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Small craft — Remote mechanical steering systems

Petits navires — Appareils à gouverner commandés à distance

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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 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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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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 second edition of ISO 8848, together with ISO 23411:2020, cancels and replaces ISO 8848:1990, ISO 9775:1990 and ISO 15652:2003, which have been technically revised.

The main changes compared to the previous edition are as follows:

— ISO 8848:1990, ISO 9775:1990 and ISO 15652:2003 have been consolidated into this document;

— added "mechanical" in the title;

— updated definitions;

— updated requirements to meet current industry practices;

— added 7.7 regarding control lever to steering wheel clearance;

— steering wheel requirements and tests have been removed.

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 — Remote mechanical steering systems

1 Scope

This document specifies design, construction, installation and test requirements for remote mechanical cable steering systems and the output ram interface point to rudders, jet drives, outboard and sterndrive engines for small craft.

It is applicable to three distinct classes of steering systems for use on various types of craft:

— standard duty steering systems, for small craft with single and twin installations of outboard engines with a total over 15 kW power, and with rudders, sterndrives, and water-jet drives;

— light duty steering systems, for small craft with a single outboard engine of 15 kW to 40 kW power;

— mini-jet steering systems, excluding personal watercraft.

NOTE Standard and light duty steering systems are mechanically interchangeable. A standard duty steering system can be used on a craft designed for a light duty system. However, a light duty steering system cannot be used on a craft that requires a standard duty steering system. Mini-jet steering systems are mechanically differentiated from the previously mentioned systems and can only be used on mini-jet craft as defined in this document.

This document does not address emergency means for steering the craft.

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 10240:2019, *Small craft — Owner's manual*

ISO 12217-1:2015, *Small craft — Stability and buoyancy assessment and categorization — Part 1: Non-sailing boats of hull length greater than or equal to 6 m*

ISO 12217-2:2015, *Small craft — Stability and buoyancy assessment and categorization — Part 2: Sailing boats of hull length greater than or equal to 6 m*

ISO 12217-3:2015, *Small craft — Stability and buoyancy assessment and categorization — Part 3: Boats of hull length less than 6 m*

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:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
craft-mounted steering system
assembly including all components necessary to transmit remote manual effort to the end of the *output ram* (3.20) and a means to secure an output ram guide tube to the craft

3.2
interface point
point of mechanical interface in the *steering system* (3.11) where a connection is made between the *output ram* (3.20) and the craft components that are not supplied as part of the same assembly

3.3
control element
device connected to the *steering mechanism* (3.6) that allows the operator to apply manual steering effort to the *steering system* (3.11)

EXAMPLE *Steering wheel* (3.13), *handlebar* (3.5), *joystick* (3.7).

3.4
drag link
device in an *engine-mounted steering system* (3.10) by which the linear force of the *output ram* (3.20) is transmitted to the engine steering arm

3.5
handlebar
mechanical means for applying a manual steering effort to the *steering mechanism* (3.6) in a horizontal configuration, with hand grips at each end and the helm connected at the middle

3.6
steering mechanism
device, to which a *control element* (3.3) is attached for manual application of a controlling force, and by which the controlling force is fed into a *steering system* (3.11)

3.7
joystick
operator input device for the simultaneous control of thrust, steering and propulsion

3.8
mini-jet craft
craft weighing less than 1 000 kg, with an inboard engine powering a water-jet pump as its primary method of propulsion, designed to be operated with one or more persons within the confines of a hull

3.9
minimum retained system performance
system performance after test(s) such that at least 90 % of the steering arc normally available each side of the mid-position can be obtained by exertion of no more than 27 N·m of torque at the *steering mechanism* (3.6), through the *control element* (3.3)

Note 1 to entry: This criterion does not define the *steering system* (3.11) performance while a craft is underway, but is rather intended to provide quantitative limits for design and test purposes.

3.10
engine-mounted steering system
assembly including all components necessary to transmit a remote manual effort to the end of the *output ram* (3.20) which is affixed to an engine mounted steering tube and a *drag link* (3.4) supplied by the engine manufacturer

3.11
steering system
assembly including all components necessary to transmit a remote manual effort to the rudder, outboard engine, sterndrive or water-jet drive

3.12
two-cable steering system
two independent cables attached at the *interface point(s)* (3.2) of the *output ram(s)* (3.20) and at the helm and driven by a common steering shaft, generally used to minimize steering backlash or lost motion

3.13
steering wheel
mechanical means for applying a manual steering effort to the helm, normally a circular configuration with a continuous loop at the distal end of support spokes with the helm connected at the rotational axis

3.14
steering wheel diameter
actual diameter
D_a
diameter of the circle formed by the outermost sections of the *steering wheel* (3.13)

Note 1 to entry: See Figure 6.

3.15
steering wheel dish
distance between the two parallel planes formed by the aft rim surface and the forward hub surface of a *steering wheel* (3.13)

Note 1 to entry: See Figure 6.

3.16
craft
small craft
recreational boat, and other watercraft using similar equipment, of up to 24 m length of hull (L_H)

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

[SOURCE: ISO 8666:2020, 3.15, modified – Note 1 to entry has been added.]

