



PART 4

CHAPTER 3 Propulsion and Maneuvering Machinery

SECTION 6 Waterjets

1 General (2024)

1.1 Application (1 July 2020)

The requirements of this section apply to all propulsion waterjets, steerable as well as non-steerable. Where waterjets are steerable, the requirements in 4-3-4/1.10 are also applicable.

Waterjets units installed on vessels over 24 m (79 ft) for propulsion, are to be designed, constructed, certified and installed in accordance with the requirements of this section.

Waterjets units installed on vessels 24 m (79 ft) and below for propulsion, are to be designed, constructed and installed in accordance with the requirements of this section. Also see 1.1 TABLE 1.

TABLE 1
Certification of Waterjets for Propulsion (2024)

<i>Water Jets</i>	<i>Certificate Type</i>	<i>Design Assessed</i>	<i>Manufacture Survey</i>	<i>Installation Surveyor attendance</i>	<i>Sea Trial Surveyor Attendance</i>
for vessels for ≤ 24 m (79 ft) in length	W	x	=	x	x
for vessels for > 24 m (79 ft) in length	SC	x	x	x	x

Symbol Description

SC: Society Certificate

W: Work's Certificate

1.2 Objective (2024)

1.2.1 Goals

Waterjets covered in this section are to be designed, constructed, operated, and maintained to:

<i>Goal No.</i>	<i>Goals</i>
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	<i>Provide sufficient power for going astern, to secure proper control and bring the ship to rest in all normal circumstances.</i>
PROP 4	Provide means to maneuver the vessel.
PROP 5	Provide redundancy and/or reliability to maintain maneuverability.
PROP 6	<i>Be provided with means to enable the safe conduct of mooring operations</i>
PROP 7	<i>be provided with means to reduce the risk of impending or imminent slowdown or shutdown.</i>
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 deviation from their 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.

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

<i>Goal No.</i>	<i>Goal</i>
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 water jets are to be in accordance with the following functional Requirements.

<i>Functional Requirement No.</i>	<i>Functional Requirements</i>
Materials (MAT)	
MAT-FR1	The material and manufactured components for waterjets are to withstand the maximum working stresses without any deformation or fatigue failure.
MAT-FR2	Hardness to be considered for wear/abrasion resistance. Hardness also to be considered when the material is exposed to seawater.
MAT-FR3	Avoid galvanic corrosion due to dissimilar materials.
Propulsion (PROP)	
PROP-FR1	Single or multiple waterjet systems are designed to provide single failure redundancy for continuous operation.
PROP-FR2	Waterjets and components are to be designed to withstand the most severe conditions related to torque, stress, temperature, and vibrations.
PROP-FR3	Astern thrust is to be provided for controlling the vessel in all operating conditions.

<i>Functional Requirement No.</i>	<i>Functional Requirements</i>
PROP-FR4	Bearings are to be able to withstand all loads anticipated during their service life in conjunction with an inspection/replacement program.
PROP-FR5	Provide means to prevent water ingress to shafts not exposed to water.
Automation: Control, Monitoring and Safety Systems (AUTO)	
AUTO-FR1	Provide means to effectively operate, control and monitor the waterjet operation.
AUTO-FR2	Provide visual and audible notification upon occurrence of fault in the system, preventing overload.

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 Plans and Particulars to be Submitted (2024)

Detailed plans are to be submitted for the force transmitting parts of waterjet units, including material specifications, as indicated in 1.3 TABLE 2 below:

TABLE 2
Plans and Particulars to be Submitted (2024)

<i>Description</i>
General arrangements of the waterjet installation containing as applicable the following: - Waterjet room (I) - Local hull structure (I) - Waterjet unit including driver and intermediate shafting (I) - Hydraulic system including tanks, circuit, flowrate and pressure, alarm and setpoints (I) - Lubrication oil system including tanks, circuit, flowrate and pressure, alarm and setpoints (I)
Foundations (R)
Watertight boundaries and fittings (R)
Data sheet including: (R) - Rated power, - Impeller speed, - Vessel speed, - Thrust and - Operations limitations including cavitation limits and impeller speed vs. vessel speed
Shafting and components (R)
Impeller (R)
Stator housing (R)
Shafting and components (R)
Casing (R)
Steering and reversing mechanism (R)
Actuators (R)

