

**RULES  
FOR THE CLASSIFICATION OF  
SHIPS**

*Part 9 – MACHINES  
January 2018*

*Amendments No. 3  
July 2019*

**CROATIAN REGISTER OF SHIPPING**

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By the decision of the General Committee of Croatian Register of Shipping,

Amendments No. 3 to the  
**RULES FOR THE CLASSIFICATION OF SHIPS**  
PART 9 – Machines, edition January 2018

have been adopted on 17th June 2019 and shall enter into force on 1st July 2019

## INTRODUCTORY NOTES

These amendments are necessary to read together with the requirements in the Rules for the Classification of Ships, Part 9 - Machines, edition January 2018 as amended by Amendments No. 1, edition July 2018 and by as amended by Amendments No. 2, edition January 2019.

Table 1 contains review of amendments, where items changed or added in relating to previous edition are given, with short description of each modification or addition. All major changes throughout the text are shaded.

The purpose of issuing of these amendments is to provide compliance with is to provide compliance with IACS Unified Requirements UR M51 (Corr.1 Oct 2018).

The subject Rules are including the requirements of the following international Organisations:

**International Maritime Organization (IMO)**

Conventions: International Convention for the Safety of Life at Sea 1974 (SOLAS 1974) and all subsequent amendments up to and including the 2014 amendments (MSC.365/93)  
Protocol of 1988 relating to the International Convention for the Safety of Life at Sea 1974, as amended (SOLAS PROT 1988)

Circulars: MSC.1/Circ.1425

**International Association of Classification Societies (IACS)**

Unified Requirements (UR): A3 (2017), F29 (Rev. 6, 2005), M2 ( 1971), M3 (Rev. 5, 2006), M9 (Corr. 2, 2007), M10 (Rev. 4, 2013), M11 (1972), M12 (1972), M16 (Rev. 1, 2005), M26 (Corr. 1, 2005), M28 (1978), M42 (Rev. 4, 2011), M44 (Corr.2, Nov 2016), M51 (Corr. 1, Oct 2018), M53 (Rev. 3, 2017), M56 (Rev. 3, 2015), M59 (1996), M60 (1997), M61 (2003), M63 (2005), M66 (Rev. 3, 2008), M67 (Rev. 2, 2015), M71 (Corr.1, 2016), M72 (Rev.1, 2016), M73 (Corr.1, 2016), Z26 (2015)

Unified Interpretations (UI): SC76 (1985), SC94 (Corr. 1, Jan 2018), SC133 (1998), SC189 (2004), SC228 (2008), SC242 (Corr.1, 2011 reinstated), SC246 (Rev.1, 2015)

**International standards**

**International Organisation for Standardisation**

ISO 1122-1:1998 Corr. 1:1999 Corr. 2:2009, ISO 6336-1:2006 Corr. 2008, ISO 6336-2:2006 Corr. 2008, ISO 6336-3:2006 Corr. 2008, ISO 6336-5:2003, ISO 19019:2005

## TABLE 1 - REVIEW OF AMENDMENTS

This review comprises amendments in relation to the Rules for the classification of ships, Part 9 - Machines, edition January 2018, as amended with by Amendments No. 1, edition July 2018 and by as amended by Amendments No. 2, edition January 2019.

<i>ITEM</i>	<i>DESCRIPTION OF THE AMENDMENTS</i>
<b>SECTION 2 – INTERNAL COMBUSTION ENGINES</b>	
Head 2.14.12 – Work trials (Factory Acceptance Test)	2.14.12. 3 has been amended

## 2 INTERNAL COMBUSTION ENGINES

■ Head **2.4 – TESTING OF INTERNAL COMBUSTION ENGINES**, para. 2.14.12 – Works trials (Factory Acceptance Test), item 2.14.12.3.4 has been amended and should be read as follows:

### 2.14.12 Works trials (Factory Acceptance Test)

#### 2.14.12.1 Objectives

The purpose of the works trials is to verify design premises such as power, safety against fire, adherence to approved limits (e.g. maximum pressure), and functionality and to establish reference values or base lines for later reference in the operational phase.

