Excerpt from ABS Rules Developed for Thrusters

Booklet developed on 1 January, 2026

Excerpt from ABS Rules Developed for Thrusters

American Bureau of Shipping

Incorporated by Act of legislature

of the State of New York 1862.

Disclaimer:

While every effort has been made to ensure the accuracy and completeness of the Vendor Rule Book, where there are discrepancies between the Vendor Rule Book content and the pdf versions of the Rules and Guides on American Bureau of Shipping (ABS) Eagle.org, the pdf versions from the web site are to be considered the official version.

ABS Plaza

1701 City Plaza Drive

Spring, Texas 77389 USA

CONTENTS

Foreword

Purpose

This booklet is an excerpt from the ABS Rules. It has been created to support equipment manufacturers in identifying the appropriate ABS Rules for their products.

Application

Equipment manufacturers seeking to have their products approved for marine and offshore applications under ABS classification or certification will find this booklet a practical reference for determining which sections of the ABS Rules are applicable to their specific equipment types.

This excerpt does not replace or supersede the complete ABS Rules. Users are responsible for consulting the full text of the applicable Rules and ensuring compliance with the most current edition, including any published corrigenda and notices.

Additional Information

For questions regarding the applicability of specific Rules to your equipment. Please contact your local ABS office.

The ABS Rules are available in their complete form at American Bureau of Shipping (ABS) Eagle.org.

1 General

1.1 Application (2024)

The requirements of this section apply to

- Maneuvering thrusters not intended for propulsion
- Azimuthal and non-azimuthal thrusters (and to alternative propulsion and steering systems without a rudder, as applicable) intended for propulsion, maneuvering or dynamic positioning
- A combination of these duties

Maneuvering thrusters intended to assist maneuvering and dynamic positioning thrusters, where fitted, may, at the request of the owners, be certified in accordance with the requirements of this section. In such cases, appropriate optional class notations as indicated in 1.3 will be assigned upon verification of compliance with corresponding requirements of this section.

Thrusters intended for propulsion, with or without combined duties for assisting in maneuvering or dynamic positioning, are to comply with the requirements of this section in association with other relevant requirements of Part 4, Chapter 3.

Thruster types not provided for in this section, such as cycloidal propellers, pump or water-jet type thrusters, are to be considered based on the manufacturer's submittal on design and engineering analyses.

Thrusters are to be constructed with sufficient strength, capacity and the necessary supporting systems to provide reliable propulsion and steering to the vessel in all operating conditions. ABS technical assessment and approval are to be given to the suitability of any essential component which is not duplicated.

For a vessel fitted with multiple steering systems, each steering system is to be so arranged that the failure of one of them will not render the other one inoperative. Each of the steering systems is equipped with its own dedicated steering gear, provided that each of the steering systems is fulfilling the requirements for main steering gear (as given in 4-3-4/1.10) and each of the steering systems is provided with an additional function for positioning and locking the failed steering system in a neutral position after a failure of its own power unit(s) and actuator(s).

1.2 Objective (2024)

1.2.1 Goals

The thrusters addressed in this section are to be designed, constructed, operated, and maintained to:

Goal No.	Goal
PROP 1	provide sufficient thrust/power to move or maneuver the vessel when required.
PROP 2	provide Redundancy and/or reliability to maintain propulsion.
PROP 3	*provide sufficient power for going astern, to secure proper control and bring the ship to rest in all normal circumstances.*
PROP 4	provide means to maneuver the vessel.
PROP 5	provide redundancy and/or reliability to maintain maneuverability.
PROP 6	*be provided with means to enable the safe conduct of mooring operations*
PROP 7	be provided with means to reduce the risk *of impending or imminent slowdown or shutdown.*
POW 2	provide power to enable the equipment to perform its required function necessary for the safe operation of the vessel.

Goal No.	Goal
FIR 4	*detect, contain control and suppress or swiftly extinguish a fire in the compartment of origin*
AUTO 1	perform its functions as intended and in a safe manner.
AUTO 2	indicate the system operational status and alert operators of any essential machinery/systems deviate from its defined design/operating conditions or intended performance.
AUTO 3	have an alternative means to enable safe operation in the event of an emergency or failure of remote control.
AUTO 4	provide the equivalent degree of safety and operability from a remote location as those provided by local controls.
SAFE 1.1	minimize danger to persons on board, the vessel, and surrounding equipment/installations from hazards associate with machinery and systems.
MGMT 1	provide for safe practices in ship operation and a safe working environment

Materials are to be suitable for the intended application in accordance with the following goals and support the Tier 1 goals as listed above.

Goal No.	Goal
MAT 1	The selected materials' physical, mechanical, and chemical properties are to meet the design requirements appropriate for the application, operating conditions, and environment.

The goals in the cross-referenced Rules are also to be met.

