RULES
FOR THE CLASSIFICATION OF SHIPS

Part 9 – MACHINES
January 2020

Amendments No. 2
January 2021

CROATIAN REGISTER OF SHIPPING

Hrvatska (Croatia) • 21000 Split • Marasovića 67 • P.O.B. 187
Tel.: (...) 385 (0)21 40 81 11
Fax.: (...) 385 (0)21 35 81 59
E-mail: tech.coord@crs.hr
web site: www.crs.hr

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

Amendments No. 2 to the
RULES FOR THE CLASSIFICATION OF SHIPS
Part 9 – MACHINES

have been adopted on 22nd December 2020 and shall enter into force on 1st January 2021

INTRODUCTORY NOTES

These amendments shall be read together with the requirements in the Rules for the Classification of Ships, Part 9 – Machines, edition January 2020, as amended by Amendments No. 1, edition July 2020.

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.

This Part of the Rules includes 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 (Rev.1 2019), F29 (Rev. 6, 2005), M2 (1971), M3 (Rev. 6, 2018), 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. 4, Aug 2019), M56 (Rev. 3, 2015), M60 (1997), M61 (2003), M63 (2005), M66 (Rev. 3, 2008), M67 (Rev. 2, 2015), M71 (Corr.1, 2016), M72 (Rev.2, 2019), M73 (Corr.1, 2016), Z26 (2015), M77 (Rev.1 Aug 2019), M79 (Oct 2018), M80 (2019)

Unified Interpretations (UI):
SC76 (1985), SC94 (Rev. 2, 2016), SC133 (1998), SC189 (2004), SC228 (2008), SC242 (Rev.2, 2020), SC246 (Rev.1, 2015)

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 2020, as amended as amended by Amendments No. 1, edition July 2020.

ITEM	*DESCRIPTION OF THE AMENDMENTS*
SECTION 2 – INTERNAL COMBUSTION ENGINES	
Head 2.4 Crankshafts	existing sub-item 2.4.7.4 have been amended.
ANNEX B – STORAGE AND USE OF SCR REDUCTANTS	
Annex B	existing item 2 have been amended.

2 INTERNAL COMBUSTION ENGINES

■ Item 2.4.7 has been amended and should be read as follows:

2.4.7 Calculation of fatigue strength and acceptability criteria

2.4.7.1 The fatigue strength shall be understood as the value of equivalent von Mises alternating stress which a crankshaft can permanently withstand at the most highly stressed points.

2.4.7.2 Where the fatigue strength for a crankshaft cannot be furnished by reliable measurements, the allowable fatigue strength of crankshaft may be evaluated by means of the following formulae:

.1 Allowable fatigue strength of crankshaft related to the crankpin diameter:

$$\sigma_{DW} = \pm K\left(0{,}42 \cdot \sigma_B + 39{,}3\right) \cdot \left[0{,}264 + 1{,}073 \cdot D^{-0{,}2} + \frac{785 - \sigma_B}{4900} + \frac{196}{\sigma_B} \cdot \sqrt{\frac{1}{R_X}}\right] \text{[N/mm²]} \qquad (2.4.7.2\text{-}1)$$

.2 Allowable fatigue strength of crankshaft related to the journal diameter:

$$\sigma_{DW} = \pm K\left(0{,}42 \cdot \sigma_B + 39{,}3\right) \cdot \left[0{,}264 + 1{,}073 \cdot D_G^{-0{,}2} + \frac{785 - \sigma_B}{4900} + \frac{196}{\sigma_B} \cdot \sqrt{\frac{1}{R_G}}\right] \text{[N/mm²]} \qquad (2.4.7.2\text{-}2)$$

where:

K – factor for different types of crankshafts without surface treatment. Values greater than 1 are only applicable to fatigue strength in fillet area.