3.17
standard duty steering system
remote mechanical *steering system* (3.11) designed to the requirements of this standard for use on small craft with outboard engines (single and dual) with a total of 15 kW and greater power, inboard engines, sterndrives, and water-jet drives

3.18
light duty steering system
remote mechanical *steering system* (3.11) designed to the requirements of this standard for use on small craft with single outboard engines between 15 kW and 40 kW power that is permanently marked with a maximum power rating of 40 kW

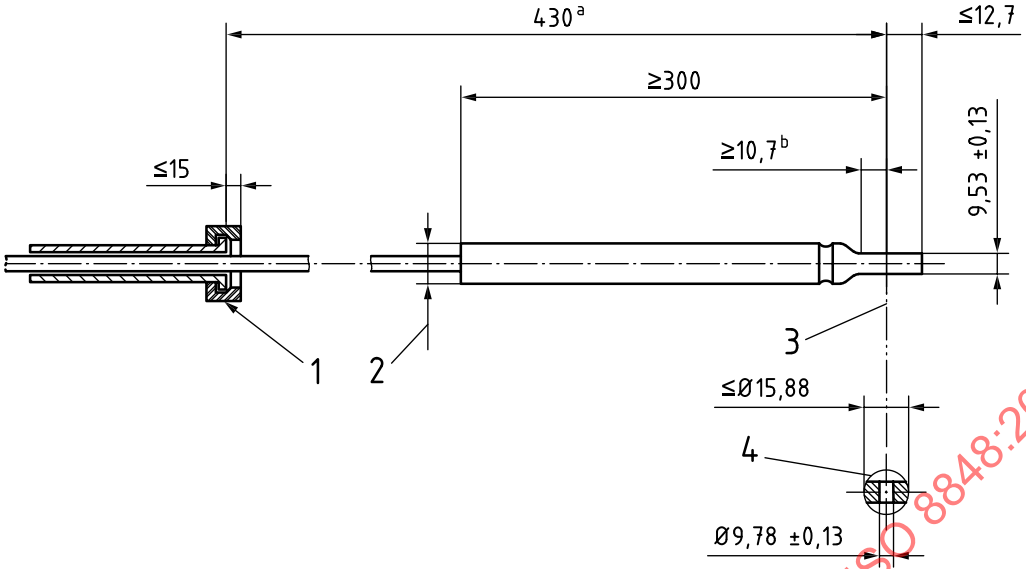
3.19
mini-jet steering system
remote mechanical *steering system* (3.11) designed to the requirements of this standard for use on *mini-jet craft* (3.8)

3.20
output ram
portion of the remote mechanical steering cable that interfaces with the outboard engine steering tube and *drag link* (3.4), steering actuator or craft mounted steering tube/rudder

4 Constructional requirements

4.1 When steering systems are factory-installed in the craft, the complete system shall be supplied. In outboard engine craft, the system shall be supplied complete to the interface point at the output ram end as shown in Figure 1.

Dimensions in millimetres



Key

1 coupler nut
2 output ram tube
3 interface point
4 end fitting

a Mid-travel position.
b Flat.

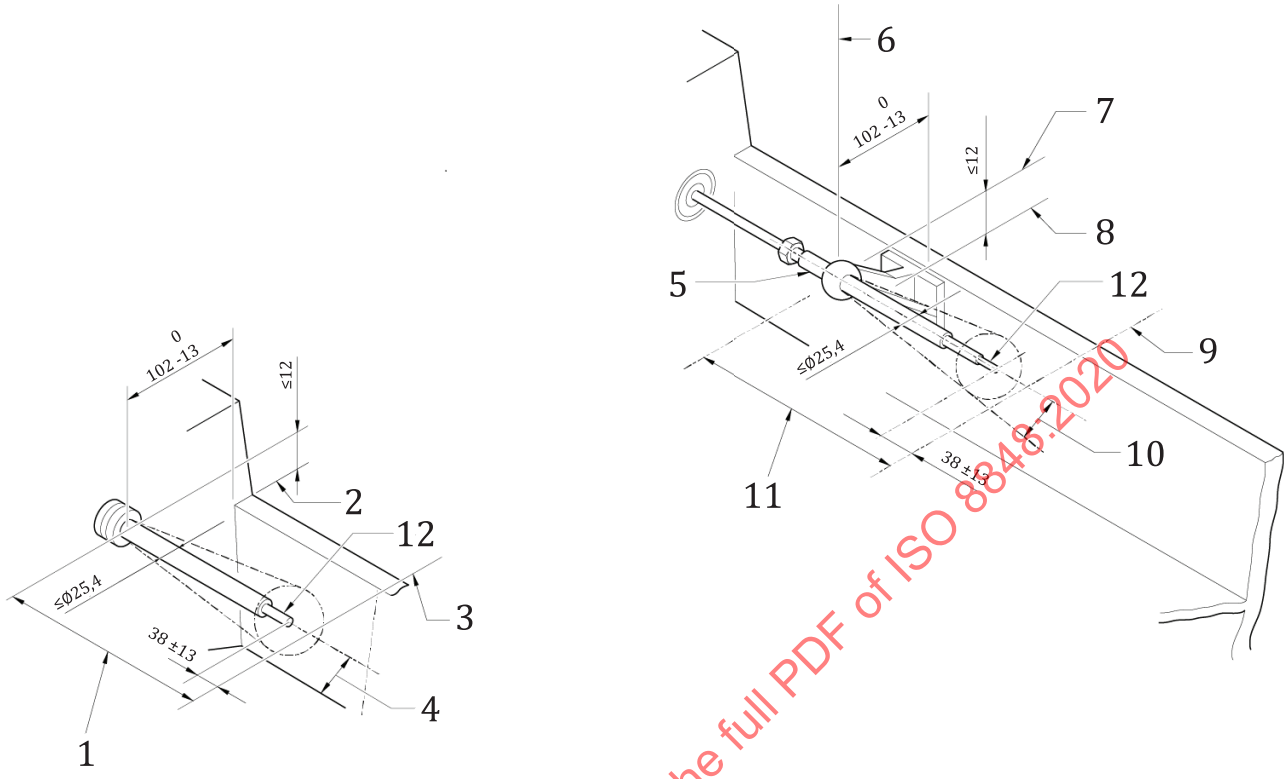
NOTE Minimum travel: 100 mm each side of mid-travel position.
Maximum travel: 115 mm each side of mid-travel position.
Coupler nut 7/8-14 UNF-2B thread (optional for boat mounted systems).