1.2.2 Functional Requirements

In order to achieve the above stated goals, the design, construction, and maintenance of thrusters are to be in accordance with the following functional requirements.

Functional Requirement No.	Functional Requirements
Materials (MAT)	
MAT-FR1	The material and manufactured components of the thruster are to withstand the maximum working stresses without any plastic deformation or fatigue failure.
MAT-FR2	Hardness to be considered for wear/abrasion resistance for material is exposed to seawater.
Propulsion (PROP)	
PROP-FR1	Single or multiple thruster systems are to be designed to provide single failure redundancy for performing the intended service for vessels.
PROP-FR2	Thrusters and components are to be designed to withstand the most severe conditions related to torque, stress, temperature, and vibrations.
PROP-FR3	Propeller blades and mechanisms are to withstand the maximum rated power without any plastic deformation or fatigue failure.
PROP-FR4	Bearings are to be able to withstand all loads anticipated during its service life in conjunction with an inspection/replacement program.
PROP-FR5	Provide means for inspection of gear train without disassembling thruster unit.
PROP-FR6	Provide steering system is to be capable of steering the vessel in any horizontal direction and rotating thrusters at maximum torque.
PROP-FR7 (POW)	Permanent magnet thrusters are to be designed to provide rated thrust power under all operating conditions.
Power (POW)	
POW-FR1	Prime movers are to be designed to provide power to thrusters to reliably propel and steer the vessel in all operating conditions.
Automation: Control, Monitoring and Safety Systems (AUTO)	
AUTO-FR1	Provide means to effectively operate, control and monitor the operation.

Functional Requirement No.	Functional Requirements
AUTO-FR2	Provide visual and audible notification upon occurrence of fault in the system to prevent overload.
AUTO-FR3	Provide means to communicate between each control station and thruster room.
AUTO-FR4 (SAFE)	Provide arrangement to monitor the bilge level and remove bilge from thruster compartments.
Safety of Personnel (SAFE)	
SAFE-FR1	Provide means for inspection of gear train without disassembling thruster unit.
Fire Safety (FIR)	
SAFE-FIR (SAFE)	Provide means to detect and extinguish a fire in thruster locations.
Safety Management (MGMT)	
MGMT-FR1 (PROP, POW & SAFE)	Provide means for ventilation of thruster rooms for continuous operations in all conditions.

The functional requirements covered in the cross-referenced Rules are also to be met

1.2.3 Compliance

A vessel is considered to comply with the goals and functional requirements within the scope of classification when the applicable prescriptive requirements are complied with or when an alternative arrangement has been approved. Refer to Part 1D, Chapter 2.

1.3 Class Notations

1.3.1 APS Notation **(2024)**

Self-propelled vessels, where fitted with thrusters capable of producing thrusts primarily in the athwartship direction and intended to assist in maneuvering the vessel, at the discretion of the owners, are to comply with the provisions requirements of 4-3-5/1 through 4-3-5/13 of this section and upon verification of compliance, the optional class notation *APS* (athwartship thruster) will be assigned.

1.3.2 PAS Notation **(2024)**

Non-self-propelled vessels, where fitted with thrusters to assist in the maneuvering or propelling while under tow, at the discretion of the owners, are to comply with the provisions requirements of 4-3-5/1 through 4-3-5/13 of this section; and upon verification of compliance, the optional class notation *PAS* (propulsion assist) will be assigned.

1.3.3 Dynamic Positioning Systems Notations

For dynamic positioning systems and associated notations, see the ABS *Guide for Dynamic Positioning Systems*.

1.5 Definitions

For the purpose of this section the following definitions apply:

1.5.1 Thruster

1.5.1(a) General.

Thrusters are devices capable of delivering side thrust or thrusts through 360° to improve the vessel's maneuverability particularly in confined waters. There are three generic types of thrust-producing devices: the lateral or tunnel thruster, commonly known as “bow-thruster”, which consists of a propeller installed in a athwartship tunnel; jet type thruster, which consist of a pump taking suction from the keel and discharge to either side; and azimuthal thruster, which can be rotated through 360° so that thrust can be developed in any direction. Cycloidal propellers can be considered a type of azimuthal thruster.

1.5.1(b) Propeller-type thruster.

Regardless of whether they are normally used for propulsion, propellers intended to be operated for an extended period of time during service in a condition where the vessel is not free running approximately along the direction of the thrust are to be considered thrusters for the purposes of this section.

1.5.2 Continuous Duty Thruster

A continuous duty thruster is a thruster designed for continuous operation, such as dynamic positioning thrusters, propulsion assist, or main propulsion units.

1.5.3 Intermittent Duty Thruster

An intermittent duty thruster is a thruster which is designed for operation at peak power or rpm levels, or both, for periods not exceeding one (1) hour followed by periods at the continuous rating or less, with total running time not exceeding eight (8) hours in twenty (20) hours. Such thrusters are not meant to operate more than 1000 hours per year.

