume or be equipped with a system that prevents pressure in the tank from exceeding 80 % of the fuel tank design pressure.

6.2.4 Fill and vent openings

Fill and vent openings shall be at or above the liquid level when the tank is filled to its rated capacity with the personal watercraft in its static floating position.

The vent-line termination or a gooseneck in the vent-line routing shall be arranged at sufficient height to prevent spillage of fuel through the vent line during filling under normal operating conditions of the personal watercraft.

6.2.5 Fuel tank static-pressure test

6.2.5.1 A representative fuel tank shall not leak if tested using the procedures specified in 6.2.5.2 and 6.2.5.3.

6.2.5.2 Fill the tank with air or inert gas to exceed 80 % of the maximum test pressure of 21 kPa.

6.2.5.3 Tank fittings and seams shall be checked for leaks using a method other than the pressure drop test.

NOTE Soapy test solutions must be non-corrosive and non-toxic. Ammonia, present in some soaps and detergents, creates a condition that attacks brass fittings like those used in fuel systems. Damage can be undetectable at first, and these fittings can develop cracks in a matter of months creating a very hazardous situation.

6.2.6 Fuel tank shock test

6.2.6.1 A representative fuel tank shall not leak when shock tested using the procedures specified in 6.2.6.2 to 6.2.6.7.

6.2.6.2 Confirm that the tank does not leak when pressure tested according to 6.2.5.

6.2.6.3 If the tank is non-metallic, precondition the tank by filling it to capacity with petrol that has at least a 50 % aromatic content. Keep the fuel in the tank at 21 °C or higher for at least 30 days prior to testing.

6.2.6.4 Mount the empty shock test tank on an impact-test machine platform in a manner similar to how the tank is installed in the personal watercraft.

6.2.6.5 Fill the tank to capacity with water.

6.2.6.6 Apply 1 000 cycles of vertical accelerations of 245 m/s^2 at a rate of 80 cycles or less per minute. Apply the accelerations within 76 mm of the centre of the horizontal mounting surface of the tank. The duration of each vertical acceleration cycle measured from the base of the shock envelope shall be between 6 ms and 14 ms.

6.2.6.7 Check the tank for leaks using the procedure specified in 6.2.5.

6.3 Fuel tank installations

6.3.1 Non-encased metallic fuel tanks

6.3.1.1 Each fuel tank shall not support a deck, bulkhead or other structural component.

6.3.1.2 Fuel tanks shall not be integral with the hull or engine.

6.3.1.3 Each metallic fuel tank installed shall allow water to drain from the top surface when the personal watercraft is in its static floating position.

6.3.1.4 Each fuel tank support, chock or strap that is not integral with a metallic fuel tank shall be separated from the tank surface by a material that does not absorb moisture.

6.3.1.5 Cellular plastic shall not be the sole support for a metallic fuel tank.

6.4 Fuel tank filling system

6.4.1 Each fuel fill opening shall be located so that, when the personal watercraft is in its static floating position, a fuel overflow of up to 19 l/min for at least 5 s does not enter the enclosed compartments of the personal watercraft when all compartment openings are closed.

6.4.2 Each hose in the tank filling system shall be secured to a pipe, spud or hose fitting by a method that prevents leaks and prevents the hose from becoming disconnected.

6.5 Fuel pumps

6.5.1 Each fuel pump with a diaphragm shall not leak fuel into the personal watercraft if the primary diaphragm fails.

6.6 Fuel stop valves

Each electrically operated fuel stop valve in a fuel line between the fuel tank and the engine shall open only when the ignition switch is on.

6.7 Fuel filters and strainers

Each fuel filter and strainer shall be supported on the engine or watercraft structure independent from its fuel-line connections, unless the fuel filter or strainer is inside a fuel-system component.

6.8 Spud, pipe and hose fitting

Except when used for a tank filling line, each spud, pipe or hose fitting used with hose clamps shall have a bead, flare or a series of annular grooves or serration no less than 0,4 mm in depth.

6.9 Clips, straps and hose clamps

6.9.1 Clips, straps and hose clamps shall be of a corrosion resistant material and shall not cut or abrade the fuel line.

6.9.2 Hose clamps, when used, shall be used with fuel hose designed for clamps.

6.9.3 Hose clamps, when used, shall be beyond the bead or flare, or over the serration of the mating spud, pipe or hose fitting.

6.10 Metallic fuel line

6.10.1 Each metallic fuel line connecting the fuel tank with the fuel inlet connection on the engine shall not be made of carbon steel. Except for corrugated flexible fuel lines, each metallic fuel line shall have a minimum wall thickness of 0,74 mm.

6.10.2 Each metallic fuel line that is mounted to the personal watercraft's structure shall be connected to the engine by a flexible fuel hose and shall be attached to the personal watercraft's structure within 10 cm of its connections to a metallic fuel line.

6.11 Plugs and fittings

A fuel system shall not have a fitting for draining fuel.