K = 1,05 – for continuous grain flow forged or drop-forged crankshafts;
= 1,0 – for free form forged crankshafts (without continuous grain flow);
= 0,93 – for cast steel crankshafts manufactured by companies using the cold rolling process approved by the *Register*, with cold rolling treatment in fillet area.

R_X = R_H – in the fillet area;
= $D_O/2$ – in the oil bore area;

σ_B – minimum tensile strength of crankshaft material, [N/mm²].

For other parameters see 2.4.4.1.

When a surface treatment process is applied, it must be approved by the *Register*. Guidance for calculation of surface treated fillets and oil bore outlets is presented in Appendix V of the *Guidance for the calculation of crankshafts for internal combustion engines (QW114)* of the *Register*.

2.4.7.3 The formulae 2.4.7.2-1 and 2.4.7.2-2 are subject to the following conditions:

.1 Surfaces of the fillet, the outlet of the oil bore and inside the oil bore (down to a minimum depth equal to 1,5 times the oil bore diameter) shall be smoothly finished.

.2 For calculation purposes R_H, R_G or R_X are to be taken as not less than 2 mm.

2.4.7.4 As an alternative the fatigue strength of the crankshaft can be determined by experiment based either on full size crankthrow (or crankshaft), or on specimens taken from a full size crankthrow. For evaluation of test results, see Appendix IV of the *Guidance for the calculation of crankshafts for internal combustion engines (QW114)* of the *Register*.

2.4.7.5 Acceptability criteria

The sufficient dimensioning of a crankshaft is confirmed by a comparison of the equivalent alternating stress and the fatigue strength. This comparison has to be carried out for the crankpin fillet, the journal fillet and the outlet of crankpin oil bore, based on the formula:

$$Q = \frac{\sigma_{DW}}{\sigma_v} \qquad (2.4.7.5\text{-}1)$$

Adequate dimensioning of the crankshaft is ensured if the smallest of all acceptability factors (Q) satisfies the criterion:

$$Q \geq 1{,}15 \qquad (2.4.7.5\text{-}2)$$

ANNEX B STORAGE AND USE OF SCR REDUCTANTS

■ **ANNEX B–STORAGE AND USE OF SCR REDUCTANTS** has been amended and should read as follows:

1. GENERAL

The NOx Technical Code, provides for the use of NOx Reducing Devices of which Selective Catalytic Reduction (SCR) is one option. SCR requires the use of a reductant which may be a urea/water solution or, in exceptional cases, aqueous ammonia or even anhydrous ammonia.

SCR units are typically installed in the exhaust system of a diesel engine, as close as possible to the engine. Installation and operation of SCR system is to be compatible with the engine and not to cause any adverse effects on the engine performance such as excessive back pressures or temperatures during operation. Exhaust flow compatibility of the SCR unit with the connected engine over the whole operational range of the engine shall be demonstrated. Also, SCR systems are to be designed to enable continued operation of the engine at the times the SCR system is not in operation. Redundancy of equipment is to be provided for those rotating and reciprocating components that form part of the exhaust emission abatement unit essential supplementary systems. SCR exhaust system and reaction chamber that are subjected to exhaust gas and reductant mixtures are to be constructed of suitable corrosion resistant materials.

These requirements apply to the arrangements for the storage and use of SCR reductants which are typically carried on board in bulk quantities.

2. REDUCTANT USING UREA BASED AMMONIA (e.g. 40 % / 60 % UREA/WATER SOLUTION)

2.1 Where urea based ammonia (e.g. AUS 40 – aqueous urea solution specified in ISO 18611-1) is introduced, the storage tank is to be arranged so that any leakage will be contained and prevented from making contact with heated surfaces. All pipes or other tank penetrations are to be provided with manual closing valves attached to the tank. Tank and piping arrangements are to be approved.

2.2 The storage tank may be located within the engine room.

2.3 The storage tank is to be protected from excessively high or low temperatures applicable to the particular concentration of the solution. Depending on the operational area of the ship, this may necessitate the fitting of heating and/or cooling systems. The physical conditions recommended by applicable recognized standards (such as ISO 18611-3) are to be taken into account to ensure that the contents of the aqueous urea tank are maintained to avoid any impairment of the urea solution during storage.