1.5.4 Permanent Magnet Thruster **(2019)**

A permanent magnet thruster is built around a permanent magnet motor supported on roller bearings directly connected to a propeller or other thrust-producing device.

The prime mover is integrated directly into the thruster's housing, so the permanent magnet thruster consists of an electrically-wound stationary ring that is integrated into the thruster housing to form the stator and permanent magnets attached to the shaft to serve as the rotor of an electric motor. The thrust-producing device is attached to the permanent magnet electric motor.

1.5.5 Permanent Magnet Motor **(2019)**

A permanent magnet motor is a type of brushless electric motor that uses permanent magnets rather than windings in the rotor.

1.5.6 Declared Operational Limits **(2022)**

Declared steering angle limits and maximum rotational speed are operational limits in terms of maximum steering angle, and rotational speed, or equivalent, according declared guidelines for safe operation, also taking into account the vessel's speed or propeller torque/speed or other limitation. The "declared steering angle limits" and "maximum rotational speed" are to be established by the vessel's designer and shipbuilder based on the vessel specific non-traditional steering arrangements such as azimuth thrusters, azimuth pods, steering nozzles, etc. Vessels' maneuverability tests, such as IMO Standards for Ship Maneuverability, Resolution MSC.137(76) are to be carried out not exceeding the declared operational limits.

1.5.7 Steering Gear Power Unit **(1 July 2020)**

For purposes of alternative propulsion and steering arrangements, the steering gear power units are to be considered as defined in 4-3-4/1.5.2.

1.5.8 Steering System **(2024)**

A system designed to control the direction of movement of a vessel, including the rudder, steering gear, etc.

1.7 Plans and Particulars to be Submitted **(2024)**

Plans and particulars are to be submitted for information and for review in accordance with TABLE 1.

TABLE 1
Plans and Particulars to be Submitted (2024)

Document Description
General arrangements of the thruster installation containing as applicable the following: • Thruster room **(I)** • Local hull structure **(I)** • Thruster unit including driver and intermediate shafting **(I)** • Hydraulic system including tanks, circuit, flowrate, pressure, alarm and setpoints **(I)**
Foundations **(R)**
Watertight boundaries and fittings **(R)**
Data sheet including rated power, speed and thrust. **(R)**
For azimuthal thrusters the mechanical and control system for rotating and thruster assembly **(R)**
Operations and maintenance manual **(I)**
Plans and particulars for components associated with the thruster are to be submitted, as applicable: • Supporting structures **(R)**: Section 3-1-2 and 3-2-2/5.11 • Diesel engine prime mover **(R)**: 4-2-1/1.5 • Electric motor and controller **(R)**: 4-8-1/5.5.1 and 4-8-1/5.5.4 • Gearing **(R)**: 4-3-1/1.5 • Shafting, Clutches, Flexible Couplings **(R)**: 4-3-2/1.5 • Propellers **(R)**: 4-3-3/1.5 • Steering **(R)**: 4-3-4/1.11 • Piping system **(R)**: 4-6-1/9 • Hoses **(R)**: 4-6-2/5.7 • Control and instrumentation **(R)**: 4-9-1/7

Symbol Description

R: Documents to be reviewed;

I: Documentation for information and verification for consistency with related review.

3 Materials

3.1 General (2026)

Material specifications are to be in accordance with Part 2, Chapter 3 of the ABS *Rules for Materials and Welding (Part 2)* or other specifications approved under 4-3-5/3.3.1. Except as noted in 4-3-5/3.3, materials intended for thrusters required to be constructed under survey are to be tested and inspected in accordance with 4-3-5/13 TABLE 3. The material tests, where so indicated in 4-3-5/13 TABLE 3, are to be witnessed by the Surveyor.

Where alternative material specifications are proposed, complete chemical composition and mechanical properties similar to the material required by these Rules are to be submitted for approval.

Materials used in the construction of the steering equipment components are to comply with the requirements of 3-2-14/1.5, as applicable.

3.3 Alternative Materials and Tests

3.3.1 Alternative Specifications

Material manufactured to specifications other than those given in Part 2, Chapter 3 of the ABS *Rules for Materials and Welding (Part 2)* may be accepted, provided that such specifications are approved in connection with the design and are verified or tested in the presence of a Surveyor, as applicable, as complying with the specifications

3.3.2 Thruster Rated 375 kW (500 hp) or Less

Materials for thrusters of 375 kW (500 hp) or less, including shafting, gears, pinions, couplings and coupling bolts are accepted on the basis of the manufacturer's certified mill test reports and a satisfactory surface inspection and hardness check witnessed by a Surveyor.