Figure 1 — Output ram

4.2 Installation of the steering system shall be in accordance with the instructions provided by the steering system manufacturer.

4.3 Craft suitable for twin outboard engines shall be so designated, and it shall also be specified whether the craft is suitable for engine-mounted steering systems, craft-mounted steering systems or both. If the craft is suitable for craft-mounted steering systems, it shall also be specified whether engine well mounting, transom mounting or both (see Figure 2) may be used.

Dimensions in millimetres



a) Engine well mounting

b) Transom mounting

Key

1	380 mid-travel position	7	centreline of swivel to be 0 +12 above transom
2	engine mounting face of clamp bracket	8	face of clamp bracket
3	engine centreline	9	engine centreline
4	articulation 15° min.	10	articulation 15° min.
5	7/8-14 NF.2B thread – 16 min. length on tube	11	mid-travel position
6	swivel axis 102 0 -13 square off face of transom	12	interface point

NOTE Minimum travel: 100 mm each side of mid-travel position.
Maximum travel: 115 mm each side of mid-travel position.

Figure 2 — Craft-mounted steering system

4.4 Components of the steering system shall be resistant to corrosion, either by virtue of material or coating thereof, and shall be galvanically compatible with adjoining components.

4.5 All threaded fasteners whose integrity affects safe operation of the system, such that separation or loss of the fastener would cause sudden loss of steering without warning, shall be provided with a locking means.

4.6 Threaded fasteners whose integrity affects operation of the system, such that separation or loss of the fastener would cause sudden loss of steering without warning, and that can be expected to be disturbed by installation or adjustment procedures, shall be referenced by instructions for correct assembly and shall either:

— be locked by a device whose presence is determinable by visual inspection, or by feel, following assembly; or

— incorporate integral locking means, provided the fastener cannot be omitted or substituted without making the system inoperable.

NOTE Self-locking nuts with plastic inserts that create mechanical plastic interference meet the requirements of this subclause.

4.6.1 Loose lock-washers, distorted thread nuts, or separately applied adhesives are prohibited.

4.6.2 Plain, threaded jam nuts are prohibited except that they may be used to permit adjustment and shall then be designed so that total separation of parts or other complete loss of steering will not occur, should they loosen.

NOTE These assemblies are not intended to be disassembled for installation; the choice of locking means is within the discretion of the system manufacturer.

4.6.3 A locking device shall be so designed that its presence can be determined by visual inspection or feel after installation.

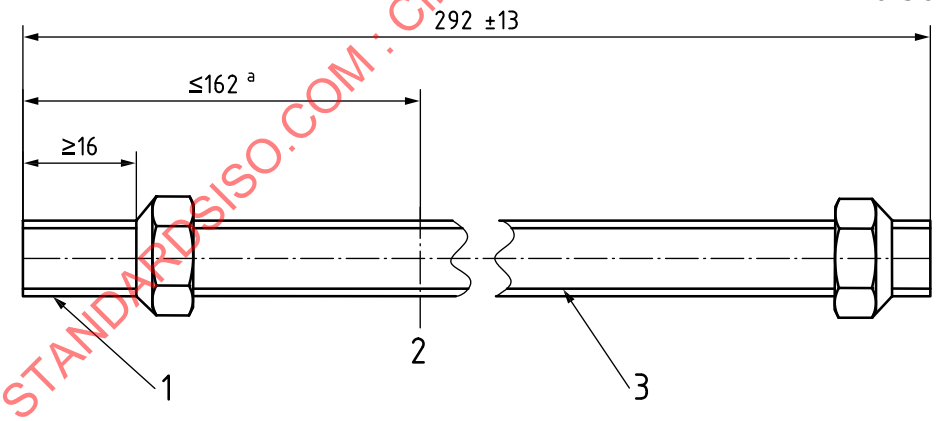
4.7 Connection fittings, including quick-disconnect fittings relying only upon a spring or springs to maintain the connection, shall not be used.

5 Outboard engine and inboard-sterndrive design requirements

5.1 The steering stops on the outboard engine shall permit at least 30° of angular movement to either side of the centreline.

5.2 The outboard engine steering system shall meet the applicable dimensional requirements indicated in Figures 1, 3, and 4.

