RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

Part D Machinery Installations

Rules for the Survey and Construction of Steel Ships
Part D 2020 AMENDMENT NO.1
Guidance for the Survey and Construction of Steel Ships
Part D 2020 AMENDMENT NO.1

Rule No.47 / Notice No.26 30 June 2020
Resolved by Technical Committee on 22 January 2020

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An asterisk (*) after the title of a requirement indicates that there is also relevant information in the corresponding Guidance.

RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

RULES

Part D Machinery Installations

2020 AMENDMENT NO.1

Rule No.47 30 June 2020

Resolved by Technical Committee on 22 January 2020

An asterisk (*) after the title of a requirement indicates that there is also relevant information in the corresponding Guidance.

Rule No.47 30 June 2020
AMENDMENT TO THE RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

"Rules for the survey and construction of steel ships" has been partly amended as follows:

Part D MACHINERY INSTALLATIONS

Amendment 1-1

Title of Chapter 2 has been amended as follows.

Chapter 2 ~~DIESEL~~ RECIPROCATING INTERNAL COMBUSTION ENGINES

2.4 Safety Devices

Paragraph 2.4.1 has been amended as follows.

2.4.1 Speed Governors and Overspeed Protective Devices

1 Each diesel engine used as main propulsion machinery in diesel ships is to be provided with a speed governor so adjusted to prevent the engine speed from exceeding the number of maximum continuous revolutions by more than 15 %.

2 In addition to this speed governor, each diesel engine used as main propulsion machinery in diesel ships that has a continuous maximum output of 220 *kW* or above, which can be declutched or which drives a controllable pitch propeller, is to be provided with a separate overspeed protective device. The overspeed protective device, including its driving gear, are to be independent from the governor required by **-1**, and be so adjusted that the engine speed may not exceed the number of maximum continuous revolutions by more than 20 %.

3 Diesel engines used to drive generators are to be provided with governors specified in the requirements in ~~**2.4.2, Part H**~~ **5**. However, if a diesel engine which is used as main propulsion machinery for an electric propulsion ship drives a generator used to supply electrical power exclusively to propulsion motors, the requirements specified in **5.1.2-2, Part H** are to be applied.

4 In addition to the speed governor, each diesel engine used as main propulsion machinery of electric propulsion ships and those diesel engines used to drive generators that have a maximum continuous output of 220 *kW* or above are to be provided with a separate overspeed protective device. The overspeed protective device, including its driving gear, are to be independent from the governor required by **-3**, and be so adjusted that the engine speed may not exceed the number of maximum continuous revolutions by more than 15 %.

5 Speed governors of reciprocating internal combustion engines driving generators are to be have the following characteristics:

(1) Reciprocating internal combustion engines driving main generators

(a) Momentary speed variations are, in principle, to be 10 % or less of the maximum rated speed when the rated loads of generators are suddenly thrown off. However, in cases where it is difficult to meet the above requirements, the characteristics of such governors may be acceptable in the following cases.

i) In cases where momentary variations are 10 % or less of the rated speed when the maximum load on board is suddenly thrown off and the speed is returned to within 1 % of the final steady speed in not more than 5 *seconds*, momentary variations in excess of 10 % of rated speeds may be acceptable in cases where rated loads of such

generators are suddenly thrown off.

ii) The momentary variations given in **i)** above, in cases where the rated loads of generators suddenly thrown off are less than any adjusted values of the intervention of overspeed devices as required by **-4**.

(b) Momentary speed variations are, in principle, to be 10 % or less of the maximum rated speed when 50 % of the rated loads of generators are suddenly thrown-on followed by the remaining 50 % of such loads suddenly being thrown-on after an interval to restore the steady state. Speeds are to return to within 1 % of final steady speeds in not more than 5 *seconds*.

(c) In cases where the throwing-on methods are difficult according to the requirements in **(b)** above, and where a three-stage or more throwing-on method is adopted, throw-on power calculation sheets which take into consideration **i)** to **iv)** are to be submitted to the Society for approval:

i) power restoration after blackout,

ii) sequential starting,

iii) starting with large start-up loads, or

iv) instantaneous load transfers in cases where one set of generators fails (during parallel running).

