

SECTION 10 TESTS ON BOARD

1 General

1.1 Application

1.1.1 This Section covers shipboard tests, both at the moorings and during sea trials. Such tests are additional to the workshop tests required in the other Sections of this Chapter.

1.2 Purpose of shipboard tests

1.2.1 Shipboard tests are intended to demonstrate that the main and auxiliary machinery and associated systems are functioning properly, in respect of the criteria imposed by the Rules. The tests are to be witnessed by a Surveyor.

1.3 Documentation to be submitted

1.3.1 A comprehensive list of the shipboard tests intended to be carried out by the shipyard is to be submitted to the Society.

For each test, the following information is to be provided:

- scope of the test
- parameters to be recorded.

2 General requirements for shipboard tests

2.1 Trials at the moorings

2.1.1 Trials at the moorings are to demonstrate the following:

- a) satisfactory operation of the machinery.
- b) quick and easy response to operational commands.
- c) protection of the various installations, as regards:
 - the protection of mechanical parts
 - the safeguards for personnel.
- d) accessibility for cleaning, inspection and maintenance.

Where the above features are not deemed satisfactory and require repairs or alterations, the Society reserves the right to require the repetition of the trials at the moorings, either wholly or in part, after such repairs or alterations have been carried out.

2.2 Sea trials

2.2.1 Scope of the tests

Sea trials are to be conducted after the trials at the moorings and are to include the following:

- a) demonstration of the proper operation of the main and auxiliary machinery, including monitoring, alarm and safety systems, under realistic service conditions

- b) check of the propulsion capability when one of the essential auxiliaries becomes inoperative
- c) detection of dangerous vibrations by taking the necessary readings when required.

2.2.2 Yachts in a series

If the builder is granted with a BV Mode I survey certificate, and for yachts manufactured in a series, the sea trials of a prototype of the series provided they have been satisfactorily attended by the Surveyor. The MTI plan is to precise basin test on the series yachts.

3 Shipboard tests for machinery

3.1 Conditions of sea trials

3.1.1 Sea trials conditions

Except in cases of practical impossibility, or in other cases to be considered individually, the sea trials are to be carried out:

- with the yacht in the completed condition with permanently installed engine(s) - where applicable - and all usual equipment in place
- under weather and sea conditions corresponding as far as possible to the conditions for which the yacht is intended to operate
- when fitted, with an engine of the largest power for which it has been approved
- in light weight and fully loaded condition.

3.1.2 Power of the machinery

- a) The power developed by the propulsion machinery in the course of the sea trials is to be as close as possible to the power for which classification has been requested. In general, this power is not to exceed the maximum continuous power at which the weakest component of the propulsion system can be operated. In cases of diesel engines and gas turbines, it is not to exceed the maximum continuous power for which the engine type concerned has been approved
- b) Where the rotational speed of the shafting is different from the design value, thereby increasing the stresses in excess of the maximum allowable limits, the power developed in the trials is to be suitably modified so as to confine the stresses within the design limits.

3.1.3 Determination of the power and rotational speed

- a) The rotational speed of the shafting is to be recorded in the course of the sea trials, preferably by means of a continuous counter

- b) In general, the power is to be determined by means of torsionometric readings, to be effected with procedures and instruments deemed suitable by the Society

As an alternative, for reciprocating internal combustion engines, the power may be determined by measuring the fuel consumption and on the basis of the other operating characteristics, in comparison with the results of bench tests of the prototype engine

Other methods of determining the power may be considered by the Society on a case by case basis.

3.2 Navigation and manoeuvring tests

3.2.1 Speed trials

- a) Where required by the Rules, the speed of the yacht is to be determined using procedures deemed suitable by the Society
- b) The yacht speed is to be determined as the average of the speeds taken in not less than two pairs of runs in opposite directions.