3.3.3 Certification Under Quality Assurance Assessment **(1 July 2023)**

For thrusters certified under quality assurance assessment as provided for under 1, material tests required by 3.3 need not be witnessed by the Surveyor for the following components:

- Shafts, shaft flanges, keys
- Gears (propulsion and steering)
- Impellers
- Couplings
- Coupling bolts

Such tests may be conducted by the thruster manufacturer whose certified material test reports will be accepted instead.

5 Design

5.1 Prime Movers

5.1.1 Internal Combustion Engines

Internal combustion engines used for driving thrusters are to comply with the design, construction, testing and certification requirements of Part 4, Chapter 2. Engine support systems are to be in accordance with Section 4-6-5; except that standby pumps and similar redundancy specified for propulsion engines are not required for thruster engines.

5.1.2 Electric Motors

Electric motors driving thrusters are to comply with the design, construction, testing and certification requirements of Section 4-8-3. Power for thruster motors may be derived from ship service generators; except that precautions, such as interlock arrangements, are to be fitted to prevent starting except when there are enough generators on-line to support the starting and running of the thruster motor. All ship service generators may be put on line for this purpose, see 4-8-2/3.1.2.

5.1.3 Hydraulic Motors **(2024)**

Hydraulic motors delivering propulsion torque to thrusters are to be certified by the Surveyor at manufacturers' plants in accordance with 4-6-1/7.3. When applicable to optional notations *APS*, *PAS* and *DPS*, in addition to the required test, hydraulic motors are to be designed based on applicable pressure vessel and piping standards for pressure retaining components, allowable stress for torque components, and recognized standard for seals. As an alternative to design review, mass produced motors are accepted on the basis of specification review and a prototype test to 150% of the rated load, subject to agreement on design standards and manufacturing process.

5.3 Propellers

5.3.1 General

Thruster propellers are to comply with the requirements of Section 4-3-3, except as modified below.

5.3.2 Propeller Blades of Conventional Design

Where the propeller blades are of conventional design with skew angle not exceeding 25°, the thickness of the propeller blade is not to be less than determined by the following equations. Fillets at the root of the blades are not to be considered in the determination of the blade thickness.

5.3.2(a) Fixed pitch propellers.

The minimum required blade thickness at 0.25 radius, $t_{0.25}$, is to be determined by the following equations:

$$t_{0.25} = K_1\sqrt{\frac{AH}{C_nCRN}} \pm \left(\frac{C_s}{C_n}\right)\left(\frac{BK}{4C}\right) \quad \text{mm (in.)}$$

$$A = 1.0 + \frac{6.0}{P_{0.70}} + 4.3P_{0.25} \quad \text{for free running propellers;}$$

$$A = 7.2 + \frac{2.0}{P_{0.70}} + 4.3P_{0.25} \quad \text{For propellers performing bollard pull, athwartship thrusting, dynamic positioning and similar duties;}$$

$$B = \frac{4300wa}{N}\left(\frac{R}{100}\right)^2\left(\frac{D}{20}\right)^3$$

$$C = (1.0 + 1.5P_{0.25})\,(Wf - B)$$

Other symbols are defined in 5.3.2(d).

5.3.2(b) Controllable pitch propellers.

The minimum required blade thickness at 0.35 radius, $t_{0.35}$, is to be determined by the following equations:

$$t_{0.35} = K_2\sqrt{\frac{AH}{C_nCRN}} \pm \left(\frac{C_s}{C_n}\right)\left(\frac{BK}{6.3C}\right) \quad \text{mm (in.)}$$

$$A = 1.0 + \frac{6.0}{P_{0.70}} + 3P_{0.35} \quad \text{for free running propellers;}$$

$$A = 7.2 + \frac{2.0}{P_{0.70}} + 3P_{0.35} \quad \text{for non-free running propellers [see 5.3.2(a)]}$$

$$B = \frac{4900wa}{N}\left(\frac{R}{100}\right)^2\left(\frac{D}{20}\right)^3$$

$$C = (1.0 + 0.6P_{0.35})\,(Wf - B)$$

Other symbols are defined in 5.3.2(d).

5.3.2(c) Nozzle propellers (wide-tip blades).

The minimum required blade thickness at 0.35 radius, $t_{0.35}$, is to be determined by the following equations:

$$t_{0.35} = K_3\sqrt{\frac{AH}{C_nCRN}} \pm \left(\frac{C_s}{C_n}\right)\left(\frac{BK}{5.6C}\right)$$ mm (in.)

$$A = 1.0 + \frac{6.0}{P_{0.70}} + 2.8P_{0.35}$$ for free running propellers;

$$A = 7.2 + \frac{2.0}{P_{0.70}} + 2.8P_{0.35}$$ for non-free running propellers [see 5.3.2(a)]

$$B = \frac{4625wa}{N}\left(\frac{R}{100}\right)^2\left(\frac{D}{20}\right)^3$$

$$C = (1.0 + 0.6P_{0.35})\,(Wf - B)$$

Other symbols are defined in 5.3.2(d).