#### 2.14.12.2 Records

- .1 The following environmental test conditions are to be recorded:
  - Ambient air temperature;
  - Ambient air pressure;
  - Atmospheric humidity.
- .2 For each required load point, the following parameters are normally to be recorded:
  - Power and speed;
  - Fuel index (or equivalent reading);
  - Maximum combustion pressures (only when the cylinder heads installed are designed for such measurement);
  - Exhaust gas temperature before turbine and from each cylinder (to the extent that monitoring is required in IACS UR M73 and M35/36);
  - Charge air temperature;
  - Charge air pressure;
  - Turbocharger speed (to the extent that monitoring is required in IACS UR M73).
- .3 Calibration records for the instrumentation are, upon request, to be presented to the attending Surveyor.
- .4 For all stages at which the engine is to be tested, the pertaining operational values are to be measured and recorded by the engine manufacturer. All results are to be compiled in an acceptance protocol to be issued by the engine manufacturer. This also includes crankshaft deflections if considered necessary by the engine designer.
- .5 In each case, all measurements conducted at the various load points are to be carried out at steady state operating conditions. However, for all load points provision should be made for time needed by the Surveyor to carry out visual inspections. The readings for MCR, i.e. 100% power (rated maximum continuous power at corresponding rpm) are to be taken at least twice at an interval of normally 30 minutes.

#### 2.14.12.3 Test loads

- .1 *Test loads for various engine applications are given be low. In addition, the scope of the trials may be expanded depending on the engine application, service experience, or other relevant reasons.*

NOTE:

Alternatives to the detailed tests may be agreed between the manufacturer and the Register when the overall scope of tests is found to be equivalent.

- .2 *Propulsion engines driving propeller or impeller only*

A) 100% power (MCR) at corresponding speed  $n_0$  at least 60 min.

B) 110% power at engine speed  $1.032n_0$ : Records to be taken after 15 minutes or after steady conditions have been reached, whichever is shorter.

NOTE:

Only required once for each different engine/turbocharger configuration.

C) Approved intermittent overload (if applicable): testing for duration as agreed with the manufacturer.

D) 90% (or normal continuous cruise power), 75%, 50% and 25% power in accordance with the nominal propeller curve, the sequence to be selected by the engine manufacturer.

- E) Reversing manoeuvres (if applicable).

NOTE:

After running on the test bed, the fuel delivery system is to be so adjusted that overload power cannot be given in service, unless intermittent overload power is approved by the Register. In that case, the fuel delivery system is to be blocked to that power.

**.3 Engines driving generators for electric propulsion**

- A) 100% power (MCR) at corresponding speed  $n_0$ : at least 60 min.  
B) 110% power at engine speed  $n_0$ : 15 min. - after having reached steady conditions.  
C) Governor tests for compliance with IACS UR M3.1 and M3.2 are to be carried out.  
D) 75%, 50% and 25% power and idle, the sequence to be selected by the engine manufacturer.

NOTE:

After running on the test bed, the fuel delivery system is to be adjusted so that full power plus a 10% margin for transient regulation can be given in service after installation onboard.

The transient overload capability is required so that the required transient governing characteristics are achieved also at 100% loading of the engine, and also so that the protection system utilised in the electric distribution system can be activated before the engine stalls.

**.4 Engines driving generators for auxiliary purposes**

- A) 100% power (MCR) at corresponding speed  $n_0$ : at least 60 min.  
B) 110% power at engine speed  $n_0$ : 15 min. - after having reached steady conditions.  
C) Governor tests for compliance with IACS UR M3.1 and M3.2 are to be carried out.  
D) 75%, 50% and 25% power and idle, the sequence to be selected by the engine manufacturer.

Note:

After running on the test bed, the fuel delivery system is to be adjusted so that full power plus a 10% margin for transient regulation can be given in service after installation onboard.

The transient overload capability is required so that the required transient governing characteristics are achieved also at 100% loading of the engine, and also so that the protection system utilised in the electric distribution system can be activated before the engine stalls.