Exception: a plug used to remove fuel and/or water within the fuel filter or strainer shall have a tapered pipe thread or be a screw-type fitting with a locking device other than a split lock washer.

6.12 Vent and fuel distribution hoses and connections

6.12.1 Each fuel hose shall meet the requirements of 6.15.

6.12.2 Each fuel hose shall be secured by a method that prevents leaks and prevents the hose from becoming disconnected.

6.13 Fuel fill system grounding

Any metal or metallic plated component of a petrol tank and its filling system that is in contact with petrol shall be grounded so that its electric resistance to the personal watercraft's ground is less than 1 Ω.

Grounding wires shall not be installed between a hose and its clamps.

6.14 Fire test

6.14.1 The fuel system in a representative personal watercraft equipped with its complete engine and fuel system shall not leak when tested using the following procedure.

6.14.2 Fill the fuel tank with fuel to 25 % of total capacity.

6.14.3 Close all bilge drains that can allow the fuel to flow out of the engine compartment.

6.14.4 Confirm that the fuel system meets the requirements of 6.1.3.

6.14.5 Pour an amount of heptane over the engine sufficient to burn for at least 2,5 min, but no longer than 5 min.

6.14.6 Ignite the heptane.

6.14.7 Observe burning heptane after ignition.

6.14.8 Close the engine compartment.

6.14.9 Wait 2,5 min.

6.14.10 Open the engine compartment and extinguish any remaining flame with carbon dioxide (CO_2).

6.14.11 Pressurize the fuel system to 2 kPa with air or inert gas.

Tank fittings and seams shall be checked for leaks using a method other than the pressure drop test.

NOTE Soapy test solutions must be non-corrosive and non-toxic. Ammonia, present in some soaps and detergents, creates a condition that attacks brass fittings like those used in fuel systems. Damage can be undetectable at first, and these fittings can develop cracks in a matter of months creating a very hazardous situation.

6.15 Fuel-hose specifications

6.15.1 General

All fuel hoses shall either meet the performance specifications in ISO 7840:2021 (fire-resistant) or ISO 8469:2021 (non-fire-resistant), or meet the hose specifications in 6.15.2 to 6.15.10, which apply to two types of fuel hose for personal watercraft. One type is a reinforced hose with a cover and the other is a hose without a cover.

6.15.2 Tensile strength and elongation

A test for tensile strength and elongation shall be made, and specimens shall meet the conditions given in Table 1.

Table 1 — Tensile strength and elongation

Specification	Hose with cover		Hose without cover
	Tube material	Cover material	Hose material
Original strength	8 MPa	7 MPa	8 MPa
Original elongation	200 % minimum	200 % minimum	200 % minimum

6.15.3 Dry heat resistance

After heat ageing in accordance with ISO 7840:2021 for 70 h at 100 °C ± 2 °C, specimens taken from the hose shall not have a reduction in tensile strength of more than 20 % or a reduction in elongation of more than 50 %.

6.15.4 Ozone resistance

The test procedure, apparatus and acceptance level shall be in accordance with Methods 1, 2 or 3 of ISO 7326:2016. This test applies to the outer surface of the hose only and cracks in the inner surface or cut edges shall be ignored.

6.15.5 Oil resistance

After 70 h immersion at 100 °C ± 2 °C in Oil No. 3 in accordance with ISO 1817:2022, Table A.3. Specimens taken from the hose shall meet the conditions given in Table 2.

Table 2 — Oil resistance

Specification	Hose with cover		Hose without cover
	Tube material	Cover material	Hose material
Reduction in tensile strength	Not more than 40 %	—	Not more than 40 %
Reduction in elongation	Not more than 40 %	—	Not more than 40 %
Volumetric change	−5 % to + 25 %	0% to + 100 %	−5 % to + 25 %

6.15.6 Burst test

The minimum burst pressure of the hose shall be 294 kPa.

NOTE Requirements for the hose burst test are provided in ISO 1402.

6.15.7 Vacuum collapse test

A 1 m length of hose shall be held in a straight line, and nowhere along its length shall the diameter decrease by more than 20 % during application of a vacuum of 68 kPa for a minimum of 15 s and not more than 60 s. The vacuum collapse test on preformed parts shall be done on the finished part. This test does not apply to hoses of nominal diameter greater than 25 mm.

6.15.8 Cold flexibility

The test specimen shall be conditioned in accordance with ISO 7840:2021 at −20 °C ± 2 °C for 5 h, and then flexed in the cold chamber through 180° from the centreline to a diameter of ten times the maximum outside diameter of the hose. The flexing shall take place within 4 s and the hose shall not fracture or show any cracks or breaks, or a proof pressure of 0,7 MPa shall be applied to determine hose damage.

6.15.9 Adhesion test (reinforced hose with cover)

The minimum load required to separate a 25 mm width of tube and cover at 23 °C ± 2 °C in accordance with ISO 7840:2021 shall be 27 N.