Dimensions in millimetres



Key

1 engine axis

2 7/8-14 UNF-2A thread both ends

3 tube ø int. $16^{+0,25}_{0}$

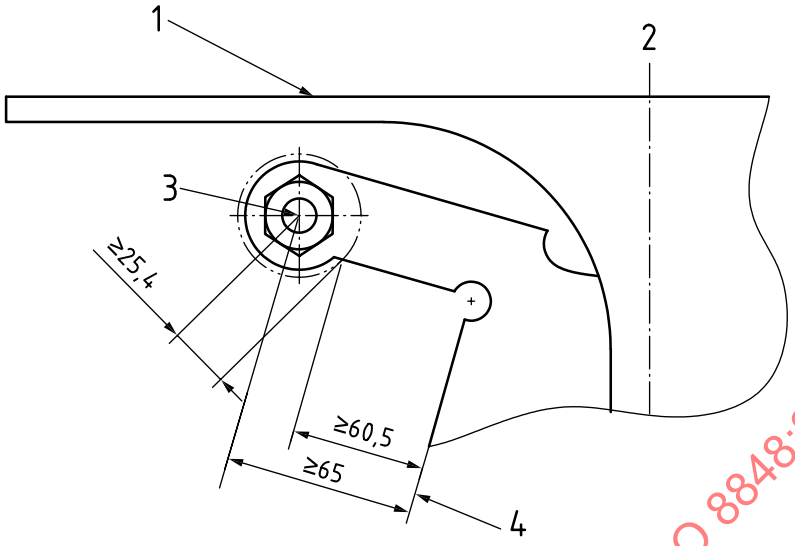
a Either side.

NOTE 1 The tube can be threaded equal length on both ends or reversible for port steering installations.

NOTE 2 The above inner tube dimensions are for the as installed tube.

Figure 3 — Engine-mounted steering tube

Dimensions in millimetres



Key

1	steering arm	3	tilt axis
2	steering axis	4	transom mating surface

Figure 4 — Engine-mounted steering tilt axis

5.3 The drag link and the necessary fittings to attach an outboard engine to the steering output ram shown in Figure 1 shall be supplied with the outboard engine.

5.4 The outboard engine shall be designed so that, with any combination of engine turn and tilt, there shall be no damaging interference between the engine, its accessories, and both the craft-mounted steering system installed as shown in Figure 2 and the engine-mounted steering system, provided the engine is designed for both systems. Appropriate written information and installation instructions shall be provided, clearly indicating the type of steering system(s) that should be used.

5.5 All mechanical parts of a steering system transmitting steering forces shall meet the applicable steering system component requirements in 8.2.

NOTE 1 Electrical parts of a steering system are addressed in ISO 25197.

NOTE 2 Hydraulic parts of a steering system are addressed in ISO 10592.

5.6 Outboard engines shall be designed so that the geometry ensures that the static loads defined below, when applied at the steering-arm connection point normal to the steering arm in its plane of operation, throughout the maximum steering arc, do not result in steering output ram loadings greater than those specified in 8.3.1.

— 3 300 N for standard duty steering system;

— 2 200 N for light duty steering system.

5.7 The steering arm of the outboard engine shall be provided with a 3/8-24 UNF thread, or a plain hole of 9,65 mm to 9,9 mm diameter at the connection point.

5.8 Sterndrives designed for remote mechanical steering systems shall be designed with proper geometry to ensure that a torque of 680 Nm applied about the sterndrive steering axis does not result in a steering component loading greater than that specified in 8.3.1.

6 Steering system requirements

6.1 Craft-mounted steering systems

6.1.1 Craft-mounted steering systems for outboard engine installations shall meet the dimensional requirements indicated in Figure 1 and Figure 2. When a joint as shown in Figure 2 is replaced by a universal joint with two movement axes, the axis perpendicular to the transom face shall be located 0 mm to 13 mm above the engine clamp bracket horizontal mounting face. The second axis shall be 100 mm to 115 mm from the inner surface of the transom and shall be not more than 28,5 mm from the first axis toward the engine. If the swivel is mounted in the engine well side fitting, the engine well shall provide for 380 mm mid-travel position from the swivel axis to the engine axis.

6.2 Steering systems

6.2.1 Steering systems shall be capable of operating throughout a temperature range of −20 °C to +80 °C.

6.2.2 Storage temperature range — All materials used in the construction of the system and its accessories shall be capable of withstanding an ambient temperature of −40 °C to +85 °C for at least 1 week duration.

NOTE This requirement is not intended to require operation at these temperatures, but is included to determine that the system withstands the storage temperatures of this document.

6.2.3 Steering systems and components shall meet the applicable test requirements specified in Clause 8.

6.2.4 The steering system shall be capable of unobstructed movement throughout its full range of intended cable travel without interference.

6.2.5 Ball joints used to connect the steering system to the rudder, sterndrive, outboard and water jet drives shall be installed so that total loss of steering does not occur if the ball separates axially from its socket.

NOTE A flat washer larger than the socket bore meets this requirement.

For mini-jet craft installations, ball joints used to connect the steering system to the jet drive shall have redundancy such that axial failure of the ball-to-socket connection does not result in total loss of steering.

6.2.6 Steering systems and components shall meet the applicable test requirements specified in Clause 8.

6.2.7 Plastics and elastomers which can be exposed to sunlight shall be chosen to resist degradation by ultraviolet radiation.

6.2.8 Plastics and elastomers which can be installed in engine compartments shall be chosen to resist degradation by saline atmospheres, fuel, oil, ozone and heat.

6.3 Steering cables

6.3.1 Steering cables shall be permanently marked with a dimension at the output end with a steering system length which shall be the length from the steering wheel shaft centre to the hole centre in the steering output ram at the mid-travel position.