2.4 If a urea storage tank is installed in a closed compartment, the area is to be served by an effective mechanical ventilation system of extraction type providing not less than 6 air changes per hour which is independent from the ventilation system of accommodation, service spaces, or control stations. The ventilation system is to be capable of being controlled from outside the compartment. A warning notice requiring the use of such ventilation before entering the compartment shall be provided outside the compartment adjacent to each point of entry.

Alternatively, where a urea storage tank is located within an engine room a separate ventilation system is not required when the general ventilation system for the space is arranged so as to provide an effective movement of air in the vicinity of the storage tank and is to be maintained in operation continuously except when the storage tank is empty and has been thoroughly ventilated.

2.5 Each urea storage tank is to be provided with temperature and level monitoring arrangements. High and low level alarms together with high and low temperature alarms are also to be provided.

2.6 Where urea based ammonia solution is stored in integral tanks, the following are to be considered during the design and construction:

- These tanks may be designed and constructed as integral part of the hull, (e.g. double bottom, wing tanks).
- These tanks are to be coated with appropriate anti-corrosion coating and cannot be located adjacent to any fuel oil and fresh water tank.
- These tanks are to be designed and constructed as per the structural requirements applicable to hull and primary support members for a deep tank construction.
- These tanks are to be included in the ship's stability calculation.

2.7 The requirements specified in item 2.4 also apply to closed compartments normally entered by persons:

- when they are adjacent to the urea integral tanks and there are possible leak points (e.g. manhole, fittings) from these tanks; or
- when the urea piping systems pass through these compartments, unless the piping system is made of steel or other equivalent material with melting point above 925 degrees C and with fully welded joints.

2.8 The reductant piping and venting systems are to be independent of other ship service piping and/or systems. Reductant piping systems are not to be located in accommodation, service spaces, or control stations. The vent pipes of the storage tank are to terminate in a safe location on the weather deck and the tank venting system is to be arranged to prevent entrance of water into the urea tank.

2.9 Reductant tanks are to be of steel or other equivalent material with a melting point above 925 degrees C. Pipes/piping systems are to be of steel or other equivalent material with melting point above 925 degrees C, except downstream of the tank valve, provided this valve is metal seated and arranged as fail-to-closed or with quick closing from a safe position outside the space in the event of fire; in such case, type approved plastic piping may be accepted even if it has not passed a fire endurance test. Reductant tanks and pipes/piping systems are to be made with a material compatible with reductant or coated with appropriate anti-corrosion coating.

2.10 For the protection of crew members, the ship is to have on board suitable personnel protective equipment. Eyewash are to be provided, the location and number of these eyewash stations are to be derived from the detailed installation arrangements.

2.11 Urea storage tanks are to be arranged so that they can be emptied of urea and ventilated by means of portable or permanent systems.

3. REDUCTANT USING AQUEOUS AMMONIA (28 % OR LESS CONCENTRATION OF AMMONIA)

Aqueous ammonia is not to be used as a reductant in a SCR except where it can be demonstrated that it is not practicable to use a urea based reductant. Where an application is made to use aqueous ammonia as the reductant then the arrangements for its loading, carriage and use are to be derived from a risk based analysis.

4. REDUCTANT USING ANHYDROUS AMMONIA (99.5 % OR GREATER CONCENTRATION OF AMMONIA BY WEIGHT)

Anhydrous ammonia is not to be used as a reductant in a SCR except where it can be demonstrated that it is not practicable to use a urea based reductant and where the Flag Administration agrees to its use. Where it is not practicable to use a urea reductant then it is also to be demonstrated that it is not practicable to use aqueous ammonia. Where an application is made to use anhydrous ammonia as the reductant then the arrangements for its loading, carriage and use are to be derived from a risk based analysis.