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Small craft — Remote hydraulic steering systems

Petits navires — Système de direction hydraulique commandé à distance

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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 second edition cancels and replaces the first edition (ISO 10592:1994), which has been technically revised.

The main changes are as follows:

— in Clause 3, definitions have been updated;

— throughout the text, requirements have been updated to meet the state of the art;

— the steering wheel requirements and tests have been removed;

— former Clause 12, Designation, has 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 hydraulic steering systems

1 Scope

This document specifies the requirements for the design, installation and testing of engine-mounted and craft-mounted remote hydraulic steering systems used with single and multiple engine installations of outboard engines over 15 kW per engine, as well as with single and multiple engines of inboard, sterndrive, and water jet drives, all used on small craft.

This document does not address emergency means of 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 8848:2022, *Small craft — Remote mechanical steering systems*

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 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
burst pressure
pressure at which the system exceeds the ultimate strength of the weakest hydraulic component, resulting in a drop of hydraulic pressure

3.2
component interface
mechanical interface (3.4) or *hydraulic interface* (3.3) at a point in the *steering system* (3.14) where a connection is made between components that are not supplied as part of the same assembly kit

Note 1 to entry: If hydraulic fluid lines are not shipped as part of the steering kit, there is an interface between the helm and the fluid lines, and between the *output device* (3.12) and the fluid lines.

3.3
hydraulic interface
interface between two or more hydraulic components where force and motion are transmitted by hydraulic fluid

3.4
mechanical interface
interface where force and motion are transmitted mechanically

3.5
component proof pressure
pressure rating for helms, lines, fittings and *output devices* (3.12) at which the component performs as intended

3.6
component maximum working pressure
pressure equivalent to one-half of the *component proof pressure* (3.5)

3.7
drag link
link rod
link arm
mechanical device used in a *steering system* (3.14) by which the force of the *output device* (3.12) is transmitted to the *steering arm* (3.22), in either a *craft-mounted steering system* (3.15) or an *engine-mounted steering system* (3.8)

3.8
engine-mounted steering system
steering system (3.14) in which the reactionary forces of the *output device* (3.12) are resisted by the propulsion device

3.9
hydraulic helm
mechanism, exclusive of the steering wheel or control element, through which remote manual effort is converted to hydraulic pressure and flow

3.10
remote hydraulic steering system
steering system (3.14) that utilizes a *hydraulic helm* (3.9) to convert operator steering inputs into hydraulic pressure and flow to actuate an *output device* (3.12) with no additional energy source

3.11
minimum retained system performance
system performance after tests such that at least 90 % of the *steering arm* (3.22) travel normally available on each side of the mid-position can be attained by exertion of no more than 27 Nm of torque at the helm through the steering wheel or control element

Note 1 to entry: This criterion does not define the *steering system* (3.14) performance while a *craft* (3.23) is underway, but is intended to provide quantitative limits for design and testing purposes.

3.12
output device
hydraulic cylinder, rotary actuator or other device that converts hydraulic pressure and flow into force on, and movement of, the steerable device

3.13
rate of steering response
ratio of output movement to input movement

3.14
steering system
assembly that includes all components necessary to transmit remote manual effort to the steerable device

3.15
craft-mounted steering system
steering system (3.14) in which the reactionary forces of the *output device* (3.12) are resisted by the *craft* (3.23)

3.16
hydraulic fitting
part or design feature on a component used to join (i.e. connect) any pressure retaining components in the *steering system* (3.14)

3.17.1
system design peak pressure
<single and twin engines> greater of the pressures generated by the application of either a 1 672 Nm *system torque* (3.20) to the steering axis of the outboard engine(s), inboard engine rudder, sterndrive, or water jet drive(s), or a single tangential load of 445 N; or *system relief pressure* (3.19) if relief activates during application of a 445 N load at D_s on the steering wheel rim or at D_s on the handgrip with the largest diameter D_s wheel specified for the hydraulic helm

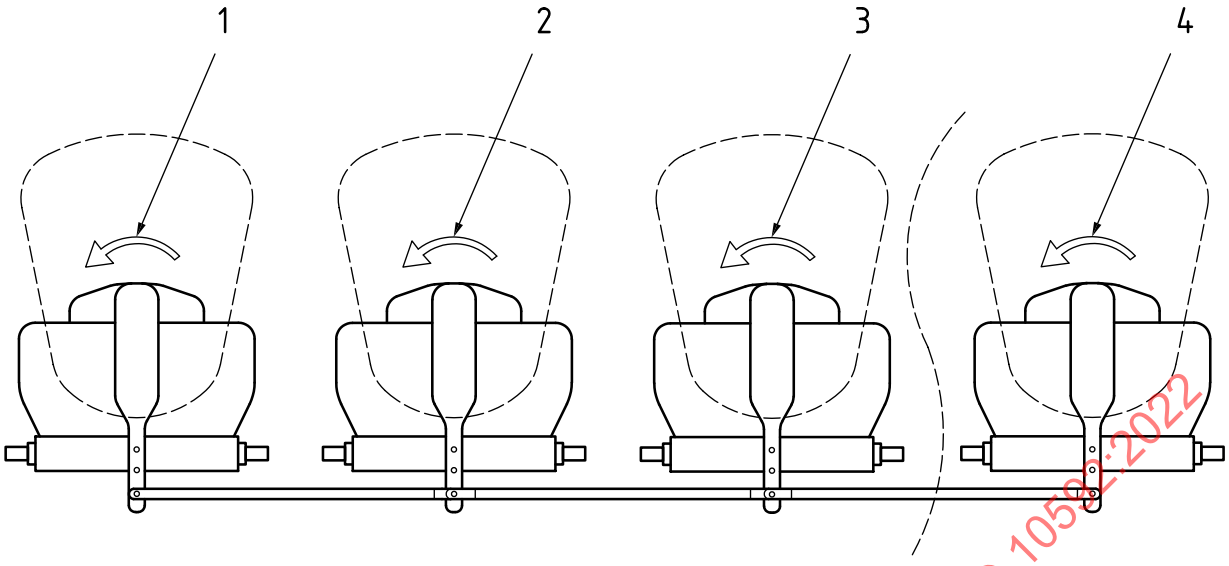
3.17.2
system design peak pressure
<triple and quadruple outboard engines> greater of the pressures generated by the application of either a 3 344 Nm *system torque* (3.20) to the steering axis of the outboard engines, or a single tangential load of 445 N; or *system relief pressure* (3.19) if relief activates during application of a 445 N load at D_s on the steering wheel rim or at D_s on the handgrip with the largest diameter D_s wheel specified for the hydraulic helm