3.2.2 Astern trials

- a) The ability of the machinery to reverse the direction of thrust of the propeller in sufficient time, and so to bring the yacht to rest within reasonable distance from maximum ahead service speed, is to be demonstrated and recorded
- b) The stopping times, yacht headings and distances recorded on trials, together with the results of trials to determine the ability of yachts having multiple propellers to navigate and manoeuvre with one or more propellers inoperative, are to be available on board for the use of the Master or designated personnel
- c) Where the yacht is provided with supplementary means for manoeuvring or stopping, the effectiveness of such means is to be demonstrated and recorded as referred to in items a) and b).

For electric propulsion systems, see [3.4].

3.3 Tests of diesel engines

3.3.1 General

- a) The scope of the trials of diesel engines may be expanded in consideration of the special operating conditions, such as towing, trawling, etc.
- b) Where the machinery installation is designed for residual or other special fuels, the ability of engines to burn such fuels is to be demonstrated.

3.3.2 Main propulsion engines driving fixed propellers

Sea trials of main propulsion engines driving fixed propellers are to include the following tests:

- a) operation at rated engine speed n_0 for at least 4 hours
- b) operation at engine speed corresponding to normal continuous cruise power for at least 2 hours

- c) operation at engine speed $n = 1,032 n_0$ for 30 minutes

Note 1: The present test is to be performed only where permitted by the following engine adjustment:

After running on the test bed, the fuel delivery system is to be so adjusted that the engine cannot deliver more than 100% of the rated power at the corresponding speed {overload power cannot be obtained in service}.

- d) operation at minimum load speed
- e) starting and reversing manoeuvres
- f) operation in reverse direction of propeller rotation at a minimum engine speed of $n = 0,7 n_0$ for 10 minutes

Note 2: The present test may be performed during the dock or sea trials

- g) tests of the monitoring, alarm and safety systems
- h) for engines fitted with independently driven blowers, emergency operation of the engine with the blowers inoperative.

3.3.3 Main propulsion engines driving controllable pitch propellers or reversing gears

- a) The scope of the sea trials for main propulsion engines driving controllable pitch propellers or reversing gears is to comply with the relevant provisions of [3.3.2].
- b) Engines driving controllable pitch propellers are to be tested at various propeller pitches.

3.3.4 Engines driving generators for propulsion

Sea trials of engines driving generators for propulsion are to include the following tests:

- a) operation at 100% power (rated power) for at least 4 hours
- b) operation at normal continuous cruise power for at least 2 hours
- c) operation at 110% power for 30 minutes
- d) operation in reverse direction of propeller rotation at a minimum engine speed 70% of the nominal propeller speed for 10 minutes

Note 1: The present test may be performed during the dock or sea trials.

- e) starting manoeuvres
- f) tests of the monitoring, alarm and safety systems.

Note 2: The above six tests are to be performed at rated speed with a constant governor setting. The powers refer to the rated electrical powers of the driven generators.

3.3.5 Engines driving auxiliaries

- a) Engines driving generators or important auxiliaries are to be subjected to an operational test for at least 4 hours. During the test, the set concerned is required to operate at its rated power for at least 2 hours
- b) It is to be demonstrated that the engine is capable of supplying 100% of its rated power and, in the case of shipboard generating sets, account is to be taken of the times needed to actuate the generator's overload protection system.

3.4 Tests of electric propulsion system

3.4.1 Dock trials

- a) The dock trials are to include the test of the electrical production system, the power management and the load limitation.
- b) A test of the propulsion plant at a reduced power, in accordance with dock trial facilities, is to be carried out. During this test, the following are to be checked:
 - electric motor rotation speed variation
 - functional test, as far as practicable (power limitation is to be tested with a reduced value)
 - protection devices
 - monitoring and alarm transmission including interlocking system.
- c) Prior to the sea trials, an insulation test of the electric propulsion plant is to be carried out.

3.4.2 Sea trials

Testing of the performance of the electric propulsion system is to be effected in accordance with an approved test program.