(d) At all loads in ranges between no loads and rated loads, all permanent speed variations are to be within ± 5 % of the maximum rated speed.

(2) Reciprocating internal combustion engines driving emergency generators

(a) Momentary speed variations are not to exceed the values specified in **(1)(a)** in cases where total emergency consumer loads are suddenly thrown off.

(b) Momentary speed variations are, in principle, not to exceed the values specified in **(1)(b)** and speeds to return to within 1 % of final steady speeds in not more than 5 *seconds* in cases where total emergency consumer loads are suddenly thrown-on. However, if it is difficult to meet the above requirements and in cases where the following **i)** through **iii)** requirements are adopted, a throwing-on in steps method may be used.

i) Total emergency consumer loads are to be thrown-on within 45 *seconds* after blackout.

ii) Prime movers are to be designed so that the maximum step loads in emergency consumer loads are to be thrown-on at one time.

iii) Documents such as thrown-on power calculations specifying the adoption of throwing-on in steps are to be submitted.

(c) At all loads in ranges between no loads and total emergency consumer loads, all permanent speed variations are not to exceed the values specified in **(1)(d)** above.

(3) Reciprocating internal combustion engines driving *a.c.* generators operating in parallel

(a) The load sharing specified in **2.4.14-4** and **-5, Part H**, is ensured, and

(b) Facilities are to be provided to adjust the governor sufficiently enough to permit adjustments of loads not exceeding 5 % of rated loads at normal frequencies.

Chapter 3 STEAM TURBINES

3.3 Safety Devices

Paragraph 3.3.1 has been amended as follows.

3.3.1 Governors and Overspeed Protective Devices

1 All main and auxiliary steam turbines are to be provided with overspeed protective devices to prevent the engine speed from exceeding the number of maximum continuous revolutions by more than 15%. Where two or more steam turbines are coupled to the same main gear wheel, only one overspeed protective device provided for all the turbines may be accepted.

2 In addition to this speed governor, each steam turbine used as main propulsion machinery in steam turbine ships which can be declutched, or which drives a controllable pitch propeller, is to be provided with a separate and independent speed governor in addition to the overspeed protective device specified in **-1** above. This additional speed governor is to be capable of controlling the speed of the unloaded turbine without bringing the overspeed protective device into action.

3 Steam ~~T~~turbines to drive generators are to be provided with governors complying with the requirements in ~~**2.4.2, Part H**~~ **4** in addition to the overspeed protective device specified in **-1** above. However, if steam turbines used as main propulsion machinery in electric propulsion ships are used to drive generators for supplying electrical power exclusively to propulsion motors, the requirements in **5.1.2-2, Part H** are to be applied.

4 Speed governors of steam turbines driving generators are to be as follows:

(1) Characteristics of governors are to comply with the requirements specified in **2.4.1-5** (in this case the term "reciprocating internal combustion engines" is to be read as "steam turbines").

(2) In cases where a steam turbine-driven *d.c.* generator is arranged to run in parallel with other generators, a switch is to be fitted on each steam turbine emergency governor for the purpose of opening the generator circuit-breaker when the emergency governor functions.

Chapter 4 GAS TURBINES

4.3 Safety Devices

Paragraph 4.3.1 has been amended as follows.

4.3.1 Governors and Overspeed Protective Devices

1 Gas turbines are to be provided with an overspeed protective device. This device is to be so adjusted that the output shaft speed may not exceed the maximum continuous speed by more than 15 % and is to have the functions specified in **4.3.2-2**.

2 Gas turbines are to be provided with a speed governor independent of the overspeed protective device specified in **-1** above. The speed governor is to be capable of controlling the speed of the unloaded gas turbine without bringing the overspeed protective device into action.