3.18
system proof pressure
pressure attained by a system if equipped with an activated pressure relief device, or a single tangential load of 450 ± 5 N at the steering wheel rim or handgrip with the largest diameter D_s wheel specified for the helm

3.19
system relief pressure
pressure limit when a pressure relief device activates

3.20
system torque
total combined torque applied to the outboard engine(s) axis (or axes), inboard rudder, sterndrive or waterjet propulsion system that is resisted by the component(s) of the *steering system* (3.14)

Note 1 to entry: Outboard engine example shown in Figure 1.



Key

1 engine 1 torque
2 engine 2 torque
3 engine 3 torque
4 engine 4 torque

Figure 1 — System torque

3.21
multiple engine installation
two or more engines, normally used simultaneously for a *craft's* (3.23) main propulsion, controlled by a common *steering system* (3.14)

3.22
steering arm
portion of the outboard engine that the *steering system* (3.14) makes *mechanical interface* (3.4) with

3.23
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 length of hull is defined in ISO 8666.

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

4 General requirements

4.1 The craft manufacturer shall install the complete remote hydraulic steering system on the craft to at least the applicable points listed in a) or b) as follows.

a) For craft with outboard engines, the steering system shall be complete from the control element to the mechanical interface for connection of the drag link supplied with the outboard engine, or shall provide an alternative means to connect the output device to the engine so that the loading magnitude and offset are consistent with the steering arm's intended purpose.

b) In all other craft, the steering system shall be complete from the control element to the output connection point on the steerable device.

4.2 All threaded fasteners whose integrity affects operation of the remote hydraulic steering system so that separation or loss of the fastener would cause total loss of steering without warning shall be provided with a locking means. This requirement does not apply to hydraulic fittings.

4.3 Threaded fasteners whose integrity affects operation of the steering system so that separation or loss of the fasteners can cause total 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

a) shall be locked by a device whose presence is determined by visual inspection, or by feel, following assembly, or

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

The requirements of 4.3 do not apply to hydraulic fittings.

NOTE Self-locking nuts with plastic inserts that create mechanical plastic interference meet the above stated requirements.

4.4 Loose lock washers, distorted thread nuts or separately applied adhesives shall not be used.

4.5 Devices that use plain threaded jam nuts to permit adjustments shall be designed so that total separation of parts, or total loss of steering, will not occur should they loosen.

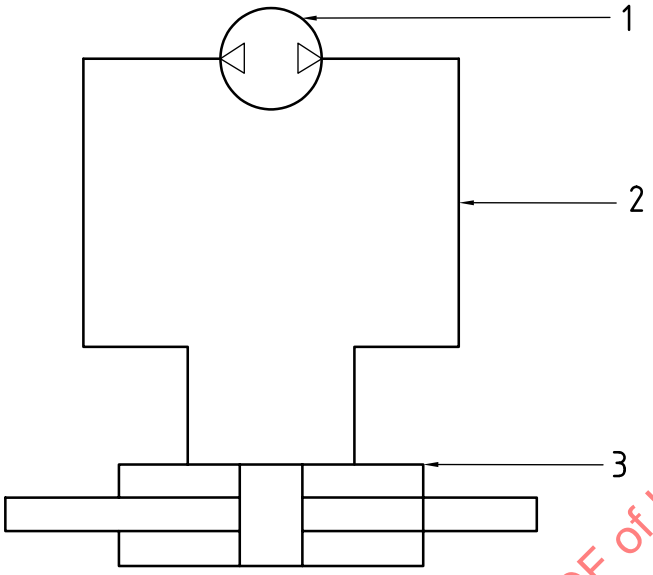
4.6 Connection fittings, including quick-disconnect fittings relying only upon a spring or springs to maintain the connection, shall not be used.

4.7 Operating temperature range — All materials used in the construction of the system and its accessories shall be capable of operating from –20 °C to +80 °C. Hydraulic system components shall not be installed in areas where the operating temperature exceeds +80 °C.

4.8 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.

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

4.9 All components including, but not limited to, hydraulic lines and fittings, and input and output devices shall be marked and selected to have a component proof pressure rating not less than the proof pressure rating on the hydraulic helm as indicated by the manufacturer of the helm. (See Figure 2).