6.15.10 Fuel resistance

6.15.10.1 After 48 h immersion at 23 °C ± 2 °C in liquid C in accordance with ISO 1817:2022, Table A.1, physical values of specimens taken from the hose shall not exceed the change in values listed in Table 3.

Table 3 — Fuel resistance

Specification	Change
Tensile strength	−45 %
Elongation	−45 %
Volume	0% to + 50 %

6.15.10.2 Permeation shall be tested in accordance with Annex B of ISO 7840:2021 and shall not exceed 300 g/m^2 over 24 h.

7 Electrical system

7.1 Exemptions

The following items are exempt from 7.2, 7.5, 7.6, 7.7 and 7.8:

a) circuits having a current flow of less than 1 A;

b) conductors which are totally inside an equipment housing;

c) resistance conductors that control circuit amperage;

d) high-voltage secondary conductors and terminations that exist in ignition systems;

e) conductors less than 175 mm of exposed length outside of a device;

f) cranking motor conductors.

7.2 Conductor type, size and identification

7.2.1 Each conductor shall be made of insulated, stranded copper.

7.2.2 Conductor insulation shall be of fire-retardant material.

7.2.3 No conductor shall be used to carry amperage greater than that specified in Table 4 for its cross-sectional area.

7.2.4 A means of identification shall be used to distinguish individual conductors.

Table 4 gives permissible continuous current ratings in amperes, determined for 30 °C ambient temperature.

Table 4 — Cross-sectional area of conductor, maximum current and minimum stranding

Cross-sectional area	Maximum current, in amperes, for single conductors at insulation temperature ratings						Minimum number of strands[a]	
mm^2	60 °C	70 °C	85 °C to 90 °C	105 °C	125 °C	200 °C	Type 1	Type 2
0,75	6	10	12	16	20	25	16	—
1	8	14	18	20	25	35	16	—
1,5	12	18	21	25	30	40	19	26
2,5	17	25	30	35	40	45	19	41
4	22	35	40	45	50	55	19	65
6	29	45	50	60	70	75	19	105
10	40	65	70	90	100	120	19	168
16	54	90	100	130	150	170	37	266
25	71	120	140	170	185	200	49	420
35	87	160	185	210	225	240	127	665
50	105	210	230	270	300	325	127	1 064
70	135	265	285	330	360	375	127	1 323
95	165	310	330	390	410	430	259	1 666
120	190	360	400	450	480	520	418	2 107
150	220	380	430	475	520	560	418	2 107

NOTE 1 The values given in this table are identical to those in ISO 13297.

NOTE 2 Conductor current ratings can be interpolated for cross-sectional areas between those shown in this table.

[a] Conductors with at least Type 1 stranding shall be used for general craft wiring. Conductors with Type 2 stranding shall be used for any wiring where frequent flexing is involved during use.

For conductors in engine compartments (ambient temperature 60 °C), the maximum current rating in Table 4 shall be de-rated by the factors given in Table 5.

Table 5 — Correction factors

Temperature rating of conductor insulation °C	Multiply maximum current from Table 4 by
70	0,75
85 to 90	0,82
105	0,86
125	0,89
200	1

NOTE For information, the voltage drop E under load, in volts, can be calculated using the following formula:

$$E = \frac{0{,}016\,4 \times I \times L}{A_c}$$

where

I is the load current, in amperes;

L is the length of conductor from the positive power source to the electrical device and back to the negative source connection, in metres;

A_c is the cross-sectional area of the conductor, in square millimetres.

7.3 Conductor support and protection

7.3.1 Each conductor shall be installed so that it is protected from physical damage.

7.3.2 Except for the first 500 mm of battery cables, conductors shall be supported by clamps or straps not more than 400 mm apart, unless the conductor(s) is contained in a conduit.

7.3.3 Clamps, straps and conduits shall be designed to prevent damage to the conductor insulation.

7.3.4 Conductors connecting components that can move with relation to each other shall be protected from stresses.

7.3.5 Conductors passing through bulkheads, junction boxes or other rigid surfaces shall be protected against chaffing with a conduit or grommets, or with a protective sheath.

7.4 External ignition protection

A representative electrical system as installed in the personal watercraft, or in an enclosure simulating the personal watercraft, shall not ignite a propane gas and air mixture (volume fraction: 4,25 % to 5,25 % propane) surrounding the electrical system when it is operated in the mode in which it draws its maximum current. The test voltage supply shall be adjusted to 120 % of the nominal system voltage, except for magneto ignition systems.

7.5 Overcurrent protection

7.5.1 Except for conductors from self-limiting generators or alternators, each ungrounded current-carrying conductor shall be protected by a manual-reset trip-free circuit breaker or fuse. The fuse or breaker shall be within 180 mm of the origin of the conductor to be protected, as long as the fuse or breaker is sized for the smallest conductor in the circuit.

If a conductor is continuously protected from physical damage by a sheath or enclosure between its terminal ends, the maximum distance to its protecting fuse or breaker can be increased to 500 mm from the power source, measured along the conductor.