3 The governors of gas turbines used to drive generators are to comply with the requirements in ~~**2.4.2-1** and **-2, Part H**~~ **4**. However, when gas turbines used as main propulsion machinery in electric propulsion ships are used to drive generators to supply electric power exclusively to propulsion motors, the requirements in **5.1.2-2, Part H** are to be applied.

4 Speed governors of gas turbines driving generators are to be as follows:

(1) Characteristics of governors are to comply with the requirements specified in **2.4.1-5** (in this case the term "reciprocating internal combustion engines" is to be read as "gas turbines").

(2) In cases where a gas turbine-driven *d.c.* generator is arranged to run in parallel with other generators, a switch is to be fitted on each gas turbine emergency governor for the purpose of opening the generator circuit-breaker when the emergency governor functions.

EFFECTIVE DATE AND APPLICATION (Amendment 1-1)

1. The effective date of the amendments is 30 June 2020.

2. Notwithstanding the amendments to the Rules, the current requirements apply to governors for which the application for approval is submitted to the Society before the effective date.

Amendment 1-2

Chapter 11 WELDING FOR MACHINERY INSTALLATIONS

11.2 Welding Procedure and Related Specifications

Sub-paragraphs -1 and -3 have been amended as follows.

11.2.1 Approval of Welding Procedure and Related Specifications*

1 The manufacturer is to obtain the approval of the welding procedures in the following cases:

(1) Where the welding procedures are first adopted for the welding work specified below.
   (a) Welding work for windlasses ~~to which approved welding procedures and related specifications are to be applied in accordance with **16.2.3**~~
   (b) Welding work for boilers (including smoke tubes, stay tubes, superheater tubes, heat exchanging tubes of thermal oil heaters, etc.), pressure vessels of Group I and Group II (including heat exchanging tubes of heat exchangers)
   (c) Welding work for the principal components of prime movers, etc. (these principal components are specified in **Table D2.1**, **3.2.1-1**, **4.1.2(5)** and **5.2.1-1**; hereinafter, this definition applies throughout this Chapter)
   (d) Welding work for pipes belonging to Group I and Group II
   (~~d~~e) Welding work using special materials
   (~~e~~f) Welding work using special welding procedures

(2) Where the items described in the approved welding procedure specifications are altered.

(3) Where considered necessary by the Surveyor.

2 (Omitted)

3 Whenever manufacturers conduct an approval test for a welding procedure and related specifications applied to a welding work specified in any of **-1(1)(b)** to **(~~e~~f)**, they are to submit detailed data in connection with this welding work to the Society for approval.

11.2.2 Execution of Tests*

Sub-paragraphs (1) to (3) have been amended as follows.

The requirements in **4.1.3 of Part M** are to be applied. However, approval tests for the following welding procedures and related specifications are to be in accordance with requirements otherwise specified.

(1) Welding procedures and related specifications applicable to the welding work for windlasses ~~specified in **11.2.1-1(1)(a)**~~ for which the approval test is carried out using a material not specified in **Part K** as a base metal

(2) Welding procedures and related specifications applicable to the welding work for boilers (excluding smoke tubes, stay tubes, superheater tubes, heat exchanging tubes of thermal oil heaters, etc.), pressure vessels of Group I and Group II (excluding heat exchanging tubes of heat exchangers) or principal components of prime movers, etc.

(3) Welding procedures and related specifications applicable to the welding work specified in **11.2.1-1(1)(~~d~~e)** or **(~~e~~f)**

Paragraph 11.2.3 has been amended as follows.

11.2.3 Range of Approval*

The requirements in **4.1.4 of Part M** are to be correspondingly applied. However, the ranges of approval for the ~~following~~ welding procedures and related specifications for the welding work specified in **11.2.1-1(1)(a)**, **11.2.2(2)** and **11.2.2(3)** are to be in accordance with the requirements otherwise specified.