Key

1 hydraulic helm marking: system proof pressure; for example: 6 900 kPa

2 line marking; for example: ≥ 6 900 kPa proof pressure rating or ≥ 3 450 kPa component maximum working pressure rating

3 cylinder marking; for example: ≥ 6 900 kPa proof pressure rating or ≥ 3 450 kPa component maximum working pressure rating

Figure 2 — Typical hydraulic steering system schematic

4.10 Components shall have a burst pressure that is not less than the system design peak pressure throughout the operating temperature range and expected burst pressure variation due to manufacture, installation, environmental exposure and in use loading, or two times component proof pressure, whichever is greater.

4.11 Hydraulic lines and fittings shall be selected in accordance with the steering equipment manufacturers' instructions.

Hydraulic quick connect fittings whose integrity affects operation of the system so that separation or loss of the connection would cause total loss of steering without warning shall incorporate a two stage integral locking means for connection integrity.

4.12 Hydraulic steering systems, including systems with pressure relief devices, shall comply with the following test to ensure that movement after a relief event is controlled:

— apply an impulse load of at least the system design peak pressure followed directly with at least one-half system design peak pressure for a duration of at least one-half second;

— the load shall be applied to the steerable device and resisted by the steering system;

— the load shall be applied within 13 degrees of steering centre;

— the system shall not have more than 17 degrees of steering movement.

4.13 Steering systems shall cause the steerable device to turn on its axis at its rate of steering response when no greater than 4 % of the full range of the steering movement of the steering wheel or control element.

4.14 Steering systems shall not cause the operator to re-grip the steering wheel or handgrip more frequently than once every 30 s due to position drift of 1/4 turn or more of the steering wheel or handgrip relative to the position of the steerable device.

4.15 Component interfaces and hardware shall be capable of withstanding the forces generated by the system operating at the system design peak pressure.

4.16 In multiple engine installations that are not mechanically connected, sudden loss of steering synchronization shall be prevented. Series plumbing of steering components meets this requirement.

4.17 When equipped with the largest diameter D_s and the deepest dish of the steering wheel for which the helm is rated, all steering components shall be capable of meeting the applicable test requirements specified in Clause 9.

5 Materials

5.1 Materials used in remote hydraulic steering systems shall be galvanically compatible or suitably plated to minimize corrosion.

5.2 Copper-base alloys shall be separated from aluminium with a galvanic barrier, such as 300 series stainless steel or equivalent, or shall be protected from exposure.

5.3 Metallic steering components that are at or below the waterline in the light craft condition, as defined in ISO 12217-1:2015, ISO 12217-2:2015 and ISO 12217-3:2015, shall be cathodic protected or galvanically isolated.

5.4 Materials used in remote hydraulic steering systems shall be resistant to deterioration by the specified hydraulic fluid and by other liquids or compounds with which the material can come in contact under normal marine services, e.g. grease, lubricating oil, common bilge solvents, and salt and fresh water.

5.5 Plastics and elastomers that can be exposed to sunlight shall be designed to resist degradation by ultraviolet radiation.

5.6 The hydraulic fluid shall be non-flammable or have a flash point of 160 °C or over.

6 Outboard engines and sterndrives

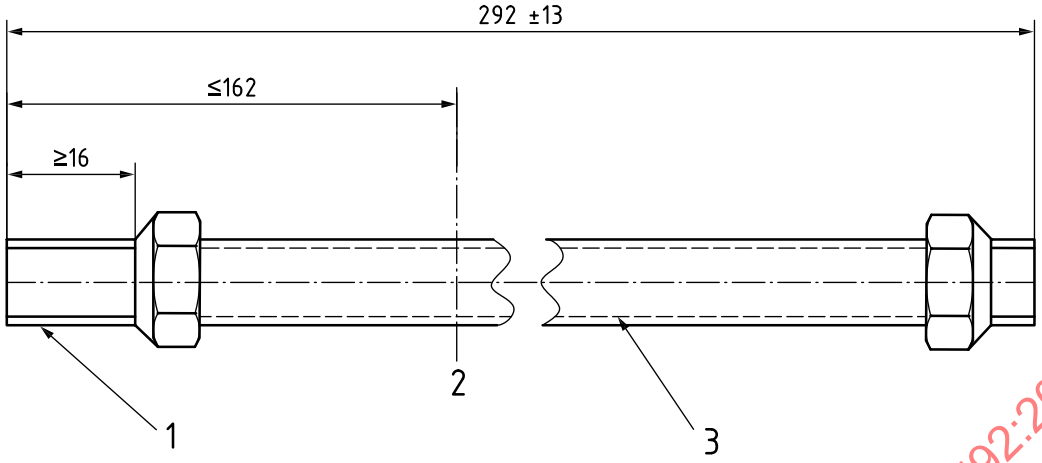
6.1 The steering stops on the outboard engine shall permit at least 30° of angular movement either side of centre.

6.2 The outboard engine shall:

a) incorporate an integrated steering system or meet the applicable dimensional requirements indicated in Figure 3 and Figure 4, and

b) provide space for the connection of the steering components as indicated in Figure 5, Figure 6 and Figure 7.