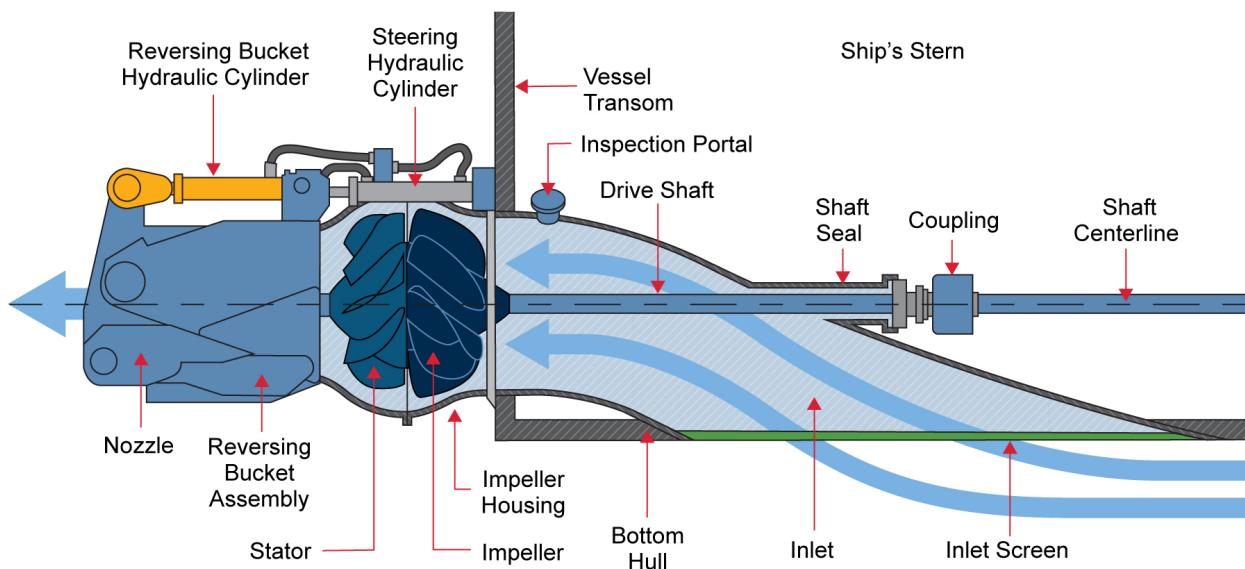
<i>Description</i>
Control and monitoring system (R)
Operations and maintenance manual (I)
Detailed design analysis (I)
Material specifications (I)

Symbol Description:

R: Documents to be reviewed

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

FIGURE 1
Illustration of a Typical Waterjet System (2024)



3 Materials

Mill certificates are to be provided for the components of the steering section. The material tests for the impellers, shafts and couplings are to be witnessed by the Surveyor. The use of galvanically dissimilar metallic materials is to be considered in the waterjet design.

TABLE 3
Required Material and Nondestructive Tests of Waterjet Components (2024)

Waterjet Part	Material Properties	Nondestructive Tests and 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
Shafts	SC(C+M)	W (UT+CD)	W	X	SC
Impeller	SC(C+M)	W (UT+CD)	W	X	SC

Waterjet Part	Material Properties	Nondestructive Tests and 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
Couplings	SC(C+M)	W (UT+CD)	W	X	SC
Actuators for Reversing	SC(C+M)	W (UT+CD)	W	X	SC
Actuators for Steering	SC(C+M)	W (UT+CD)	W	X	SC
Casing/Housing	W(C+M)				W

Symbol Description:

C: chemical composition; CD: crack detection by MPI or DP; D: cylinder bore diameter (mm); GJL: gray cast iron; GJS: spheroidal graphite cast iron; GS: cast steel; M: mechanical properties; SC: Society certificate; TR: test report; UT: ultrasonic testing; W: Work's certificate; X: visual examination of accessible surfaces by the Surveyor

5 Design (2024)

5.1 Factor of Safety (2024)

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

For a vessel fitted with multiple steering systems, each steering system is to be so arranged that the failure of one will not render the other inoperative. Each steering system is to be equipped with its own dedicated steering gear, provided that it is fulfilling the requirements for main steering gear (as given in 4-3-4/1.10) and each steering system 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).