This test program is to include at least:

- Speed rate of rise
- Endurance test:
 - operation at normal continuous cruise power for at least 4 hours
 - 1 hour at 100% rated output power with winding temperature rise below 2°K per hour, according to IEC publication 60034-1
 - operation in reverse direction of propeller rotation at the maximum torque or thrust allowed by the propulsion system for 10 minutes
- Check of the crash astern operation in accordance with the sequence provided to reverse the speed from full ahead to full astern, in case of emergency. During this test, all necessary data concerning any effects of the reversing of power on the generators are to be recorded, including the power and speed variation
- Test of functionality of electric propulsion, when manoeuvring and during the yacht turning test
- Test of power management performance: reduction of power due to loss of one or several generators to check, in each case, the power limitation and propulsion availability.

3.5 Tests of gears

3.5.1 Tests during sea trials

During the sea trials, the performance of reverse and/or reduction gearing is to be verified, both when running ahead and astern.

In addition, when the power per shaft line exceeds 220 kW, the following checks are to be carried out:

- check of the bearing and oil temperature
- detection of possible gear hammering, where required by Part C, Ch1, Sec 9, [3.5.1] of the Rules for Steel Rules.
- test of the monitoring, alarm and safety systems.

3.5.2 Check of the tooth contact

When the power per shaft line exceeds 220 kW, the following checks are to be carried out:

- a) Prior to the sea trials, the tooth surfaces of the pinions and wheels are to be coated with a thin layer of suitable coloured compound.

Upon completion of the trials, the tooth contact is to be inspected. The contact marking is to appear uniformly distributed without hard bearing at the ends of the teeth and without preferential contact lines.

The tooth contact is to comply with Tab 1.

- b) The verification of tooth contact at sea trials by methods other than that described above will be given special consideration by the Society.
- c) The tooth contact is to be checked when the casing is cast steel.

In the case of reverse and/or reduction gearing with several gear trains mounted on roller bearings, manufactured with a high standard of accuracy and having an input torque not exceeding 20000 N·m, the check of the tooth contact may be reduced at the Society's discretion.

Such a reduction may also be granted for gearing which has undergone long workshop testing at full load and for which the tooth contact has been checked positively.

In any case, the teeth of the gears are to be examined by the Surveyor after the sea trials. Subject to the results, additional inspections or re-examinations after a specified period of service may be required.

Table 1 : Tooth contact for gears

Heat treatment and machining	Percentage of tooth contact	
	across the whole face width	of the tooth working depth
quenched and tempered, cut	70	40
<ul style="list-style-type: none"> • quenched and tempered, shaved or ground • surface-hardened 	90	40

3.6 Tests of main propulsion shafting and propellers

3.6.1 Shafting alignment

Where alignment calculations are required to be submitted in pursuance of Ch 1, Sec 2, [4.2.6], the alignment conditions are to be checked on board by the Shipyard, as follows:

- a) shafting installation and intermediate bearing position, before and during assembling of the shafts:
 - optical check of the relative position of bushes after fitting
 - check of the flanged coupling parameters (gap and sag)
 - check of the centring of the shaft sealing glands.

- b) engine (or gearbox) installation, with floating yacht:
- check of the engine (or gearbox) flanged coupling parameters (gap and sag)
 - check of the crankshaft deflections before and after the connection of the engine with the shaft line, by measuring the variation in the distance between adjacent webs in the course of one complete revolution of the engine.

Note 1: The yacht is to be in the loading conditions defined in the alignment calculations.

- c) load on the bearings:
- check of the intermediate bearing load by means of jack-up load measurements
 - check of the bearing contact area by means of coating with an appropriate compound.

3.6.2 Shafting vibrations

Torsional vibration measurements are to be carried out where required by Ch 1, Sec 2, [6.1.1]. The type of the measuring equipment and the location of the measurement points are to be specified.

3.6.3 Bearings

The temperature of the bearings is to be checked under the machinery power conditions specified in [3.1.2].

3.6.4 Stern tube sealing gland

The stern tube oil system is to be checked for possible oil leakage through the stern tube sealing gland.