Dimensions in millimetres



Key

1 7/8-14 UNF-2A thread both ends

2 engine axis

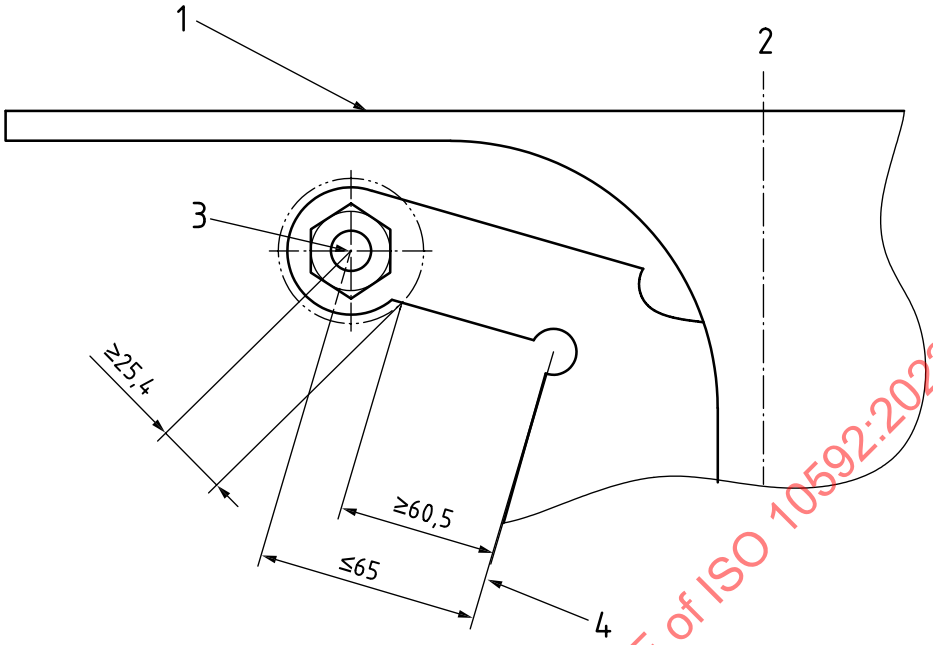
3 tube, ⌀ int. $16^{+0,25}_{0}$

NOTE 1 The steering 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

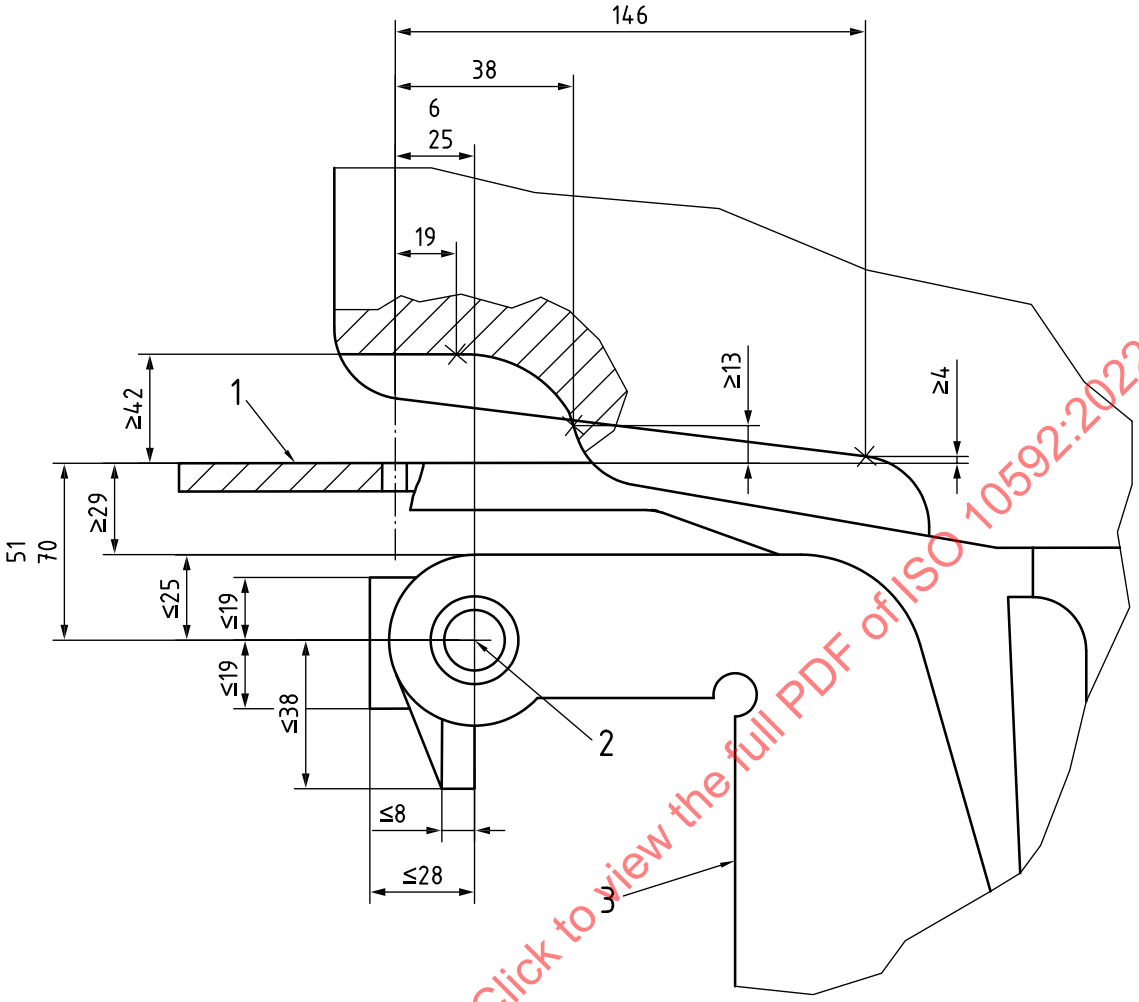


Key

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

Figure 4 — Engine-mounted steering tilt axis

Dimensions in millimetres

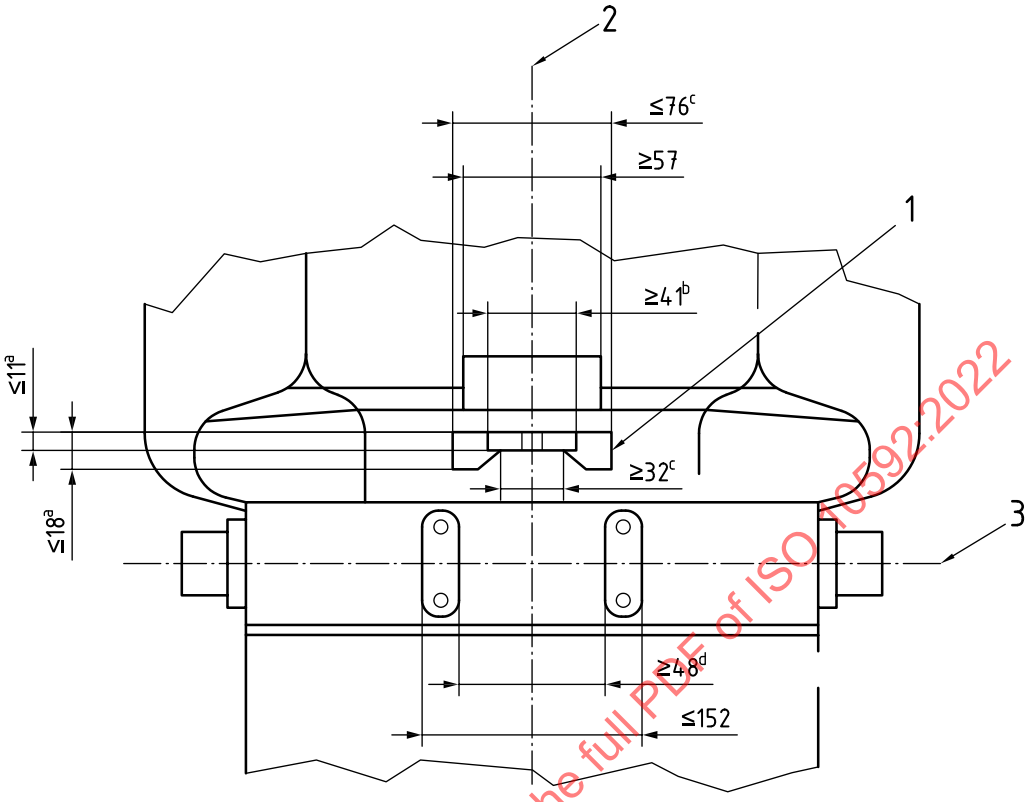


Key

1 steering arm
2 tilt axis
3 transom mating surface