5.3.2(d) Symbols.

The symbols used in the above formulas are defined, in alphabetical order, as follows (the units of measure are in SI (MKS and US) systems, respectively):

α = expanded blade area divided by the disc area

α_s = area of expanded cylindrical section at 0.25 or 0.35 radius, as applicable; mm^2 (in^2)

C_n = section modulus coefficient at 0.25 or 0.35 radius, as applicable; to be determined by the following equation:

$$C_n = \frac{I_0}{U_f W T^2}$$

If the value of C_n exceeds 0.1, the required thickness is to be computed with C_n = 0.1.

C_s = section area coefficient at 0.25 or 0.35 radius, as applicable, to be determined by the following equation:

$$C_s = \frac{a_s}{WT}$$

The values of C_s and C_n computed as stipulated above are to be indicated on the propeller drawing. For vessels below 61 m (200 ft) in length, the required thickness is to be computed with the assumed values of C_n = 0.10 and C_s = 0.69.

D = propeller diameter; m (m, ft.)

f, w = material constants, see table below:

Material type	SI & MKS units		US units	
	f	w	f	w
2	2.10	8.3	68	0.30
3	2.13	8.0	69	0.29
4	2.62	7.5	85	0.27
5	2.37	7.5	77	0.27
CF-3	2.10	7.75	68	0.28

H = power at rated speed; kW (PS, hp)

I_0 = moment of inertia of the expanded cylindrical section at 0.25 or 0.35 radius about a straight line through the center of gravity parallel to the pitch line or to the nose-tail line; mm^4 (in^4)

K = rake of propeller blade, in mm (in.) (positive for aft rake and negative for forward rake)

K_1, K_2, and K_3 are constants and are to be of values as specified below:

	SI unit	*MKS unit*	*US unit*
K_1	337	289	13
K_2	271	232	10.4
K_3	288	247	11.1

N = number of blades

$P_{0.25}$ = pitch at 0.25 radius divided by propeller diameter

$P_{0.35}$ = pitch at 0.35 radius divided by propeller diameter, corresponding to the design ahead condition

$P_{0.7}$ = pitch at 0.7 radius divided by propeller diameter, corresponding to the design ahead condition

R = rpm at rated speed

T = maximum design thickness at 0.25 or 0.35 radius from propeller drawing mm (mm, in.)

$t_{0.25}$ = required thickness of blade section at 0.25 of propeller radius; mm (mm, in.)

$t_{0.35}$ = required thickness of blade section at 0.35 of propeller radius; mm (mm, in.)

U_f = maximum normal distance from the moment of inertia axis to points in the face boundary (tension side) of the section; mm (mm, in.)

W = expanded width of a cylindrical section at the 0.25 or 0.35 radius

5.3.3 Blades of Unusual Design **(2024)**

Propellers of unusual design for thruster duties, such as:

- Fixed pitch propellers of materials other than Type 4 with skew angle $25° < \theta \leq 50°$
- Fixed pitch propellers with skew angle $\theta > 50°$
- Controllable pitch propellers with skew angle $\theta > 25°$,
- Fixed pitch propellers with wide-tip blades and skew angle $\theta > 25°$,
- Controllable pitch propellers with wide-tip blades
- Rim driven blades
- Cycloidal propellers, etc.

are subject to ABS technical assessment and approval based on submittal of propeller load and stress analyses. See 4-3-3/5.7.

5.3.4 Propeller Blade Studs and Bolts

5.3.4(a) Area.

Studs used to secure propeller blades are to have cross-sectional area at the minor diameter of the thread of not less than that determined by the equations in 4-3-3/5.13.2.

5.3.4(b) Fit of studs and nuts.

Studs are to be fitted tightly into the hub and provided with effective means for locking. The nuts are also to have a tight-fitting thread and be secured by stop screws or other effective locking devices.

5.3.5 Blade Flange and Mechanism

The strength of the propeller blade flange and internal mechanisms of controllable-pitch propellers subjected to the forces from propulsion torque is to be determined as follows:

- For intermittent duty thrusters, be at least equal to that of the blade design pitch condition.
- For continuous duty thrusters, be at least 1.5 times that of the blade at design pitch condition.

5.3.6 Blade Pitch Control

Blade pitch control system is to comply with the requirements of 4-3-3/5.13.3, as applicable.

5.5 Gears

5.5.1 Continuous Duty Gears

Gears for continuous duty thrusters are to meet the requirements of Section 4-3-1.

5.5.2 Intermittent Duty Gears

Gears for intermittent duty thrusters as defined in 1.5.3 are to be in accordance with a recognized standard and are to be submitted for consideration. See e.g. Appendix 4-3-1-A1.

5.7 Shafts

5.7.1 Gear Shafts

Gear and pinion shaft diameters are to be determined by the equations in 4-3-1/5.9.

