M42 Steering Gear

M42 (1981) (Rev.1 1986) (Rev.2 1995) (Rev.3 1997) (Rev.4 June 2011) (Rev.5 Feb 2021) (Corr.1 Oct 2021) (Rev.6 Mar 2022)

Preamble

In addition to the requirements contained in SOLAS II-1/29 and SOLAS II-1/30 as well as related Guidelines (see Annex 2 of IMCO document MSC XLV/4) the following requirements apply to new ocean-going vessels of 500 gross tonnage and upwards. These requirements may be applied to other vessels at the discretion of the Classification Society.

1. Plans and specifications

Before starting construction, all relevant plans and specifications are to be submitted to the Classification Society for approval.

2. Definitions

The definitions relating to steering gear are given in Appendix 1.

3. Power piping arrangements

3.1 The power piping for hydraulic steering gears is to be arranged so that transfer between units can be readily effected.

3.2 Where the steering gear is so arranged that more than one system (either power or control) can be simultaneously operated, the risk of hydraulic locking caused by single failure is to be considered.

3.3 For all vessels with non-duplicated actuators, isolating valves are to be fitted at the connection of pipes to the actuator, and are to be directly fitted on the actuator.

3.4 Arrangements for bleeding air from the hydraulic system are to be provided where necessary.

3.5 Piping, joints, valves, flanges and other fittings are to comply with Classification Society requirements for Class 1 components. The design pressure is to be in accordance with paragraph M42.6.8.

Note:

1. Rev.4 of this UR applies to ships contracted for construction on or after 1 July 2012.

2. The “contracted for construction” date means the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. For further details regarding the date of “contract for construction”, refer to IACS Procedural Requirement (PR) No. 29.

3. Rev.5 of this UR is to be uniformly implemented by IACS Societies on ships for which the date of contract for construction is on or after 1 July 2022.

4. Rev.6 of this UR is to be uniformly implemented by IACS Societies on ships for which the date of contract for construction is on or after 1 July 2023.

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4. Rudder angle limiters

Power-operated steering gears are to be provided with positive arrangements, such as limit switches, for stopping the gear before the rudder stops are reached. These arrangements are to be synchronized with the gear itself and not with the steering gear control.

5. Materials

Ram cylinders; pressure housings of rotary vane type actuators; hydraulic power piping valves, flanges and fittings; and all steering gear components transmitting mechanical forces to the rudder stock (such as tillers, quadrants or similar components) should be of steel or other approved ductile material, duly tested in accordance with the requirements of the Classification Society. In general, such material should not have an elongation of less than 12 per cent nor a tensile strength in excess of 650 N/mm^2.

Grey cast iron may be accepted for redundant parts with low stress level, excluding cylinders, upon special consideration.

6. Design

6.1 The construction should be such as to minimize local concentrations of stress.

6.2 Welds

a) The welding details and welding procedures should be approved.

b) All welded joints within the pressure boundary of a rudder actuator or connecting parts transmitting mechanical loads should be full penetration type or of equivalent strength.

6.3 Oil seals

a) Oil seals between non-moving parts, forming part of the external pressure boundary, should be of the metal upon metal type or of an equivalent type.

b) Oil seals between moving parts, forming part of the external pressure boundary, should be duplicated, so that the failure of one seal does not render the actuator inoperative. Alternative arrangements providing equivalent protection against leakage may be accepted at the discretion of the Administration.

6.4 All steering gear components transmitting mechanical forces to the rudder stock, which are not protected against overload by structural rudder stops or mechanical buffers, are to have a strength at least equivalent to that of the rudder stock in way of the tiller.

6.5 For piping, joints, valves, flanges and other fittings see paragraph M42.3.4.

6.6 Rudder actuators other than those covered by SOLAS II-1/29.17 and relating Guidelines should be designed in accordance with Class 1 pressure vessels (notwithstanding any exemptions for hydraulic cylinders).