Figure 5 — Outboard engine connection — Side view

Dimensions in millimetres



Key

1 steering arm

2 steering axis

3 tilt axis

a Maximum steering arm thickness, or steering hooks in the case of bolt-on-tillers, is stated at the mounting hole. Thicker sections at a distance of 38 mm from the mounting hole towards the axis of rotation will not interfere with the steering arm connection.

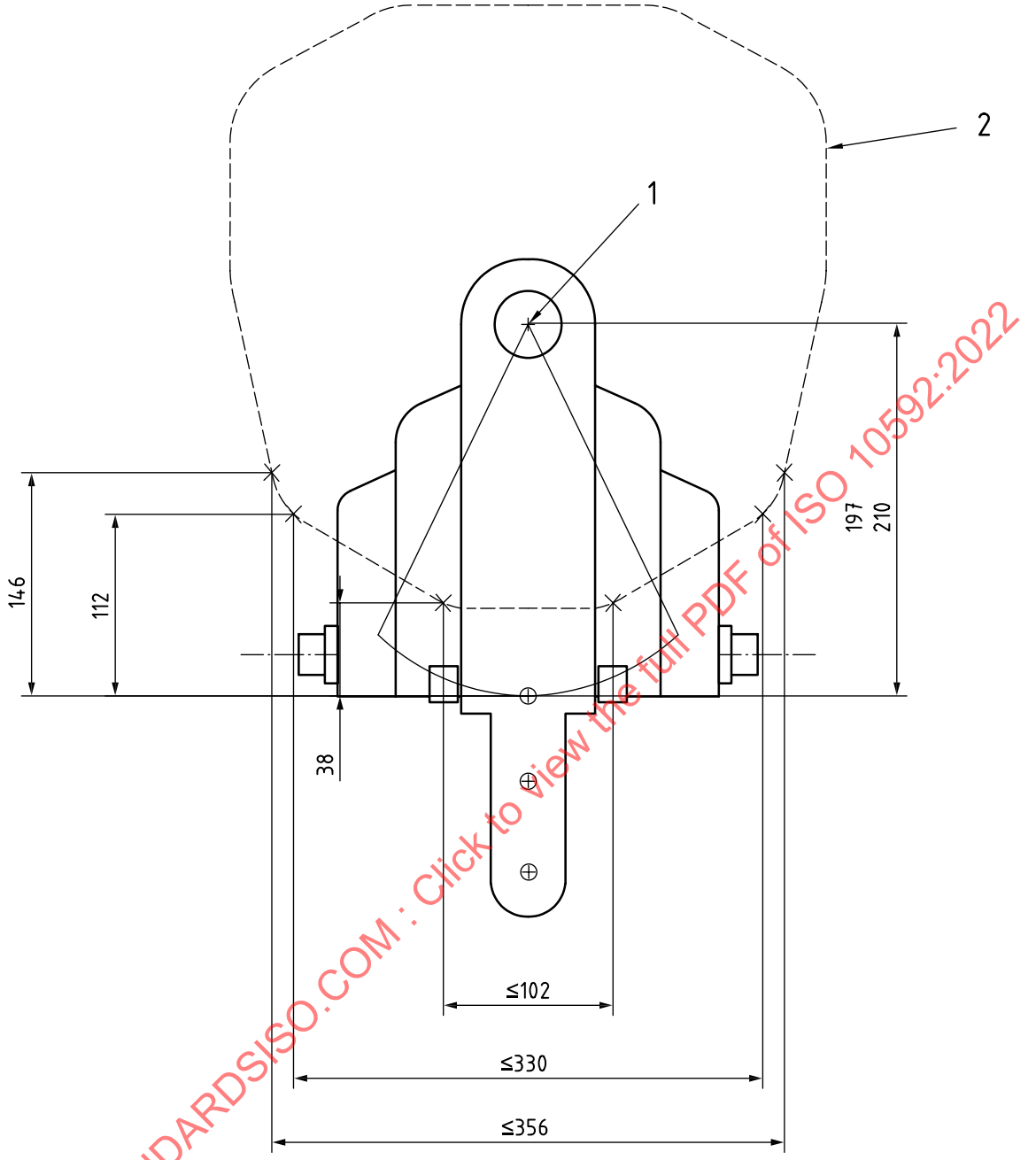
b Surface that outboard manufacturer's link arm or drag link attaches to shall be flat over the width of the steering arm.