3.6.5 Propellers

- For controllable pitch propellers, the functioning of the system controlling the pitch from full ahead to full astern position is to be demonstrated. It is also to be checked that this system does not induce any overload of the engine.
- The proper functioning of the devices for emergency operations is to be tested during the sea trials.

3.7 Tests of piping systems

3.7.1 Hydrostatic tests of piping after assembly on board

- When the hydrostatic tests of piping referred to in Ch 1, Sec 4, [10.4.2] are carried out on board, they may be carried out in conjunction with the leak tests required in [3.7.2]
- Low pressure pipes, such as bilge or ballast pipes are to be tested, after fitting on board, under a pressure at least equal to the maximum pressure to which they can be subjected in service
- Fuel pipes are to be subjected, after fitting on board, to a hydraulic test under a pressure not less than 1,5 times the design pressure, with a minimum of 4 bars.

3.7.2 Leak tests

Except otherwise permitted by the Society, all piping systems are to be leak tested under operational conditions after completion on board at a pressure not less than:

- 1,25 times the design pressure p , if welded joints have been made on board, or
- the setting pressure of safety valves or other overpressure protective devices in the alternative case.

3.7.3 Functional tests

During the sea trials, piping systems serving propulsion and auxiliary machinery, including the associated monitoring and control devices, are to be subjected to functional tests at the nominal power of the machinery. Operating parameters (pressure, temperature, consumption) are to comply with the values recommended by the equipment manufacturer.

3.7.4 Performance tests

The Society reserves the right to require performance tests, such as flow rate measurements, should doubts arise from the functional tests.

3.8 Tests of steering gear

3.8.1 General

- The steering gear is to be tested during the sea trials under the conditions stated in [3.1] in order to demonstrate, to the Surveyor's satisfaction, that the applicable requirements of Ch 1, Sec 3 are fulfilled
- For controllable pitch propellers, the propeller pitch is to be set at the maximum design pitch approved for the maximum continuous ahead rotational speed
- If the yacht cannot be tested at the deepest draught, alternative trial conditions will be given special consideration by the Society. In such case, the yacht speed corresponding to the maximum continuous number of revolutions of the propulsion machinery may apply.

3.8.2 Tests to be performed

Tests of the steering gear are to include at least:

- functional test of the main and auxiliary steering gear with demonstration of the performances required by Ch 1, Sec 3
- test of the steering gear power units, including transfer between steering gear power units
- test of the isolation of one power actuating system, checking the time for regaining steering capability
- test of the hydraulic fluid refilling system
- test of the alternative power supply required by Ch 1, Sec 3
- test of the steering gear controls, including transfer of controls and local control
- test of the means of communication between the navigation bridge, the engine room and the steering gear compartment
- test of the alarms and indicators

- i) where the steering gear design is required to take into account the risk of hydraulic locking, a test is to be performed to demonstrate the efficiency of the devices intended to detect this.

Note 1: Tests d) to i) may be carried out either during the mooring trials or during the sea trials.

Note 2: For yachts of length less than 24 m, the Society may accept departures from the above list, in particular to take into account the actual design features of their steering gear.

Note 3: Azimuth thrusters are to be subjected to the above tests, as far as applicable.

4 Inspection of machinery after sea trials

4.1 General

4.1.1

- a) For all types of propulsion machinery, those parts which have not operated satisfactorily in the course of the sea trials, or which have caused doubts to be expressed as to their proper operation, are to be disassembled or opened for inspection.

Machinery or parts which are opened up or disassembled for other reasons are to be similarly inspected.

- b) Should the inspection reveal defects or damage of some importance, the Society may require other similar machinery or parts to be opened up for inspection.
- c) An exhaustive inspection report is to be submitted to the Society for information.

4.2 Diesel engines

4.2.1

- a) For all diesel engines, where it is technically possible, the following items are to be verified:
- the deflection of the crankshafts
 - the cleanliness of the lubricating oil filters.
- b) In the case of propulsion engines for which power tests have not been carried out in the workshop, some parts, agreed upon by the interested parties, are to be disassembled for inspection after the sea trials.