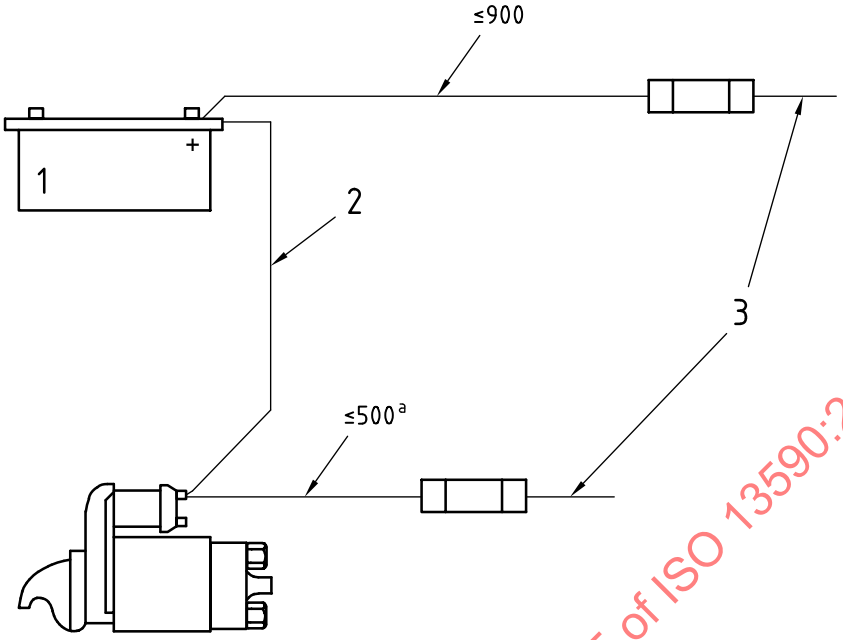
An ungrounded supply conductor starting at a storage battery shall have its breaker or fuse within 900 mm of the battery, measured along the conductor (see Figure 1).

7.5.2 The voltage rating of each circuit breaker or fuse shall not be less than the nominal voltage of the circuit it is protecting.

7.5.3 The current ratings of the circuit breaker or fuse shall not be more than 150 % of the value in Table 4 for the conductor it is protecting, including the correction factor if any part of the conductor is in an engine compartment.

7.5.4 Circuit breakers or fuses for non-self-limiting generators and alternators shall have a current rating not exceeding 120 % of the maximum rated output at 60 °C.

Dimensions in millimetres



Key

1 battery

2 cranking motor conductor (no length restriction)

3 conductors to various loads as needed (no length restriction)

[a] A distance up to 500 mm is allowed if the conductor, throughout this distance, is contained in an enclosure or sheath such as a junction box, control box or enclosed panel.

Figure 1 — Breaker/fuse location for an ungrounded supply conductor starting at a storage battery

7.6 Conductor terminations

7.6.1 All connections outside junction boxes or enclosures shall be made with closed ring, eyelet, captive spade, or mechanical or spring-lock-type connectors. Wire nuts shall not be used on any connection.

7.6.2 Single or multi-connector plugs outside junction boxes or enclosures shall not separate under a tensile force of 25 N applied for 1 min.

7.6.3 A soldered joint shall not be the sole means of connection to any conductor, except for battery-terminal connectors with soldered joints at least 1,5 times longer than the diameter of the conductor.

7.6.4 Conductor joints outside junction boxes or enclosures shall not break when subjected for 1 min to the tensile force given in Table 6 for the smallest conductor in the connection.

7.6.5 Ungrounded terminal fittings and conductors shall be protected from accidental short circuiting with grounded metal or other ungrounded circuits in the event of loosening a termination.

Continuously energized terminations without circuit protection shall be covered with boots or be equivalently protected.

Table 6 — Tensile test values for wire joints
(Conductor-conductor and conductor-connector joints)

Wire cross-section mm^2 (AWG)	**Tensile force** N
0,8 (18)	44
1 (16)	64
2 (14)	132
3 (12)	157
5 (10)	175
8 (8)	200
13 (6)	220
16 (5)	265
19 (4)	315
25 (3)	350
32 (2)	400
40 (1)	440
NOTE AWG means "American Wire Gauge".	

7.7 Batteries

7.7.1 Each installed battery shall not move by more than 25 mm in any direction when a pulling force of twice the battery weight is applied through the centre of gravity of the battery as follows:

a) vertically in both directions, for a duration of 1 min;

b) horizontally and parallel to the personal watercraft's centreline, for a duration of 1 min fore and 1 min aft;

c) horizontally and perpendicular to the personal watercraft's centreline, for a duration of 1 min to starboard and 1 min to port.

7.7.2 Each battery shall be installed so that metallic objects cannot come in contact with the ungrounded battery terminals.

7.7.3 Each metallic fuel line and fuel-system component within 100 mm above the horizontal plane of the battery top surface, as installed, shall be shielded with dielectric material.