c Top and bottom surfaces shall be flat over a minimum of 32 mm section centred on the steering arm at the mounting hole section.

d Area required for access of bolt/nut to mounting hole in steering arm.

Figure 6 — Outboard engine connection — Plan view

Dimensions in millimetres



Key

1 axis of rotation
2 lower cowling

Figure 7 — Outboard engine connection — Top view

6.3 The outboard engine(s) steering system shall be designed so that, with any combination of engine turn and tilt, there shall be no damaging interference between the engine(s), its accessories and the craft. Appropriate written information and installation instructions shall be provided, clearly indicating the type of steering system(s) that should be used with outboard engine(s).

NOTE Use of transom accessories, such as engine lift plates, can result in damaging interference.

6.4 The outboard engine shall be designed so that the geometry ensures that a static force of 3 300 N applied at the steering arm connection point normal to the steering arm in its plane of operation, throughout the maximum steering arc, does not result in a steering output device axial force greater than 9 000 N in tension and compression measured at the mechanical interface point.

6.5 The steering arm of the outboard engine shall be provided with a 3/8-24 UNF thread, or a plain hole of 9,6 mm to 9,9 mm in diameter, at the connection point.

6.6 Sterndrives shall be designed so that the geometry ensures that a torque of 680 Nm applied about the sterndrive steering axis does not result in a steering output device axial force greater than 9 000 N in tension and compression measured at the mechanical interface point.

7 Steering system requirements

7.1 Engine-mounted steering systems shall incorporate the dimensional requirements indicated in Figure 3 and Figure 4.

7.2 Steering systems with the end of the output device co-axial with the engine-mounting steering tube shall meet the mechanical interface requirements of ISO 8848:2022.

7.3 Craft-mounted steering systems and engine-mounted steering systems for outboard engine installations shall meet the requirements of 6.3.

7.4 The hydraulic helm shall be permanently marked by the component manufacturer with:

a) the largest diameter D_s and deepest dish wheel, to be visible when the helm is installed with the steering wheel removed (see Figure 8);

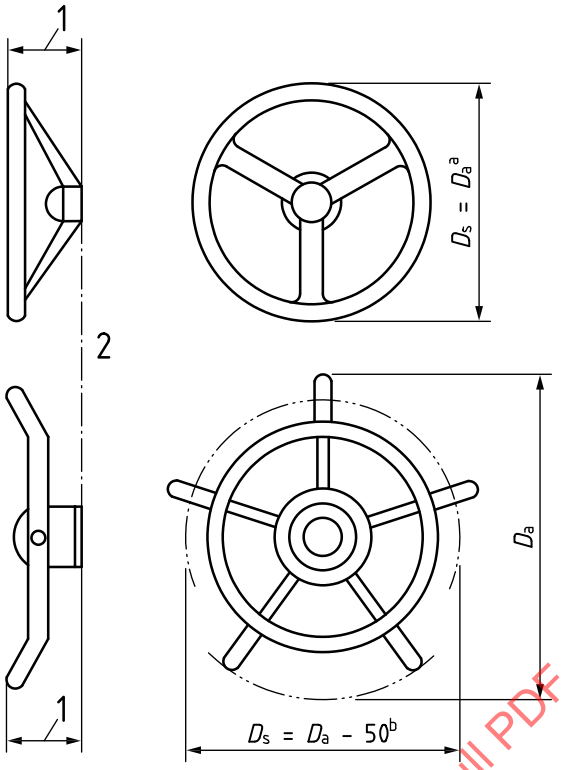
b) the system proof pressure, to be visible at the front of the helm with the steering wheel installed, or at the back of the installed helm adjacent to the hydraulic line connection location;

c) a reference to this document;

d) the name or trademark of the manufacturer;

e) the model type;

f) the year of production.