6.3.2 The cable or steering-system output device shall provide the following amounts of travel:

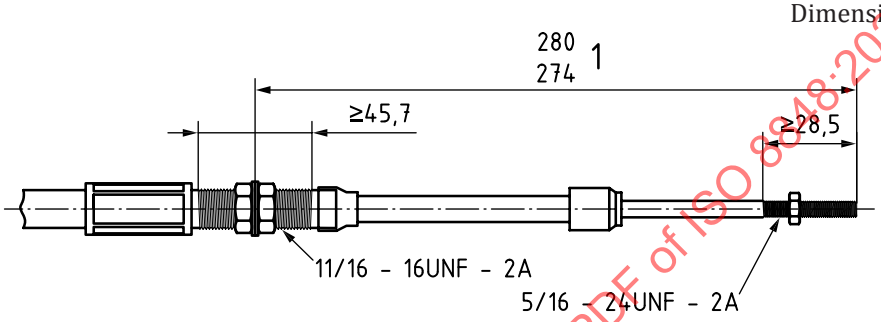
— 100 mm to 115 mm on each side of mid-travel for standard duty and light duty steering systems;

— 89 mm to 95,4 mm on each side of mid-travel for mini-jet steering systems.

6.3.3 For light duty steering systems, the steering cable shall be permanently marked by the manufacturer that the maximum power permissible is 40 kW.

6.3.4 Mini-jet craft steering system output device shall follow the mounting requirements specified in Figure 5.

Dimensions in millimetres



Key

1 mid-travel

Figure 5 — Output mounting configuration

6.3.5 Light duty and standard duty steering cables shall not be interchangeable with steering cables for mini-jet craft steering systems.

6.3.6 Ferrous metals used for the core of a steering cable, installed below the maximum load waterline, shall be corrosion-resistant and equivalent to 300 series stainless steel.

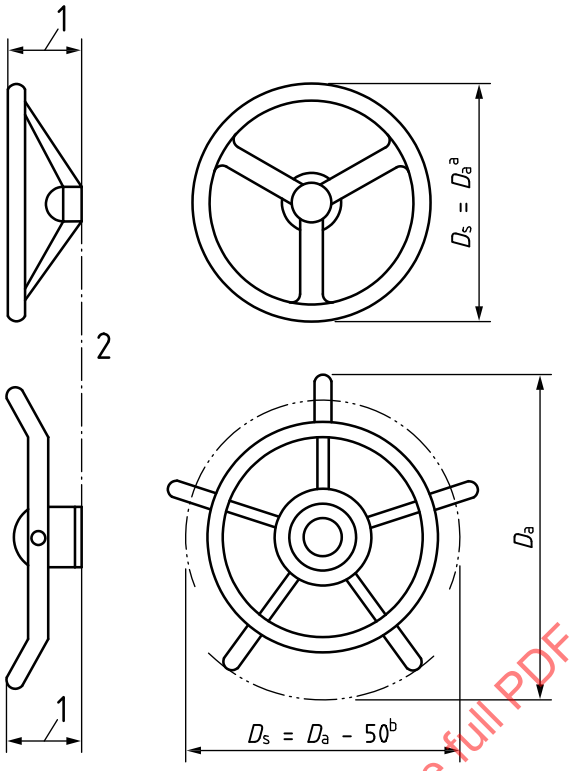
6.3.7 The minimum bend radius of the cable shall be specified by the cable manufacturer.

6.3.8 Each cable in a two-cable steering system shall individually meet the requirements of this document.

6.4 Steering mechanisms

6.4.1 Installation instructions for steering mechanisms shall include recommendations for the largest diameter D_s and deepest steering wheel dish (see Figure 6) that may be used with the helm.

Dimensions in millimetres



Key

1 steering wheel dish
2 forward hub surface
D_a actual diameter
D_s standard diameter for the application of loads
a For steering wheels without handgrips, $D_s = D_a$.
b For external spoke steering wheels, $D_s = D_a - 50$ mm.

NOTE For non-circular steering wheels, D_s is the largest diameter that can be inscribed in the steering wheel shape.

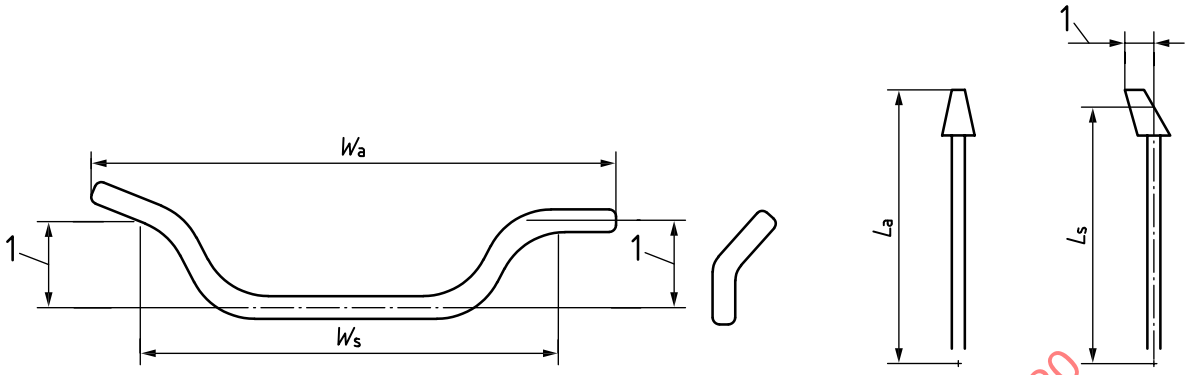
Figure 6 — Steering wheel terms

6.4.2 Steering mechanisms that use a steering wheel shall be permanently marked on the helm assembly, such that the marking is visible when the steering wheel is removed, with the manufacturer's recommendation of the largest steering wheel diameter and the deepest steering wheel dish that may be used.