**.5 Propulsion engines also driving power take off (PTO) generator**

- A) 100% power (MCR) at corresponding speed  $n_0$ : at least 60 min.  
B) 110% power at engine speed  $n_0$ : 15 min. - after having reached steady conditions.  
C) Approved intermittent overload (if applicable): testing for duration as agreed with the manufacturer.  
D) 90% (or normal continuous cruise power), 75%, 50% and 25% power in accordance with the nominal propeller curve or at constant speed  $n_0$ , the sequence to be selected by the engine manufacturer.

NOTE:

After running on the test bed, the fuel delivery system is to be adjusted so that full power plus a margin for transient regulation can be given in service after installation onboard. The transient overload capability is required so that the electrical protection of downstream system components is activated before the engine stalls. This margin may be 10% of the engine power but at least 10% of the PTO power.

**.6 Engines driving auxiliaries**

- A) 100% power (MCR) at corresponding speed  $n_0$ : at least 30 min.  
B) 110% power at engine speed  $n_0$ : 15 min. - after having reached steady conditions.  
C) Approved intermittent overload (if applicable): testing for duration as agreed with the manufacturer.  
D) For variable speed engines, 75%, 50% and 25% power in accordance with the nominal power consumption curve, the sequence to be selected by the engine manufacturer.

## NOTE:

After running on the test bed, the fuel delivery system is normally to be so adjusted that overload power cannot be delivered in service, unless intermittent overload power is approved. In that case, the fuel delivery system is to be blocked to that power.

**2.14.12.4 Turbocharger matching with engine****.1 Compressor chart**

Turbochargers shall have a compressor characteristic that allows the engine, for which it is intended, to operate without surging during all operating conditions and also after extended periods in operation.

For abnormal, but permissible, operation conditions, such as misfiring and sudden load reduction, no continuous surging shall occur.

In this section, *surging* and *continuous surging* are defined as follows:

*Surging* means the phenomenon, which results in a high pitch vibration of an audible level or explosion-like noise from the scavenger area of the engine.

*Continuous surging* means that surging happens repeatedly and not only once.

**.2 Surge margin verification**

Category C turbochargers used on propulsion engines are to be checked for surge margins during the engine workshop testing as specified below. These tests may be waived if successfully tested earlier on an identical configuration of engine and turbocharger (including same nozzle rings).

For 4-stroke engines the following shall be performed without indication of surging:

- With maximum continuous power and speed (=100%), the speed shall be reduced with constant torque (fuel index) down to 90% power.
- With 50% power at 80% speed (= propeller characteristic for fixed pitch), the speed shall be reduced to 72% while keeping constant torque (fuel index).

For 2-stroke engines the surge margin shall be demonstrated by at least one of the following methods:

- The engine working characteristic established at workshop testing of the engine shall be plotted into the compressor chart of the turbocharger (established in a test rig). There shall be at least 10% surge margin in the full load range, i.e. working flow shall be 10% above the theoretical (mass) flow at surge limit (at no pressure fluctuations).
- Sudden fuel cut-off to at least one cylinder shall not result in continuous surging and the turbocharger shall be stabilised at the new load within 20 seconds. For applications with more than one turbocharger the fuel shall be cut-off to the cylinders closest upstream to each turbocharger. This test shall be performed at two different engine loads: The maximum power permitted for one cylinder misfiring and at the engine load corresponding to a charge air pressure of about 0.6 bar (but without auxiliary blowers running).
- No continuous surging and the turbocharger shall be stabilized at the new load within 20 seconds when the power is abruptly reduced from 100% to 50% of the maximum continuous power.

**2.14.12.5 Integration tests**

For electronically controlled engines, integration tests are to be made to verify that the response of the complete mechanical, hydraulic and electronic system is as predicted for all intended operational modes and the tests considered as a system are to be carried out at the works. If such tests are technically unfeasible at the works, however, these tests may be conducted during sea trial. The scope of these tests is to be agreed with the *Register* for selected cases based on the FMEA required in UR M44.

**2.14.12.6 Component inspections**

Random checks of components to be presented for inspection after works trials are left to the discretion of the *Register*.