Commentary:

Refer to IACS UI SC242 for additional details pertaining to propulsion and steering systems other than traditional arrangements with a rudder, such as waterjets.

End of Commentary

Design basis stress calculations for the impellers, shafting, steering mechanism, and reversing mechanism are to be submitted to substantiate the suitability and strength of component parts for the intended service. For the purpose of design review the stress calculations are to cover the “worst case” condition for each component. The factor of safety for the above components is not to be less than 2.0 when determined by the following equation:

$$\frac{1}{FS} = \frac{S_s}{U} + \frac{S_a}{E}$$

nor less than 4.0 when determined by the following equation:

$$FS = \frac{U}{S_s}$$

where

FS	=	factor of safety
S_s	=	steady stress of low cycle alternating stress
S_a	=	alternating stress
U	=	ultimate tensile strength of material
E	=	corrected fatigue strength of material (based on 10^8 cycles)

5.2 Housings

Calculations or test results to substantiate the suitability and strength of the pressure and suction housing are to be submitted for review. The condition with the inlet of the suction blocked is also to be considered. A factor of safety of not less than 4 based on the ultimate tensile strength of the material (or 2 based on the yield strength) is to be maintained at each point in the housing.

Housing are to be hydrostatically tested to 1.5 times the maximum working pressure or to 3.4 bar (3.5 kgf/cm², 50 psi) whichever is greater.

5.3 Reversing Mechanisms

Astern thrust is to be provided in sufficient amounts to secure proper control of the vessel in all normal circumstances. The reversing mechanism is to provide for reversing at full power.

5.4 Impeller Bearings

Antifriction bearings are to have a B10 life of at least 80,000 hours.

5.5 Hydraulic Cylinders (2020)

Hydraulic cylinders are to be manufactured and inspected in accordance with the requirements of 4-6-7/3.5.5.

5.6 Shaft Seals (2020)

Approved type shaft seals are to be used.

7 Control and Instrumentation (2024)

7.1 Control System

Effective means of controlling the waterjet from the navigation bridge are to be provided. Control power is to be from the waterjet motor controller or directly from the main switchboard. Waterjets are also to be fitted with means for local control.

7.3 Instrumentation

Alarms and instrumentation are to be provided as indicated below in 7.3 TABLE 4, as applicable:

TABLE 4
Instrumentation for Waterjets

<i>Monitored Parameters</i>	<i>Navigation Bridge</i>	<i>Main Control Station</i>
Engine low lubricating oil pressure alarm	x ⁽¹⁾	x
Engine coolant high temperature alarm	x ⁽¹⁾	x
Motor overload alarm	x ⁽¹⁾	x
Waterjet power supply failure alarm	x	x

<i>Monitored Parameters</i>	<i>Navigation Bridge</i>	<i>Main Control Station</i>
Waterjet RPM	x	x
Waterjet RPM versus vessel speed high ratio	x ⁽¹⁾	x
Steering and reversing failure alarm	x ⁽¹⁾	x
Hydraulic oil pressure Low	x	x
Hydraulic oil reservoir low level	x ⁽¹⁾	x
Lubricating oil temperature high	x ⁽¹⁾	x
Lubricating oil pressure Low	x	x
Lubricating oil reservoir low level	x ⁽¹⁾	
Thrust direction (for steerable waterjets)	x	x
Fire detection	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, the system response under failure in 4-3-4/13.1.9 and instrumentation for monitoring in 4-3-4/15 for steering gear are also applicable.

9 Survey at Manufacturer's Facility (2024)

Components of waterjets are to be inspected, tested and certified by ABS as shown in 3.

11 Sea Trials (2024)

Upon installation, performance tests are to be carried out in the presence of a Surveyor during sea trials as per 4-1-1/9. See also 4-3-4/1.10.6