5.7.2 Propeller and Line Shafts

Shafting is to be in accordance with the requirements of 4-3-2/5.1 through 4-3-2/5.17, and cardan shafts, 4-3-2/5.21.

5.7.3 Couplings and Clutches

Shaft couplings, clutches, etc. are to be in accordance with the requirements of 4-3-2/5.19.

5.9 Anti-friction Bearings

Full bearing identification and life calculations are to be submitted. Calculations are to include all gear forces, thrust vibratory loads at maximum continuous rating, etc. The minimum L10 life is not to be less than the following:

i	Continuous duty thrusters (propulsion and dynamic positioning):	20,000 hours
ii	Intermittent duty thrusters:	5,000 hours

Shorter life is to be considered in conjunction with an approved bearing inspection/replacement program reflecting calculated life.See 4-3-4/5.9 for non-duplicated components.

5.11 Steering Systems for Vessel's Directional Control (2024)

Function of a steering mechanism is to rotate azimuthal thrusters for purpose of steering the vessel at any horizontal angles. The steering mechanism is to be capable of rotating thrusters delivering the maximum torque under all conditions.

Steering components such as pinion gears and slewing bearings are to meet the applicable requirements of Section 4-3-1, as applicable. Alternatively, gears that are rated based on the recognized standards can be accepted subject to ABS technical assessment and approval.

Hydraulic motors driving pinions for steering mechanisms are to be certified by the Surveyor at manufacturers' plants in accordance with 4-6-1/7.3.

Steering systems for azimuthal thrusters are to meet the requirements of Section 4-3-4, as applicable, and the following requirements.

5.11.1 Vessels with Only One Azimuthal Thruster (1 July 2020)

For vessels that are arranged with only one azimuthal thruster as the only means of propulsion and steering, the thruster is to be provided with steering systems of a redundant design such that a single failure in one system does not affect the other system. See 4-3-4/1.10.

5.11.2 Cargo Vessels with Multiple Azimuthal Thrusters (1 July 2025)

For cargo vessels that are arranged with multiple azimuthal thrusters as the only means of propulsion and steering, each thruster is to be provided with at least one steering system. The steering system for each thruster is to be independent of the steering system for the other thrusters. See 4-3-4/1.10.

On a case-by-case basis and where agreed by the flag Administration and ship owner, multiple thrusters as the only means of propulsion and steering may be accepted provided that the performance and steering capability of the vessel can be maintained in accordance with 4-3-4/1.10.3(a) while any one of the steering gear steering actuating systems is out of operation.

5.11.3 Passenger Vessels with Two Azimuthal Thrusters (1 July 2020)

For passenger vessels that are arranged with two azimuthal thrusters as the only means of propulsion and steering, each thruster is to be provided with steering systems of a redundant design such that a single failure in one system does not affect any other system. See 4-3-4/1.10.

5.12 Arrangements (1 July 2020)

See 4-3-4/1.10.

5.13 Access for Inspection

Adequate access covers are to be provided to permit inspection of gear train without disassembling thruster units.

5.15 Permanent Magnet Thruster (2019)

5.15.1 Plans to be Submitted (2024)

General arrangement drawings indicating the key principal dimensions and detailed drawings and documents showing the following information are to be submitted for review:

- Design specifications for permanent magnet motor, stator, housing, bearing, blades, and cables
- Detailed material and welding connections
- Thruster rating (e.g., torque, power, thrust, RPM)
- Water sealing arrangements, (ingress of seawater or cooling water results in motor damage)
- Electrical drawing for power supply from the generators, switchboards, transformers, converters
- Design analysis of permanent magnet fixation and fastening procedure
- Operational characteristics, including conditions, limitations, and restrictions
- Blade material specifications in accordance with recognized standards, including chemical, mechanical, fatigue, thermal expansion properties/characteristics, and effects from continuous exposure to/operation in sea water
- Methodology and detailed calculations determining the maximum loading on the blades (e.g., CFD analysis, model tank testing)
- Assessment of the blade vibration characteristics while in service, including blade natural frequency
- Detailed fabrication of the blade material, quality assurance methodology/programs applied, along with inspection and testing carried out
- Method of attaching the blades to the rotor, including details of the endurance/operational tests the manufacturer has run
- Detailed service history experience data available from previous units that have been in operation
- Any other information/arrangements/details that are considered necessary by the reviewing office
- Test plan, See

5.15.2 Structure

Refer to the applicable Rules for the structure requirements associated with azimuthing pods listed in 3-2-14/25.

5.15.3 Permanent Magnet Materials Standards

The permanent magnets are to be designed, constructed, and tested in accordance with a recognized code or standard.

5.15.4 Machinery and Electrical Systems

The requirements listed in 4-3-5/5.15 for machinery and electrical systems associated with the permanent magnet thruster are in addition to those listed in Part 4 of these Rules.