7.7.4 Each battery shall not be directly above or below a fuel tank, fuel filter or fitting in a fuel line.

7.7.5 A vent system or other means shall be provided to allow the discharge from the personal watercraft of hydrogen gas released by the battery.

7.7.6 Each battery terminal connector shall not depend on spring tension for its mechanical connection to the terminal.

7.8 Secondary circuits of ignition systems

7.8.1 Each conductor in a secondary circuit of an ignition system shall meet the requirements of 7.1 to 7.6.

7.8.2 The connection of each ignition conductor to a spark plug, coil or distributor shall have a tight fitting cap, boot or nipple.

8 Ventilation

8.1 Personal watercraft shall have a ventilation system that meets the requirements specified in 8.2 to 8.8.

8.2 Ventilation in a compartment in a personal watercraft shall be achieved by having

a) a supply opening or duct from the atmosphere or from a ventilated compartment that is open to the atmosphere; and

b) an exhaust opening into another ventilated compartment or an exhaust duct to the atmosphere.

8.3 Each exhaust opening or exhaust duct shall originate in the lower third of the compartment.

8.4 The two openings shall be separated by locating them either at the fore and aft sides of the engine compartment, or on opposite sides of the personal watercraft.

8.5 Each supply and exhaust opening or duct in a compartment shall be above the normal accumulation of bilge water.

8.6 Except as specified in 8.7, the combined area of supply openings or supply ducts, and the combined area of exhaust openings or exhaust ducts, shall have a minimum internal cross sectional area calculated as follows:

$$A = 3\,300 \ln (V/0{,}14)$$

where

A is the minimum combined internal cross-sectional area of the openings or ducts, in square millimetres;

V is the net compartment volume equal to the total compartment volume minus the volume of permanently installed components in it, in cubic metres.

8.7 The minimum internal cross-sectional area of each supply and exhaust opening or duct shall exceed 1 940 mm^2.

8.8 Ventilation shall be supplied to any compartment not open to the atmosphere and containing either a petrol powered engine or fuel tank.

9 Hull structure test

9.1 Drop test

A representative personal watercraft shall be tested in accordance with 9.2 and 9.3.

NOTE An alternative to the drop test of 9.2 and 9.3, are the structural calculations according to ISO 12215-5.

9.2 Testing

Load the personal watercraft to the maximum load, m_{ML}. The distribution of this load shall represent occupants in their normal positions.

NOTE Requirements for the maximum load are found in ISO 8666.

The loaded personal watercraft shall be dropped horizontally from a height of 2,5 m (measured from water to the lowest point of the personal watercraft) into the water.

9.3 Passing or failing the test

There shall be no structural failures in the form of fractures, cracks, tears, separation, etc. on any part of the hull or personal watercraft component, such as the deck, when the personal watercraft is closely examined at the end of the test.

10 Floatation test

10.1 General

This test is intended to provide manufacturers of personal watercraft with specific guidelines for determining the amount of floatation necessary to keep a portion of the personal watercraft above the surface of the water after it has been swamped and safely support each person it is rated to carry.

10.2 Test conditions

Each personal watercraft shall be loaded with its permanent equipment or with a weight equivalent to its permanent equipment.

The fuel and/or oil tanks shall be full.

An additional weight of 10 kg shall be added for each person that the personal watercraft is rated to carry. The additional weight shall be secured to a portion of the personal watercraft that is submerged during the test.

10.3 Test procedure

The personal watercraft shall be swamped, allowing calm, fresh water to flow between the inside and outside of the personal watercraft, either over the sides, through a hull opening, or both. Entrapped air in the flooded portion of the personal watercraft shall be eliminated.

If air chambers are used to provide floatation on the personal watercraft, water shall flood the two largest air chambers and all chambers that are integral with the hull.

10.4 Acceptance level

The personal watercraft shall have enough floatation to keep part of the personal watercraft above the surface of the water when it has been submerged for at least 18 h.

10.5 Floatation material

10.5.1 Introduction

Floatation materials shall meet the requirements in 10.5.2 to 10.5.8 as listed in Table 7 when used in the engine compartment bilge, and engine compartment or bilge, unless located in a sealed compartment.

Table 7 — Floatation performance tests

Tests	Areas		
	Engine compartment bilge (see 3.9)	Engine compartment unless open to atmosphere (see 3.6)	Bilge (see 3.8)
10.5.2 Vapour test		X	
10.5.3 Petrol test lasting 24 h			X
10.5.4 Petrol test lasting 30 days	X		
10.5.5 Oil test lasting 24 h			X
10.5.6 Oil test lasting 30 days	X		
10.5.7 Bilge-cleaner test lasting 24 h			X
10.5.8 Bilge-cleaner test lasting 30 days	X		

10.5.2 Vapour test

The floatation material shall not lose more than 5 % of its buoyant force after being immersed in a fully saturated petrol-vapour atmosphere for 30 days at a minimum temperature of 38 °C.