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 8 — Steering wheel terms

7.5 Output devices shall be marked by the component manufacturer with:

a) the component proof pressure rating;

b) a reference to this document;

c) the name or trademark of the manufacturer;

d) the year of production.

7.6 The component manufacturer's requirement for the hydraulic fluid shall be permanently and legibly displayed, adjacent to the filling location of the system or on the cap.

8 Installation

8.1 Hydraulic lines shall be of sufficient length to permit installation of the output device for single or multiple engine installations on those craft designed for multiple outboard engine installations.

8.2 Hydraulic lines shall accommodate the full range of intended travel without interference with the mechanical interface requirements of an outboard engine steering system including the full range of the engine tilt and trim.

8.3 Hydraulic lines shall be routed so that the ambient temperature in the space does not exceed the operating temperature range specified for the hydraulic lines used.

There shall be no joints or connections in hydraulic lines directly over exhaust system components or high temperature manifolds.

8.4 Hydraulic lines shall be installed with as few bends as practicable. Bends shall have as large a radius as practicable, and the radius shall not be smaller than the line manufacturer's recommended minimum.

The steering manufacturer recommended bend radius of the hydraulic line shall be provided on product or in the installation manual.

8.5 Hydraulic lines shall be selected and routed to avoid any stretching, crushing, restricted movement, kinking, or chafing.

The installation shall be carried out following the directions of the manufacturers of the system. Hydraulic lines shall be supported by clips, straps or other means to prevent chafing or vibration damage. The clips, straps or other devices shall be corrosion-resistant and shall be designed to prevent cutting, abrading or damage to the lines, and shall be compatible with hydraulic line materials.

Hydraulic lines and component ports/fittings should be capped/plugged until the hydraulic lines and components are fully interconnected to prevent contamination.

8.6 Hydraulic lines shall be routed to avoid any contact with sharp edges/screws.

8.7 Outboard steering systems, where the hydraulic lines must reciprocate with the steering cylinder, shall use flexible hydraulic hoses, and shall not use rigid tubing at the cylinder connection.

8.8 If the hydraulic lines pass 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 opening shall meet the degree of watertightness requirements specified in ISO 12217-1:2015, ISO 12217-2:2015 and ISO 12217-3:2015.

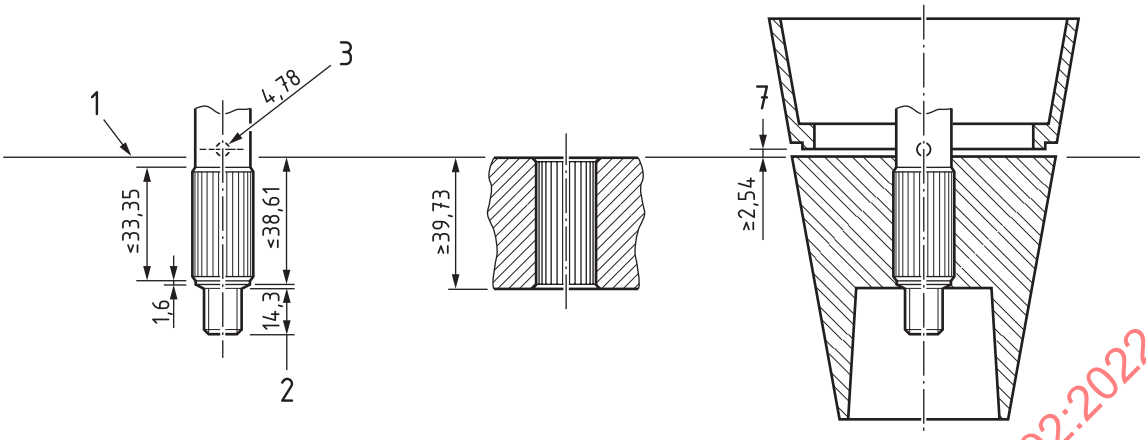
8.9 Ball joints used to connect the steering system to the steerable device shall be installed so that total loss of steering does not occur if the ball separates axially from its socket.

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

8.10 Steering wheels and helm shafts shall be selected to fit each other. Current fit configurations are shown in Figure 9.

NOTE Steering wheel requirements are addressed in ISO 23411.