5.15.4(a) Permanent Magnet Motor.

Motors 100 kW and over intended for essential services are to be designed, constructed, and tested in accordance with the requirements of 4-8-3/3.

5.15.4(b) Water Seal System.

The interface between the stator and rotor is to maintain a water seal to prevent water leaking into the motor space resulting in motor failure.

5.15.4(c) Lubricating System.

Means are to be provided for preventing any damage/interruption of service lubricating carried in the water.

5.15.4(d) Prevent Rotation.

The permanent magnet thruster is to be fitted with arrangements for stopping the rotor for safety, and to limit the risk of fires.

5.15.4(e) Unusual Design Blade. **(2024)**

Propellers of unusual design for permanent magnet thrusters are subject to ABS technical assessment and approval based on the submittal of propeller load and stress analysis. See 5.3.3.

5.15.4(f) Instrumentation.

Alarms and instrumentation are to be provided in accordance with TABLE 2, as applicable.

5.15.5 Testing and Surveys

5.15.5(a) Surveys.

The permanent magnet motor is to be surveyed during manufacturing and testing in accordance with 4-8-3/3, as applicable.

5.15.5(b) Test Plan.

A Test Plan is to be developed for each permanent magnet thruster and is to be submitted to the ABS office responsible for performing the plan review at the start of the plan review process. Copies of the test plan are to be submitted to the ABS Survey office responsible for witnessing the tests and trials for the vessel, prior to performing any tests or trials. The test plan is to identify all equipment and systems and the recommended method of performing the tests or trials, taking into account that some tests or trials may have to occur earlier, since the equipment or system may not be completely accessible at the sea trials for the vessel.

5.15.5(c) Testing and Trials. **(1 July 2020)**

See 4-3-4/1.10.6.

7 Controls and Instrumentation

7.1 Control System **(2025)**

An effective means of controlling the thruster from the navigation bridge is to be provided. Control power is to be from the thruster motor controller or directly from the main switchboard. Propulsion thrusters are also to be fitted with local means of control.

Computer-based systems that provide control, alarm, monitoring, or safety functions are to comply with Section 4-9-3.

7.3 Instrumentation

Alarms and instrumentation are to be provided in accordance with TABLE 2, as applicable.

TABLE 2
Instrumentation for Thrusters (2019)

Monitored Parameter	Navigating Bridge	Main Control Station (1, 2)
Engine low lubricating oil pressure alarm	x (1)	x
Engine coolant high temperature alarm	x (1)	x
Motor overload alarm	x (1)	x
Thruster RPM	x	x
Thrust direction (azimuthing type)	x	x
Thruster power supply failure alarm	x	x
Controllable pitch propellers hydraulic oil low pressure alarm	x (1)	x
Controllable pitch propellers hydraulic oil high pressure alarm	x (1)	x
Controllable pitch propellers hydraulic oil high temperature alarm	x (1)	x
Fire detection	x	x
Permanent Magnet Thruster stator high temperature alarm	x	x
Permanent Magnet Thruster earth fault	x	x

Notes:

1. Either an individual indication or a common trouble alarm is to be fitted at this location, provided individual indication is installed at the equipment (or main control station)
2. For vessels not fitted with a main control station, the indication is to be installed at the equipment or other suitable location

7.5 Failure Detection and Response

Notwithstanding 7.1 and 7.3 above, 4-3-4/13.1.9 and 4-3-4/15 for steering gear, apply.

9 Communications

A means of voice communication is to be provided between the navigation bridge, main propulsion control station and the thruster room.

11 Miscellaneous Requirements for Thruster Rooms

11.1 Ventilation

Thruster rooms are to be provided with suitable ventilation so as to allow simultaneously for crew attendance and for thruster machinery to operate at rated power in all weather conditions.

11.3 Bilge System for Thruster Compartments

Thrusters installed in normally unattended spaces are to be arranged such that bilge pumping can be effected from outside the space. Alternatively, where bilge pumping can only be effected from within the space, a bilge alarm to warn of high bilge water level is to be fitted in a centralized control station, the navigation bridge, or other normally manned control station. For bilge systems, see 4-6-4/5.5.11.

Thrusters in enclosed modules (capsules) are to be provided with a high water level alarm. At least one pump capable of bilging the module is to be operable from outside the module.

11.5 Fire Fighting Systems

Spaces where thrusters are located, including enclosed modules, are to be protected with fire fighting system in accordance with 4-7-2/1.