~~(1) Welding procedures and related specifications applicable to the welding work specified in **11.2.1-1(1)(a)**~~

~~(2) Welding procedures and related specifications applicable to the welding work for boilers, pressure vessels or principal components of prime movers, etc. and the welding work specified in **11.2.1-1(1)(d)** or **(e)**~~

Chapter 12 PIPES, VALVES, PIPE FITTINGS AND AUXILIARIES

12.4 Connection and Forming of Piping Systems

Paragraph 12.4.1 has been amended as follows.

12.4.1 Welding of Piping Systems*

1 The welding for piping systems is also to comply with the requirements in **12.4.1** and **Chapter 11**.

2 Welding consumables used for the welding work of pipes belonging to Group I and Group II are to be type-approved by the Society in accordance with the requirements in **Part M,** as specified in **11.1.1-2**. In cases where compliance with this requirement, however, is deemed impractical, welding consumables that satisfy the following **(1)** and **(2)** may be accepted:

(1) Welding consumables that conform to standards recognized by the Society; and

(2) Welding consumables subjected to deposited weld metal tests, the results of which are deemed appropriate by the Surveyor

EFFECTIVE DATE AND APPLICATION (Amendment1-2)

1. The effective date of the amendments is 30 June 2020.

2. Notwithstanding the amendments to the Rules, the current requirements apply to pipes and piping systems other than those which fall under the following:

(1) pipes and piping systems used on ships for which the date of contract for construction is on or after the effective date;

(2) pipes and piping systems for which the application for examinations of altered parts related to welding is submitted to the Society on or after the effective date.

Amendment 1-3

Chapter 1 GENERAL

1.3 General Requirements for Machinery Installations

1.3.1 General*

Sub-paragraphs -2(1) to (4) have been amended as follows.

2 Special consideration is to be given to the reliability of any of the single essential machinery and components listed below.

In addition, for ships in which unconventional machinery is used as the main propulsion machinery and propulsion shafting system, additional machinery which enables the ship to proceed at a navigable speed in the event of possible failure of the machinery may be required by the Society.

(1) For ~~diesel~~ ships in which reciprocating internal combustion engines are used as main propulsion machinery (excluding electric propulsion ships):
~~Diesel~~ Reciprocating internal combustion engines ~~used as the main propulsion machinery~~, high elastic couplings, reduction gears and propulsion shafting systems

(2) For ~~steam turbine~~ ships in which steam turbines are used as main propulsion machinery (excluding electric propulsion ships):
Steam turbine engines ~~used as the main propulsion machinery~~, main boilers, main condensers, reduction gears and propulsion shafting systems

(3) For ~~gas turbine~~ ships in which gas turbines are used as main propulsion machinery (excluding electric propulsion ships):
Gas turbine engines ~~used as the main propulsion machinery~~, compressors, combustors, reduction gears and propulsion shafting systems

(4) For electric propulsion ships (only those specified in **5.1.1-1, Part H**, hereinafter the same in this Part):
Propulsion motors, reduction gears and propulsion shafting systems

Title of Chapter 2 has been amended as follows.

Chapter 2 ~~DIESEL~~ RECIPROCATING INTERNAL COMBUSTION ENGINES

2.1 General

2.1.1 General*

Sub-paragraphs -1 and -2 have been amended as follows.

1 The requirements of this Chapter apply to ~~diesel~~ reciprocating internal combustion engines which are used as the main propulsion machinery or used to drive generators and auxiliaries (hereinafter referred to in this Chapter as all auxiliaries excluding auxiliary machinery for specific use etc.).
2 For ~~diesel~~ reciprocating internal combustion engines which are used for driving emergency generators, in addition to all of the requirements in this Chapter (excluding **2.2.4**, section **2.3**, **2.4.1-4** and the requirement for "devices to stop the operation of the engine" specified in **2.5.5-1**), the requirements of **18.5.2** (if controlled automatically or by remote) as well as those in **3.3** and **3.4, Part H** also apply.

Chapter 5 POWER TRANSMISSION SYSTEMS

5.3 Strength of Gears

5.3.3 Allowable Tangential Loads for Bending Strength*

Table D5.1 has been amended as follows.