6.4.3 Steering mechanisms that are intended for a handlebar shall be permanently marked with the manufacturer's recommendation of the largest handlebar width and greatest effective offset that may be used.

6.4.4 Steering mechanisms that are intended for a joystick shall be permanently marked with the manufacturer's recommendation of the largest stick allowed.

Dimensions in millimetres



Key

1 offset
W_a actual width of handlebar
W_s standard width= actual width – 50 mm
L_a actual length of joystick
L_s standard length of joystick = actual length – 50 mm

Figure 7 — Control elements

6.4.6 Steering mechanisms for mini-jet craft shall incorporate travel stops to eliminate overloading of the steering cable.

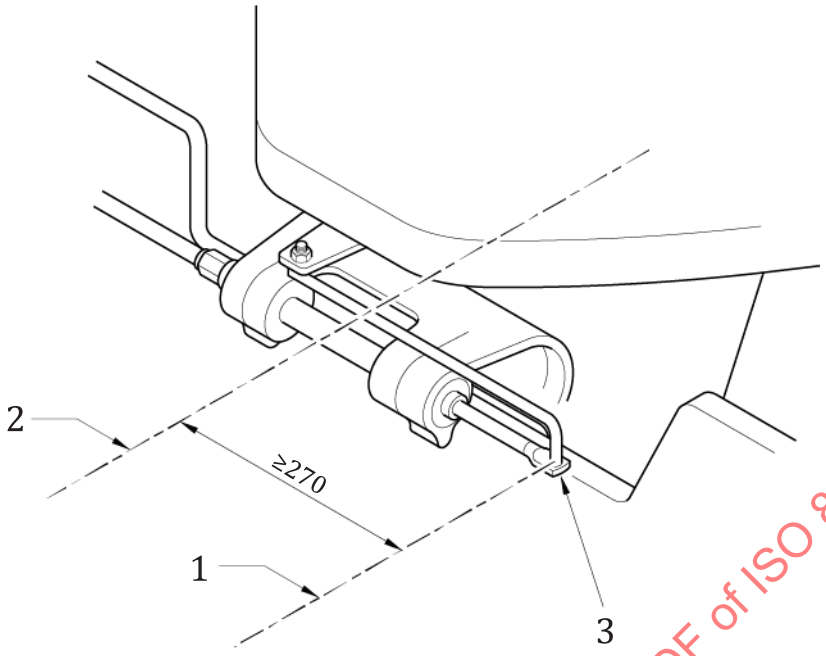
6.4.7 Helm assemblies for light duty steering systems shall be permanently marked by the steering manufacturer stating that the maximum power permissible is 40 kW.

7 Installation

7.1 Except for installations specifically intended for craft or outboard engines with special requirements, either the engine-mounted or the craft-mounted steering system shall be used.

7.2 If installing engine-mounted steering systems in outboard engine-craft, steering cables or other force-transmission means shall be selected so that, as installed and at mid-travel position, the output ram or equivalent component connection point shall reach at least 270 mm beyond the engine centreline as indicated in Figure 8.

Dimensions in millimetres



Key

1 mid-travel position
2 engine centreline
3 interface point

Figure 8 — Engine-mounted steering system

7.3 If installing craft-mounted steering systems in outboard engine-craft, steering cables or other force-transmission means shall be selected so that, as installed and at mid-travel position, the output ram or equivalent component connection point reaches at least to the engine centreline. The cable shall be attached to the craft to position the cable-anchor swivel with respect to the engine centreline as specified in Figure 2.

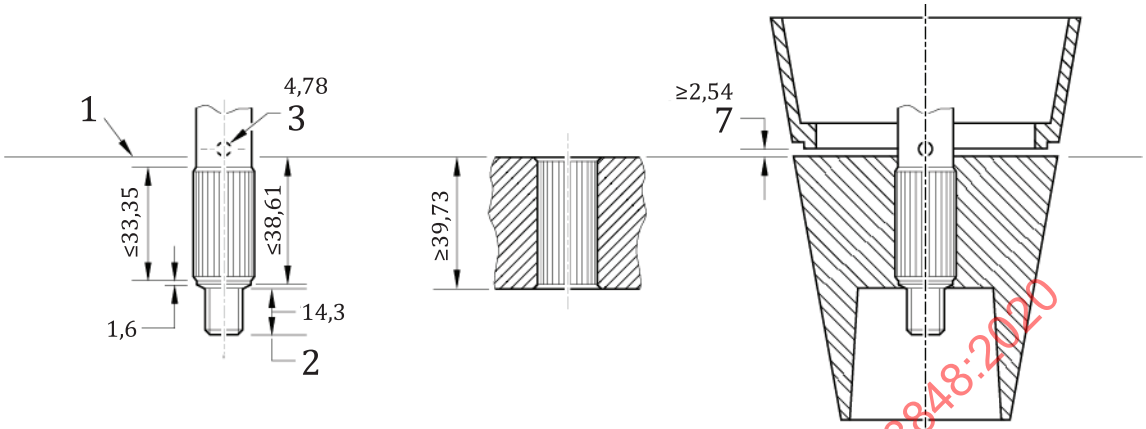
7.4 Steering systems shall be installed such that, with any combination of drive turn and tilt, there shall be no damaging interference between the outboard engine, sterndrive, or jet drive, their accessories and any part of the craft or steering system.