10.5.3 Petrol test lasting 24 h

The floatation material shall not lose more than 5 % of its buoyant force after being immersed for 24 h at 23 °C ± 2 °C in reference fuel B of ISO 1817:2022, Table A.1.

10.5.4 Petrol test lasting 30 days

The floatation material shall not lose more than 5 % of its buoyant force after being immersed for 30 days at 23 °C ± 2 °C in reference fuel B of ISO 1817:2022, Table A.1.

10.5.5 Oil test lasting 24 h

The floatation material shall not lose more than 5 % of its buoyant force after being immersed for 24 h at 23 °C ± 2 °C in reference Oil No. 2 of ISO 1817:2022, A.2.2.

10.5.6 Oil test lasting 30 days

The floatation material shall not lose more than 5 % of its buoyant force after being immersed for 30 days at 23 °C ± 2 °C in reference Oil No. 2 of ISO 1817:2022, A.2.2.

10.5.7 Bilge cleaner test lasting 24 h

The floatation material shall not lose more than 5 % of its buoyant force after being immersed for 24 h at 23 °C ± 2 °C in a 5 % solution of trisodium phosphate in water.

10.5.8 Bilge cleaner test lasting 30 days

The floatation material shall not lose more than 5 % of its buoyant force after being immersed for 30 days at 23 °C ± 2 °C in a 5 % solution of trisodium phosphate in water.

NOTE The buoyant force reduction in 10.5.2 to 10.5.8 can be measured in accordance with ASTM D2842-19.

11 Steering-system test

11.1 General

Component tests are intended to establish minimum acceptable design criteria for components of steering systems.

Each steering system, including helm, cable, and attachment components shall withstand an axial cable load of 630 N in tension and compression, applied at the connection to the jet drive, throughout its travel range, without severance of components.

11.2 Axial force test

A 540 N push-pull force shall be cycled for 10 tension-to-compression cycles at a duration of 5 s, applied as follows:

a) distributed over not more than 100 mm of a hand grip of a handlebar, applied axially to the pivot shaft.

11.3 Tangential force test

A 360 N force in either direction shall be cycled from zero-to-360-to-zero for 10 cycles at a duration of 5 s, applied as follows:

a) at the point of maximum leverage of a handlebar applied in the direction of steering arc.

11.4 Fatigue test

The steering components shall withstand a cyclic force resulting from 360 N tension and compression, applied axially to the output of the steering cable, with the helm locked at the mid-travel position. This force shall be applied for 50 000 reversals without causing separation.

11.5 Impact test

11.5.1 Impact test 1

See Figure 2 for the impact test fixture (h = 210 mm). The helm shall withstand a single impact of 160 J on the hand grip of a handlebar, without

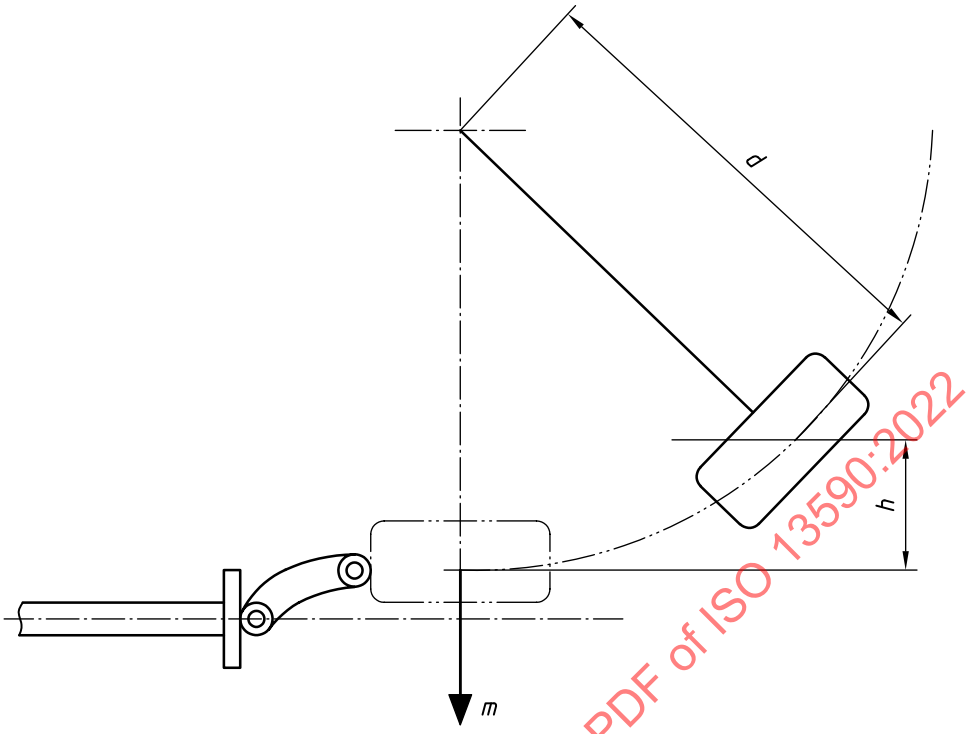
a) deformation that would cause loss of minimum retained system performance; and

b) propagation of any cracks existing before this test; and

c) the appearance of new cracks.