Table D5.1 Values of K_1 (3)(4)

Driving unit	Construction	Use	
	Kind of coupling	Gear for main propulsion	Gear for auxiliaries
Steam turbine Gas turbine Electric motor	Single-stage reduction gear Multiple-stage reduction gear	1.00 1.00(1), 1.10(2)	1.15 1.15
~~Diesel engine~~ Reciprocating internal combustion engine	Hydraulic or electromagnetic coupling High elastic coupling Elastic coupling	1.00 0.90 0.80	1.15 1.05 0.95

Notes:
(1) Applicable only to gearing connected directly to the main propulsion shafting system.
(2) Applicable to gearing connected, through effective flexible couplings, to the propulsion shafting system.
(3) Where one pinion meshes with more than two wheels, 0.9 *times* these values may be used for the value of K_1.
(4) The value of K_1 for rigid couplings is to be approved by the Society.

Chapter 6 SHAFTINGS

6.1 General

6.1.2 Drawings and Data

Sub-paragraph (1) has been amended as follows.

Drawings and data to be submitted are generally as follows:

(1) Drawings for approval (including specifications of material)
- (a) Shafting arrangement
- (b) Thrust shaft
- (c) Intermediate shaft
- (d) Stern tube shaft
- (e) Propeller shaft
- (f) Stern tube
- (g) Stern tube bearing; this drawing may be included in the drawings and data specified in **(l)** in the case of propeller shafts Kind 1*C*.
- (h) Stern tube sealing device; this drawing may be included in the drawings and data specified in **(l)** in the case of propeller shafts Kind 1*C*.
- (i) Shaft bracket bearing
- (j) Shaft couplings and coupling bolts
- (k) Shafts which transmit power to generators or auxiliaries
- (l) In the case of propeller shafts Kind 1*C*, four sets of drawings and data of the following **i)** to **viii)**:
  - i) Specifications for the devices and equipment required in **6.2.11**
  - ii) Tables of monitoring, control, and alarm items (including bearing temperatures, tank levels, seal air pressure, switchover of pumps, changeover of tanks (high or low) and changeover of spare seal rings), and their settings and indication methods
  - iii) Documents for countermeasures after alarms have been activated (including necessary operations such as valve handling after alarming)
  - iv) Drawings of stern tube bearings
  - v) Drawings of stern tube sealing devices
  - vi) Piping diagrams (including those related to the height of sensing positions for monitoring and controlling tank levels, systems for monitoring and controlling seal air pressure, and explanations of each symbol for sensors, switches, valves and other fittings and valve operations)
  - vii) Specification sheets for allowable ranges of pressure or tank levels for stern tube sealing devices determined by the manufacturer
  - viii) Shaft alignment calculation sheets

((2) is omitted.)

6.2 Materials, Construction and Strength

6.2.2 Intermediate Shafts*

Table D6.1 has been amended as follows.

Table D6.1 Values of F_1

~~For~~ In cases where steam turbines ~~installation,~~ or gas turbines ~~installation~~ are used as main propulsion machinery, or in the case of ~~diesel installation~~ reciprocating internal combustion engines with slip type coupling(1)~~,~~ or electric propulsion ~~installation~~	For all other ~~diesel installations~~ reciprocating internal combustion engines than those noted in the left hand column
95	100

Note:

(1) Slip type coupling signifies hydraulic coupling, electromagnetic coupling or the equivalent.

Paragraph 6.2.11 has been amended as follows.

6.2.11 Additional Requirements for Propeller Shaft Kind 1*C**

Means are to be provided to sufficiently ensure the integrity of the stern tube bearings in accordance with the following **(1)** to **(4)** requirements ~~specified otherwise by the Society~~ where the propeller shaft is intended to be a propeller shaft Kind 1*C*.

(1) One set of the drawings and data listed in **6.1.2(1)(l)** which has been approved and returned is to be kept on board.