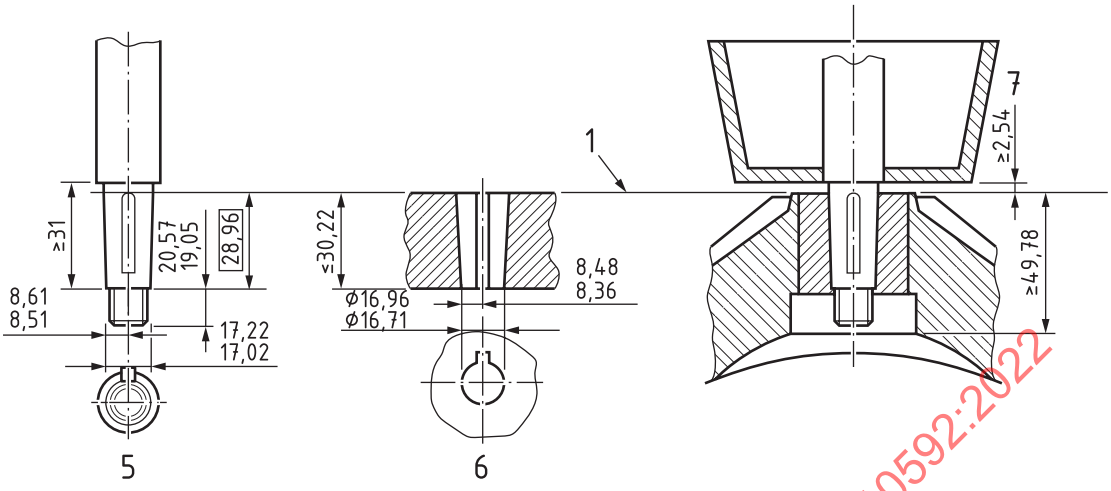
Dimensions in millimetres



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 to 17,45	Outside diameter	17,86 to 17,81
Minor diameter	15,77 to 15,66	Minor diameter	16,15 to 16,00
Pitch diameter	16,64	Pitch diameter	16,64
Tooth thickness @ P.D.	1,47 to 1,44	Tooth thickness @ P.D.	1,47 to 1,44
Base circle diameter	11,77	Base circle diameter	11,77

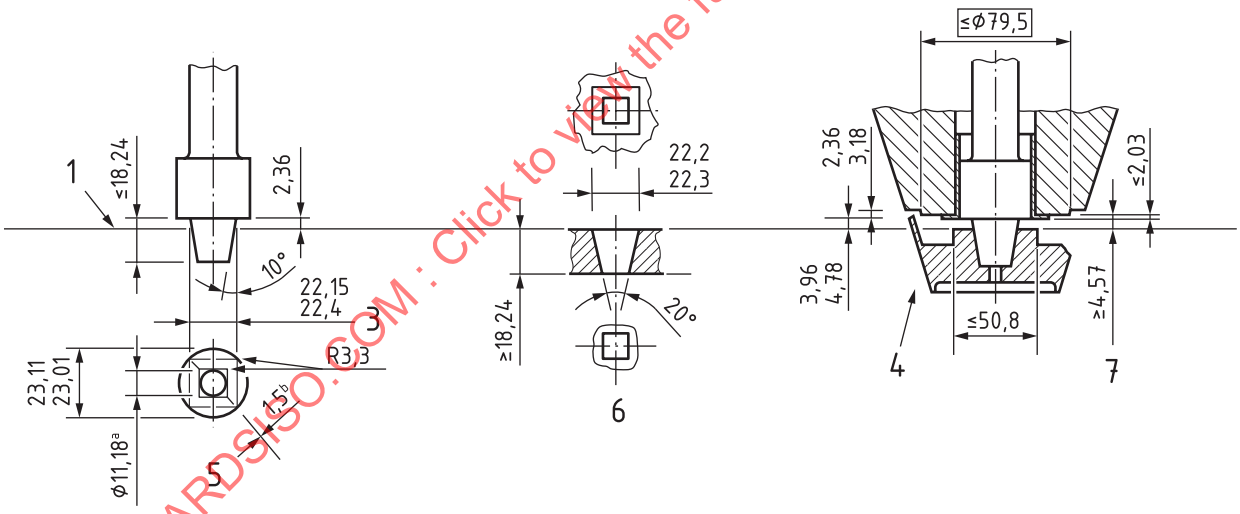
a) Spine shaft and steering wheel hub

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

9 Test requirements

9.1 Installed proof tests

9.1.1 The tests in 9.2 are intended to verify the integrity and function of each steering system as installed in the craft. Tests shall be performed upon original installation, when system component changes are made, and when servicing results in the disconnection/reconnection of mechanical or hydraulic interfaces.

9.1.2 Each installed steering system shall withstand a proof pressure test at each hard over position without leakage, disconnection, or permanent deflection of system components. The tests shall be conducted as follows:

— a sufficient tangential force shall be applied to the steering wheel rim to cause the hydraulic steering system including the output device to experience system proof pressure for a minimum duration of 60 s, during which time all hydraulic, mechanical and component interfaces shall not leak.

9.2 System application tests

9.2.1 These tests are intended to qualify the application of a steering system installed in a particular model of craft rigged with intended output devices.

9.2.2 Installed steering systems shall complete two full cycles from hard over to hard over during which all moving components are inspected to confirm that no interference or restriction of moving components is present through the full range of travel.

For outboard engine and sterndrive installations, the requirements of 6.3 shall be confirmed by testing under all combinations of trim, tilt, elevation, and steering angle.

9.2.2.1 During this test, installed systems shall demonstrate that no interference between the output device, the steerable device, tiebar, transom, or adjustable engine lift plate, engine well, or other surfaces occur.

9.2.2.2 No stretching, crushing, restricted movement of hydraulic lines, kinking of lines, or chafing of lines against bulkhead/engine well entry points or any other contact points shall occur.

9.2.3 Installed steering systems shall be tested for conformance to the steering response requirements of 4.13.

9.2.4 Installed steering systems shall be tested for their conformance to the requirements of 4.14. This test shall verify the ability to maintain course.

9.3 Steering system components tests

9.3.1 Steering system components shall withstand loads in either direction resulting from system design peak pressure, applied to the helm and transmitted to the rudder, sterndrive, water jet drive, or outboard engine, without leakage or permanent deformation of any system component.

9.3.2 Steering system components shall withstand a static pressure test at system design peak pressure at the upper and lower limits of the component operating temperature range for their locations.