11.5.2 Impact test 2

The helm shall withstand a single impact of 270 J, on the hand grip of a handlebar, without complete separation of the helm and the mechanical means for applying the manual steering effort. See Figure 2 for the impact-test fixture (h = 350 mm).



Key

d 2 285 mm ± 150 mm

m 80 kg

h 210 mm for a single impact ⩾ 160 J

h 350 mm for a single impact ⩽ 270 J

Figure 2 — Impact test fixture for steering handlebar

The impact test fixture shall be a completely filled leather bag of diameter 250 mm containing lead shot, with a mass of 80 kg in total, and suspended on a free swinging cable, such that the centre of mass is 2 285 mm ± 150 mm from a supporting pivot. The impact face of the bag shall be a 250 mm diameter end. The bag shall be elevated through sufficient arc to achieve the value of impact upon a rigidly mounted helm and control element by swinging the bag as indicated in the drawing. The fixture shall be rigidly secured against movement. Other devices than that specified, such as a falling-weight bag, can be used, providing that the impact is equivalent.

12 Stability

NOTE Personal watercraft can have limited stability when at rest and floating freely during boarding and reboarding.

When a personal watercraft is floating inverted, the operator shall be able to return the personal watercraft to the upright position.

The physical test of returning the personal watercraft to the upright position shall be performed by one person alone in the water, with the personal watercraft inverted at rest and floating freely in calm water. The personal watercraft shall be loaded with 50 % tank capacity. The person shall wear a personal flotation device with a buoyancy of minimum 50 N.

The test shall be conducted with a water depth to allow unimpeded movement of the personal watercraft. The personal watercraft shall be righted by the person without exploiting the sea bed or any external aid. The mass of the person shall not be more than 75 kg, or otherwise stated by the manufacturer. A successful attempt is required within a 5-minute test duration.

The instructions on how to return the inverted personal watercraft to the upright position shall be permanently marked on the personal watercraft with appropriate signs (pictograms) and, if necessary, written instructions. The marking shall be legible from the person in the water with the personal watercraft floating inverted.

13 Propulsion engine cut-off device

13.1 General

The personal watercraft shall be designed and equipped with a propulsion engine cut-off device that complies with the requirements in 13.2 to 13.4 and that activates when the operator dismounts deliberately or falls overboard.

13.2 Cut-off device requirements

— Propulsion engine cut-off device components that are not obvious as to their function shall be marked to indicate their function.

— The propulsion engine cut-off device shall be designed to reduce the probability of inadvertent activation during normal operation of the personal watercraft.

— A propulsion engine cut-off device connected to the engine control system shall not cause any interference or abnormal operation of the engine and its control systems.

— Enclosures for components intended to be mounted in an exposed location shall have a watertight rating equal to or greater than IP 67.

— Propulsion engine cut-off devices shall provide re-arming or bypass capabilities for restarting in a time appropriate for the propulsion system, after the device has been activated.

— The propulsion engine cut-off device re-arming or system bypass feature shall be readily accessible.

13.3 Mechanical devices employing a physical attachment to the operator

— The device for attaching the lanyard to the operator shall be designed to allow one handed operation for both attachment and detachment.

— Devices operated by pulling a lanyard free shall have a maximum pull-off force of 130 N, when applied from anywhere within a hemisphere centred on and surrounding the mounting plane of the device (see Figure 3).

13.4 Testing

— Mechanical lanyards and other components essential to the automatic propulsion engine cut-off device shall be subjected to three cycles of thermal conditioning before mechanical tests are performed. One cycle of thermal conditioning is defined as:

  — three hours at 20 ± 2 °C, followed by

  — three hours at -35 ± 2 °C, followed by

  — three hours at 20 ± 2 °C, followed by

  — three hours at 70 ± 2 °C.

a) Mechanical lanyards and other components essential to the automatic propulsion engine cut-off device subjected to thermal conditioning shall, at the completion of thermal conditioning, be subjected to 110 h of exposure to ultraviolet rays of one reflector spot (RS) sunlamp, or equivalent UV lamps, at a distance of 480 mm and be at a temperature of 60 °C.

b) After completion of thermal conditioning and UV testing, the propulsion engine cut-off device shall:

1) continue to operate as intended and shall not suffer any physical deformation other than colour fade or colour change;

2) have a maximum pull-off force of 130 N, when applied from anywhere within a hemisphere centred on and surrounding the mounting plane of the device (see Figure 3).