6.7 In application of such rules the permissible primary general membrane stress is not to exceed the lower of the following values:

$$\frac{\sigma_B}{A} \text{ or } \frac{\sigma_y}{B}$$

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where:

σ_B =specified minimum tensile strength of material at ambient temperature

σ_y =specified minimum yield stress or 2 per cent proof stress of the material, at ambient temperature

A and B are given by the Table 1.

Table 1

	Steel	Cast Steel	Nodular Cast Iron
A	3.5	4	5
B	1.7	2	3

6.8 The design pressure is to be at least equal to the greater of the following:

(i) 1.25 times the maximum working pressure,

(ii) the relief valve setting.

6.9 Accumulators, if any, are to comply with Classification Society requirements for pressure vessels.

7. Dynamic loads for fatigue and fracture mechanic analysis

The dynamic loading to be assumed in the fatigue and fracture mechanics analysis considering SOLAS II-1/29.2.2 and SOLAS II-1/29.17.1 as well as relating Guidelines, will be established at the discretion of the Classification Society.

Both the case of high cycle and cumulative fatigue are to be considered.

8. Hoses

8.1 Hose assemblies of type approved by the Classification Society may be installed between two points where flexibility is required but should not be subjected to torsional deflection (twisting) under normal operating conditions. In general, the hose should be limited to the length necessary to provide for flexibility and for proper operation of machinery.

8.2 Hoses should be high pressure hydraulic hoses according to recognized standards and suitable for the fluids, pressures, temperatures and ambient conditions in question.

8.3 Burst pressure of hoses should not be less than four times the design pressure.

9. Relief valves

Relief valves for protecting any part of the hydraulic system which can be isolated, as required by SOLAS II-1/29.2.3, should comply with the following:

(1) The setting pressure should not be less than 1.25 times the maximum working pressure.

(2) The minimum discharge capacity of the relief valve(s) should not be less than the total capacity of the pumps, which can deliver through it (them), increased by 10 per cent.

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Under such conditions the rise in pressure should not exceed 10 per cent of the setting pressure. In this regard, due consideration should be given to extreme foreseen ambient conditions in respect of oil viscosity.

The Classification Society may require, for the relief valves, discharge capacity tests and/or shock tests.

10. Electrical installations

Electrical installations should comply with the requirements of the Classification Society.

11. Alternative source of power

Where the alternative power source required by SOLAS II-1/29.14 is a generator, or an engine driven pump, automatic starting arrangements are to comply with the requirements relating to the automatic starting arrangements of emergency generators.

12. Monitoring and alarm systems

12.1 Monitoring and alarm systems, including the rudder angle indicators, should be designed, built and tested to the satisfaction of the Classification Society.

12.2 Where hydraulic locking, caused by a single failure, may lead to loss of steering, an audible and visual alarm, which identifies the failed system, shall be provided on the navigating bridge.

NOTE: This alarm should be activated whenever:

- position of the variable displacement pump control system does not correspond with given order; or

- incorrect position of 3-way full flow valve or similar in constant delivery pump system is detected.

13. Operating instructions

Where applicable, following standard signboard should be fitted at a suitable place on steering control post on the bridge or incorporated into operating instruction on board:

CAUTION

IN SOME CIRCUMSTANCES WHEN 2 POWER UNITS ARE RUNNING SIMULTANEOUSLY THE RUDDER MAY NOT RESPOND TO HELM. IF THIS HAPPENS STOP EACH PUMP IN TURN UNTIL CONTROL IS REGAINED.

The above signboard is related to steering gears provided with 2 identical power units intended for simultaneous operation, and normally provided with either their own control systems or two separate (partly or mutually) control systems which are/may be operated simultaneously.

14. Testing

14.1 The requirements of the Classification Society relating to the testing of Class 1 pressure vessels, piping and relating fittings including hydraulic testing apply.

14.2 A power unit pump is to be subjected to a type test. The type test shall be for a duration of not less than 100 hours, the test arrangements are to be such that the pump may run in

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idling conditions, and at maximum delivery capacity at maximum working pressure. During the test, idling periods are to be alternated with periods at maximum delivery capacity at maximum working pressure. The passage from one condition to another should occur at least as quickly as on board. During the whole test no abnormal heating, excessive vibration or other irregularities are permitted. After the test, the pump should be disassembled and inspected. Type tests may be waived for a power unit which has been proven to be reliable in marine service.