(2) Stern tube bearings are to comply with the following **(a)** to **(c)**:

(a) Either of the following devices to measure stern tube metal temperature at the aft end bottom along with devices to record temperature is to be provided. In addition, audible and visible high temperature alarms (with a preset value of 55 °C or below) are to be provided in main control stations as specified in **18.1.2(3)** or **(4), Part D of the Rules**.

i) Two or more temperature sensors embedded in the metal; or

ii) An embedded temperature sensor, replaceable from inboard the ship, and a spare temperature sensor. In this case, replacement of such sensors according to procedures submitted beforehand is to be demonstrated.

(b) Devices are to be installed for automatically reducing the speed of main propulsion machinery or for issuing audible and visual alarms which requires operation to reduce the running speed of the main propulsion machinery in main control stations in cases where at least one of the sensors specified in **(a)** above detects temperatures higher than preset values. In cases where means are provided to reduce the speed of main propulsion machinery automatically, the override arrangements specified in **18.2.6-3, Part D** are to be provided for bridge control devices.

(c) The adhering strength of stern tube white metal lining is to be not less than 40 *MPa*.

(3) Stern tube sealing devices are to be of such a construction as to permit repairs or replacement without drawing out the propeller shaft not to impair the oil sealing properties and the durability. For this purpose, a two-piece type sealing device is to be used or a distance piece to shift the seal ring contact position is to be provided.

(4) Piping arrangements are to comply with the following **(a)** to **(d)**:

(a) Audible and visual alarms are to be provided in main control stations to show the lubricating oil pressure of the stern tube bearing and the sealing oil (or air) pressure between the seal rings (excluding the pressure of any oil between enclosed seals) are out of their allowable ranges. In cases where the upper limit of the pressure is controlled by means of over flow piping, alarms for the upper limit may be omitted.

(b) As for the lower limit of the allowable range specified in **(a)**, low level alarms in cases

where oil tanks are provided, otherwise a non-flow alarms may be used.

(c) The lubricating oil for stern tube bearings is to be incessantly circulated. Two circulating pumps, arranged to be automatically switched over in the event of a pump stopping or a lower delivery pressure than the preset value, are to be provided. Audible and visual alarms, coming into action at the switchover, and a means to indicate which pump is working are to be provided in main control stations.

(d) In cases where the pressure of the lubricating oil for the stern tube bearing or the sealing oil between seal rings of the stern tube sealing device is changed to high or low according to the draught of the ship, means, such as a lamp linked to the valve change operation, to indicate which pressure is working are to be provided at main control stations.

6.3 Tests

6.3.2 Tests after Installation On Board*

Sub-paragraph -3 has been added as follows.

1 The sealing devices specified in **6.2.10-2** are to be tested for leakage under lubricating oil or lubricating freshwater supply pressure after installation on board.

2 For the main propulsion shafting (excluding those of waterjet propulsion systems or azimuth thrusters), confirmation tests relating to shaft alignment are to be carried out in accordance with the requirements specified otherwise by the Society.

3 In the case of propeller shafts Kind 1*C*, the devices and equipment specified in **6.2.11** are to be tested in order to verify the performance of the system in accordance with the items in the table specified in **6.2.1(1)(l)(ii)**.

Chapter 7 PROPELLERS

7.1 General

7.1.3 Materials

Sub-paragraph -2 has been amended as follows.

1 (Omitted)

2 Propellers are to have been subjected to non-destructive tests on their principal parts in accordance with **7.2.9, Part K of the Rules**.

7.2 Construction and Strength

Paragraph 7.2.1 has been amended as follows.