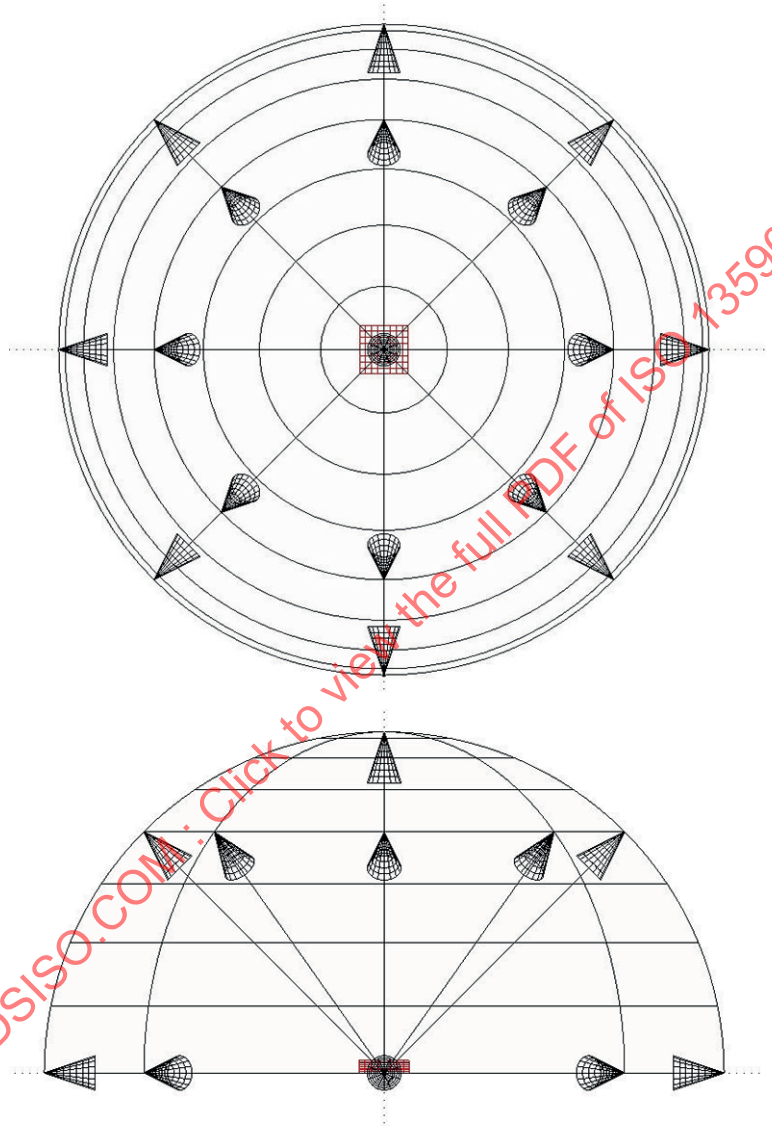


Figure 3 — Pull test directions

14 Means of reboarding

The personal watercraft shall be designed to be reboarded by a person in the water, unaided.

NOTE Personal watercraft can have limited stability when at rest and floating freely during boarding and reboarding.

The reboarding test shall be performed by one person alone in the water, with the personal watercraft at rest and floating freely in calm water. The person shall wear a personal flotation device with a buoyancy of minimum 50 N.

15 Towing

All personal watercraft shall be fitted with one or more points for accepting the towing of the personal watercraft.

NOTE Requirements for strong points are found in ISO 15084.

16 Off throttle steering when underway

The personal watercraft shall have off throttle steering capabilities or obstacle avoidance capabilities when the personal watercraft is underway and making way that comply with the following performance requirements when tested per either the remote data access method or the physical test course method, both methods detailed in Annex A.

The personal watercraft shall run the course a minimum of three times meeting all of the specified tolerances for both left and right turns at each of the two specified test speeds, and exceed the perpendicular transfer distance specified for each advance distance in Table A.2 regardless of user control adjustments available on the original equipment personal watercraft.

Tests and documentation shall confirm:

a) that all portions of the personal watercraft exceed the transfer distance specified for each advance distance throughout each test and/or remain outside the designated test triangle, or,

b) the personal watercraft comes to a halt prior to reaching the apex marker.

Actuation of an independent brake control throughout the testing procedure is acceptable if the brake control is operable without the operator removing their hands from the handlebar.

This clause does not apply to personal watercraft intended to be operated by a single operator who either stands or kneels in a tray located behind a moveable handle pole.

17 Flooding — Detection and removal of water

All personal watercraft shall have pumping, or alternative means, designed to remove normal accumulations of bilge water from the internal spaces of the hull.

18 Owner's manual

An owner's manual shall be provided with the personal watercraft, which shall include at least the following information:

a) the importance for each occupant to wear an appropriate personal floatation device when operating the personal watercraft,

b) off throttle steering characteristics and operation;

c) the bilge pumping system or alternative means;

d) instructions on how to return an inverted personal watercraft to the upright position;

e) possible hazards created by rapid deceleration when the emergency cut-off device is activated;

f) informing passengers how to bypass and/or reset the emergency cut-off device;

g) propulsion engine cut-off device tests that the operator should perform.

NOTE Requirements for owner's manuals are provided in ISO 10240.