14.3 All components transmitting mechanical forces to the rudder stock should be tested according to the requirements of the Classification Society.

14.4 After installation on board the vessel the steering gear is to be subjected to the required hydrostatic and running tests.

15. Trials

The steering gear should be tried out on the trial trip in order to demonstrate to the Surveyor's satisfaction that the requirements of the Rules have been met. The trial is to include the operation of the following:

(i) the steering gear, including demonstration of the performances required by SOLAS II-1/29.3.2 and SOLAS II-1/29.4.2. For controllable pitch propellers, the propeller pitch is to be at the maximum design pitch approved for the maximum continuous ahead R.P.M. at the main steering gear trial. If the vessel cannot be tested at the deepest draught, steering gear trials shall be conducted at a displacement as close as reasonably possible to full-load displacement as required by Section 6.1.2 of ISO 19019:2005 on the conditions that either the rudder is fully submerged (zero speed waterline) and the vessel is in an acceptable trim condition, or the rudder load and torque at the specified trial loading condition have been predicted and extrapolated to the full load condition. In any case for the main steering gear trial, the speed of ship corresponding to the number of maximum continuous revolution of main engine and maximum design pitch applies.

(ii) the steering gear power units, including transfer between steering gear power units.

(iii) the isolation of one power actuating system, checking the time for regaining steering capability.

(iv) the hydraulic fluid recharging system.

(v) the emergency power supply required by SOLAS II-1/29.14.

(vi) the steering gear controls, including transfer of control and local control.

(vii) the means of communication between the wheelhouse, engine room, and the steering gear compartment.

(viii) the alarms and indicators required by SOLAS II-1/29 and SOLAS II-1/30 as well as M42.12, these tests may be effected at dockside.

(ix) where steering gear is designed to avoid hydraulic locking this feature shall be demonstrated.

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Appendix 1

Definitions relating to steering gear

1. Steering gear control system means the equipment by which orders are transmitted from the navigating bridge to the steering gear power units. Steering gear control systems comprise transmitters, receivers, hydraulic control pumps and their associated motors, motor controllers, piping and cables. Steering gear control system is also understood to cover “the equipment required to control the steering gear power actuating system”.

2. Main steering gear means the machinery, rudder actuator(s), the steering gear power units, if any, and ancillary equipment and the means of applying torque to the rudder stock (e.g. tiller or quadrant) necessary for effecting movement of the rudder for the purpose of steering the ship under normal service conditions.

3. Steering gear power unit means:

(a) in the case of electric steering gear, and electric motor and its associated electrical equipment,

(b) in the case of electrohydraulic steering gear, an electric motor and its associated electrical equipment and connected pump,

(c) in the case of other hydraulic steering gear, a driving engine and connected pump.

4. Auxiliary steering gear means the equipment other than any part of the main steering gear necessary to steer the ship in the event of failure of the main steering gear but not including the tiller, quadrant or components serving the same purpose.

5. Power actuating system means the hydraulic equipment provided for supplying power to turn the rudder stock, comprising a steering gear power unit or units, together with the associated pipes and fittings, and a rudder actuator. The power actuating systems may share common mechanical components, i.e. tiller, quadrant and rudder stock, or components serving the same purpose.

6. Maximum ahead service speed means the greatest speed which the ship is designed to maintain in service at sea at her deepest sea going draught at maximum propeller RPM and corresponding engine MCR.

7. Rudder actuator means the component which converts directly hydraulic pressure into mechanical action to move the rudder.

8. Maximum working pressure means the maximum expected pressure in the system when the steering gear is operated to comply with SOLAS II-1/29.3.2.

9. Hydraulic locking means all situations where two hydraulic systems (usually identical) oppose each other in such a way that it may lead to loss of steering. It can either be caused by pressure in the two hydraulic systems working against each other or by hydraulic “by-pass” meaning that the systems puncture each other and cause pressure drop on both sides or make it impossible to build up pressure.

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