7.5 Cables shall be installed with a radius that shall not be smaller than the steering manufacturer's recommended minimum.

7.6 Steering wheel hubs and helm shafts shall be selected to fit each other. Current fit configurations are shown in Figure 9.

7.7 There shall be at least 65 mm of clearance between the shift and throttle control levers and the control element under all possible lever or control element positions.

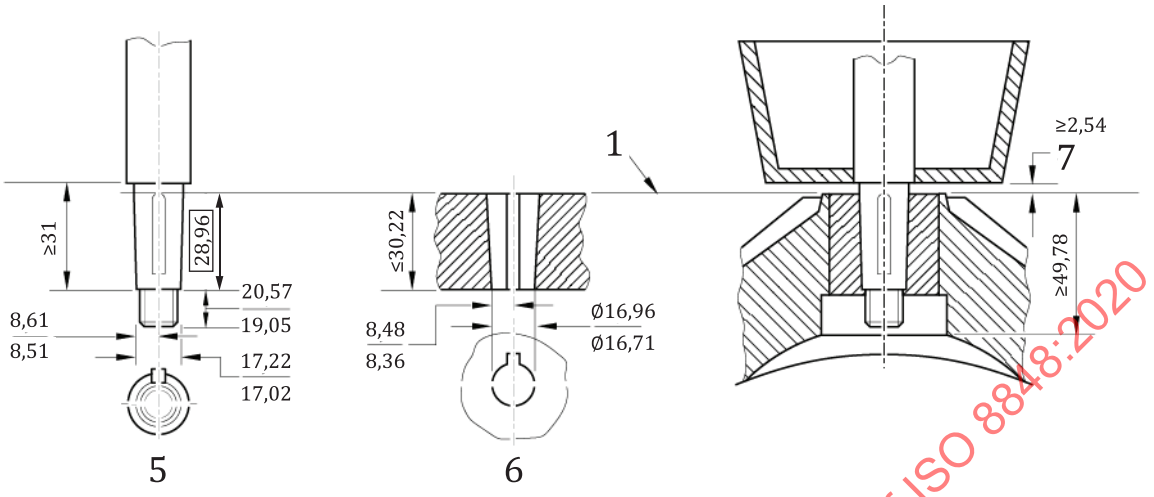
Dimensions in millimetres



Spline data – Shaft		Spline data – Hub	
Module	1.14	Module	1.14
# of teeth	19	# of teeth	19
Pressure angle	45°	Pressure angle	45°
Outside diameter	17,78 - 17,45	Outside diameter	17,86 - 17,81
Minor diameter	15,77 - 15,66	Minor diameter	16,15 - 16,00
Pitch diameter	16,64	Pitch diameter	16,64
Tooth thickness @ P.D	1,47 - 1,44	Tooth thickness @ P.D.	1,47 - 1,44
Base circle diameter	11,77	Base circle diameter	11,77

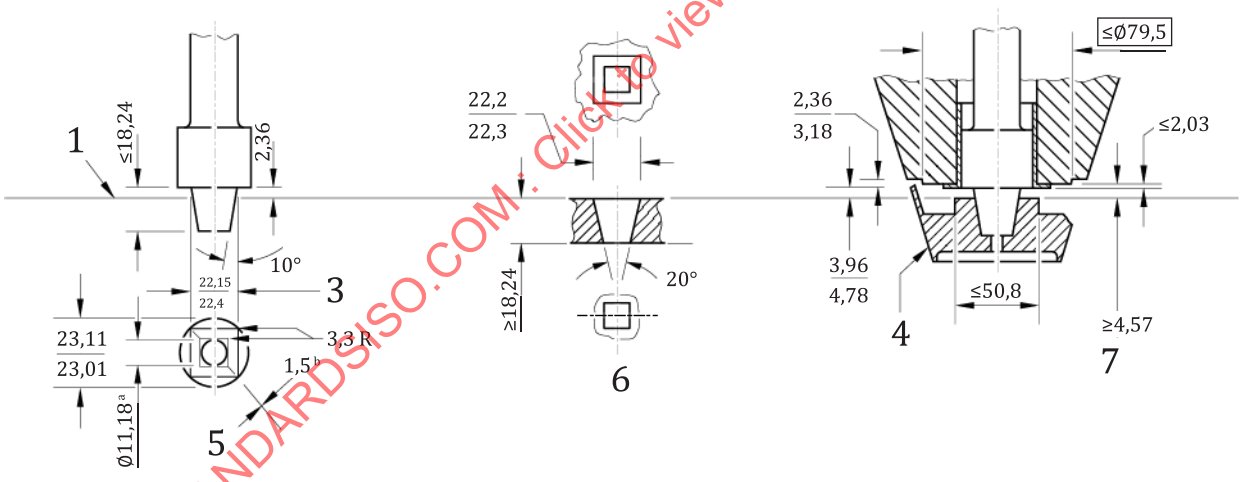
a) Spine shaft and steering wheel hub

Dimensions in millimetres



Taper data – Shaft		Taper data – Hub	
Shaft taper equals	(4,77° +0,1°/0)	Hub taper equals	(4,77° 0/−0,1°)
Key height above shaft	2 286 min.	Hub key	4,79 min., 5,07 max.

b) Tapered shaft and steering wheel hub



c) Tapered square shaft and steering wheel hub

Key

1	forward hub surface	4	optional skirt	7	clearance
2	minimum full thread	5	core diameter	a	Core.
3	pin diameter	6	square hub gauging dimension	b	Optional.