13 Certification and Trial

13.1 Survey at the Shop of the Manufacturer **(2024)**

Thrusters and associated equipment are to be inspected, tested and certified by ABS in accordance with the following requirements, as applicable:

Diesel Engines:	Section 4-2-1
Gas Turbines:	Section 4-2-3
Electric Motors:	Section 4-8-3
Hydraulic Motors:	Section 4-6-1/7.3
Gears:	Section 4-3-1
Shafting , Clutches, Flexible Couplings :	Section 4-3-2
Propellers:	Section 4-3-3

Thrusters are to be inspected, tested after assembly in accordance with manufacturer’s test procedures and certified by ABS as shown in 4-1-1/9 TABLE 2 as applicable.

13.1.1 Material Tests **(2026)**

i. *Material Tests*
Materials entered into the construction of thrusters are to be tested in the presence of a Surveyor in accordance with the requirements of 4-3-5/Table 3 below. Materials are to satisfy the requirements as specified in Chapter 3 of the ABS *Rules for Materials and Welding (Part 2)*, or other accepted standards/ specifications approved in connection with design.

ii. *Nondestructive Tests*

Nondestructive Tests (NDT): Parts requiring ultrasonic tests (UT) and surface crack detection (CD) are to be tested in accordance with the requirements of the ABS *Rules for Materials and Welding (Part 2)* and/or the ABS *Requirements for Nondestructive Testing*.

The requirements related to testing, inspection and certification of thrusters and their components are listed in 4-3-5/Table 3 below:

TABLE 3
Required Material and Nondestructive Tests of Thruster Components

Thruster and Associated Parts	Material Properties (1)	Nondestructive Tests (2) & Inspections		Visual Inspection and Component Certificate	
		Magnetic Particle, Liquid Penetrant, or Similar Tests, Ultrasonic Tests	Dimensional Inspection, Including Surface Condition	Visual Inspection (Surveyor)	Component Certificate
Shaft, Shaft Flange, Keys(3)	SC(C+M)	W (UT+CD)	W	X	SC
Gears(4)	SC(C+M)	W (UT+CD)	W	X	SC
Propellers(5)	SC(C+M)	W (CD)	W	X	SC
Impellers	SC(C+M)	NA	W	X	SC
Couplings	SC(C+M)	NA	W	X	SC
Coupling Bolts, Blade Bolts(6)	SC(C+M)	W (UT+CD)	W	X	SC
Piston Rods, Crank Pin Rings, Guide Pins(7)	SC(C+M	W (UT+CD)	W	X	SC
Thruster and Associated Parts	*Material Properties (1)*	*Nondestructive Tests (2) & Inspections*		*Visual Inspection and Component Certificate*	
		Magnetic Particle, Liquid Penetrant, or Similar Tests, Ultrasonic Tests	*Dimensional Inspection, Including Surface Condition*	*Visual Inspection (Surveyor)*	*Component Certificate*
Shaft, Shaft Flange, Keys(3)	SC(C+M)	W (UT+CD)	W	X	SC
Gears(4)	SC(C+M)	W (UT+CD)	W	X	SC
Propellers(5)	SC(C+M)	W (CD)	W	X	SC
Impellers	SC(C+M)	NA	W	X	SC
Couplings	SC(C+M)	NA	W	X	SC
Coupling Bolts, Blade Bolts(6)	SC(C+M)	W (UT+CD)	W	X	SC
Piston Rods, Crank Pin Rings, Guide Pins(7)	SC(C+M	W (UT+CD)	W	X	SC

Symbol Description:

C: chemical composition; CD: crack detection by MPI or DP; M: mechanical properties; SC: Society certificate; UT: ultrasonic testing; W: Work's certificate; X: visual examination of accessible surfaces by the Surveyor.

Notes:

1. Material properties include chemical composition and mechanical properties, and also surface treatment such as surface hardening (hardness, depth and extent), peening and rolling (extent and applied force).
2. Nondestructive examination means (e.g., ultrasonic testing, crack detection by MPI or DP) (see 4-2-1/13.2.3).
3. Material requirements for shafting are to comply with Section 4-3-2.
4. Material requirements for ge\ars are to comply with Section 4-3-1.
5. Thruster propellers are to comply with the requirements of Section 4-3-3, except as modified in 4-3-5/5.3.
6. Bolts manufactured to a recognized standard and used as coupling bolts need not to be tested in the presence of a Surveyor.
7. Piston rods, crank pin rings, and other torque transmitting components of internal mechanism of controllable pitch propellers.

13.3 Sea Trial

Upon completion of the installation, performance tests are to be carried out in the presence of a Surveyor in a sea trial. This is to include but not limited to running tests at intermittent or continuous rating and maneuvering tests not to exceed the declared operational limits.

13.5 Sea Trial Results

The stopping times, vessel headings and distances recorded on trials, together with the results of trials to determine the ability of vessel's having multiple propulsion/steering arrangements to navigate and maneuver with one or more of these devices inoperative, are to be available on board for the use of the Master or designated personnel.

15 Notification of Declared Operational Limits

At each position where the directional control system can be operated, the declared operational limits are to be permanently indicated by a placard.