Figure 9 — Steering wheel hubs and helm shafts current fit configurations

7.8 If the steering cable passes through the side of an outboard engine well below the downflooding height, as defined in ISO 12217-1:2015, ISO 12217-2:2015 and ISO 12217-3:2015, the cable opening shall meet the degree of watertightness requirements specified in ISO 12217-1:2015, ISO 12217-2:2015 and ISO 12217-3:2015.

8 Test requirements

8.1 General

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

8.1.2 The steering mechanism assemblies shall incur no loss of operating function after the tests specified in 8.2 and 8.3, when equipped with the steering wheel of largest diameter and deepest dish, or the largest recommended joystick, or the largest recommended handlebar, for which the helm is rated.

8.2 As-installed tests

8.2.1 These tests are intended to establish the acceptability of the design strength of steering systems as installed in a craft.

8.2.2 Each steering system, including steering mechanism, cable, and attachment components, shall withstand a static axial force of the value defined in Table 1 in tension and compression. For rudders, outboard, stern drive, and water-jet drives, the load shall be applied at the interface point of the steering output ram along the axis of the steering output ram. For mini-jet craft, the force shall be applied at the connection to the jet drive. The systems shall not sustain deformation or breaking of components that, following the test, causes any loss in steering capability or any dimensional change that results in non-compliance with Figure 2. The permanent deformation shall not exceed 6,35 mm measured along the axis of the output ram.

8.2.3 Tangential force test

Steering systems shall withstand a single tangential force in either direction of the forces listed in Table 1, applied as appropriate:

— at any point on the steering wheel rim (Figure 6 – diameter);

— at the centre-point of any handgrip of an external spoke steering wheel (Figure 6 – diameter); or

— at the point of maximum leverage on other steering devices (Figure 7 –L_s and W_s).

8.2.4 Axial force test

A subsequent separate single axial force of the forces listed in Table 1 shall be applied in each direction and distributed over not more than 100 mm of the rim, spoke or handgrip, at any location maintaining minimum retained system performance. Upon application of the indicated force, there shall be no fracture of the mounting surface or craft structure, nor deformation such that the required force cannot be achieved.

8.2.5 A test for minimum retained system performance shall be performed on the steering system in its condition at the end of the force tests. Repairs to the system are not allowed prior to testing for minimum retained system performance. Failure to maintain minimum retained system performance or the separation of components necessary for steering control including separation of any portion of the steering mechanism, transom, or engine well mounts from the craft as a result of the application of the forces specified in this clause all constitute failure.

Table 1 — As installed in the craft tests

Clause - As-installed tests	Mini-jet steering	Light duty steering	Standard duty steering
8.2.2 - Static force	1 430 N	2 200 N	3 300 N
8.2.3 - Tangential force	360 N	450 N	450 N
8.2.4 - Axial force	540 N	670 N	670 N
8.2.5 - Minimum retained system performance	27 Nm	27 Nm	27 Nm

8.3 Components test

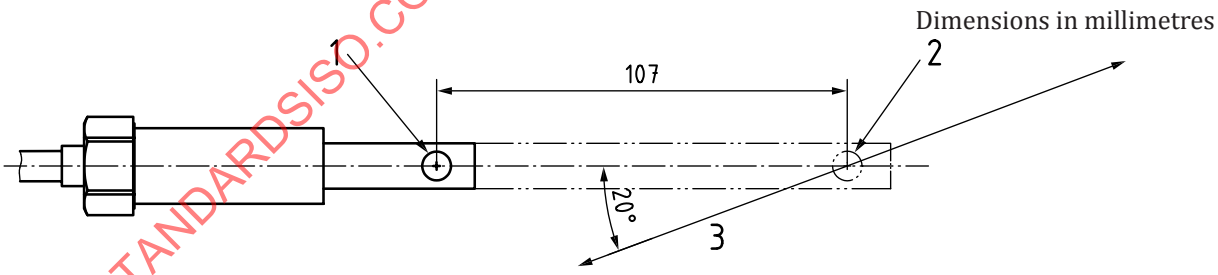
8.3.1 Steering cable and output assembly tests

NOTE Steering cable and output assembly tests listed in this subclause are not defined for mini-jet craft.

8.3.1.1 Each steering output ram and cable assembly (including craft-mounted system hardware) and each integral fitting shall withstand an axial force per the values listed in Table 2 in tension and compression, applied at the interface point of the steering output ram throughout its travel range, without breakage of components.

8.3.1.2 A separate cantilever force per the values listed in Table 2 shall be applied at the centreline of the interface point in the steering output ram, with at least 190 mm of the ram unsupported, without more than 1,25 mm of permanent deflection at the output ram interface point.

8.3.1.3 The output ram of a push-pull steering cable shall withstand a cyclic load per the values listed in Table 2 applied as shown in Figure 10, without causing separation of components. This force shall be applied for 50 000 reversals through the output ram interface point.



Key

1 fully retracted position
2 test position
3 cyclic load ± 1 670 N

Figure 10 — Output ram fatigue test