7.2.1 Thickness of Blade*

1 The thickness of the propeller blades at a radius of 0.25*R* and 0.6*R* (where *R* is the radius of the propeller) for solid propellers and at a radius of 0.35*R* and 0.6*R* for controllable pitch propellers

is not to be less than the values given by the following formula. The thickness of the highly skewed propeller blades is to conform with the provisions specified ~~elsewhere~~ in **2** below.

$$t = \sqrt{\frac{K_1}{K_2}\frac{H}{ZN_0\ell}SW}$$

where

t : Thickness of blades (excluding the fillet of blade root) (cm)

H : Maximum continuous output of main propulsion machinery (kW)

Z : Number of blades

N_0 : Number of maximum continuous revolutions (*rpm*) ~~per minute~~ divided by 100 ~~(*rpm* /100)~~

ℓ : Width of blade at radius in question (cm)

K_1 : Coefficient of the radius in question given by the following formula:

$$K_1 = \frac{30.3}{\sqrt{1 + k_1\left(\frac{P'}{D}\right)^2}}\left(k_2\frac{D}{P} + k_3\frac{P'}{D}\right)$$

D : Diameter of propeller (m)

k_1, k_2, k_3 : Values given in **Table D7.1**

P' : Pitch at radius in question (m)

P : Pitch at radius of 0.7 R (m), ~~(*R* = Radius of propeller (*m*))~~

K_2 : Coefficient given by the following formula:

$$K_2 = K - \left(k_4\frac{E}{t_0} + k_5\right)\frac{D^2N_0^2}{1000}$$

k_4, k_5 : Values given in **Table D7.1**

E : Rake at the tip of the blade (Measuring from face side base line and taking positive value for backward rake) (cm)

t_0 : Imaginary thickness of blade at propeller shaft centreline (t_0 may be obtained by drawing the each side line which connects the blade tip thickness with the thickness at 0.25R (or 0.35R for a controllable pitch propeller), in the projection of the blade section along the maximum blade thickness line.) (cm)

K : Value depending upon the type of the propeller material given in **Table D7.2**

S : (Omitted)

W : (Omitted)

Table D7.1 Values of k_1, k_2, k_3, k_4 and k_5

(Table is omitted.)

Table D7.2 has been amended as follows.

Table D7.2 Values of *K*

Material		*K*
Copper alloy castings	*KHBsC*1	1.15
	*KHBsC*2	
	*KAlBC*3	1.3
	*KAlBC*4	1.15
Stainless steel forgings for propellers	*KSCSP*1, *KSCSP*2, *KSCSP*3	1.0
	*KSCSP*4	0.9

Notes:

(1) For the blades of materials different from those specified in the above ~~T~~table, the value of *K* is to be ~~determined in each case~~ as deemed appropriate by the Society.

(2) For propellers having a diameter of 2.5 *metres* or less, the value of *K* may be taken as the value in the above ~~T~~table multiplied by the following factor:

$2 - 0.4D$ for $2.5 \geq D > 2.0$

1.2 for $2.0 \geq D$

2 The thicknesses of highly skewed propeller blades, depending upon the skew angle (i.e. the angle, on the expanded blade drawing, between the line connecting the centre of the propeller shaft with the point at the blade tip on the centreline of blade width and the tangential line drawn from the centre of the propeller shaft to the centreline of blade width (*See* **Fig. D7.1**)) is to comply with either of the following **(1)** or **(2)**:

(1) In cases where the skew angle exceeds 25 degrees but is 60 degrees or less

(a) The blade thicknesses at radii 0.25*R* (0.35*R* for a controllable pitch propeller) and 0.6*R* are not to be less than the values obtained from multiplying those values calculated by the formulae in **1 above** by coefficient *A* given below:

$$A = 1 + B\frac{\theta - 25^\circ}{60^\circ}$$

where

θ : skew angle (*degrees*)

B : 0.2 at 0.25*R* (or 0.35*R* for a controllable pitch propeller) and 0.6 at 0.6*R*

(b) Blade thickness t_x at any radius between 0.6*R* and 0.9*R* is not to be less than the value determined by the following formula. Moreover, this thickness is to provide sufficient strength against loads imparted during reversing manoeuvres, etc.

$$t_x = 0.003D + \frac{(1-x)(t_{0.6} - 0.003D)}{0.4} \ (mm)$$

where

D : diameter of propeller (*mm*)

x : ratio of the radius (equals 2*r*/*D*, where *r* is the radius (*mm*))

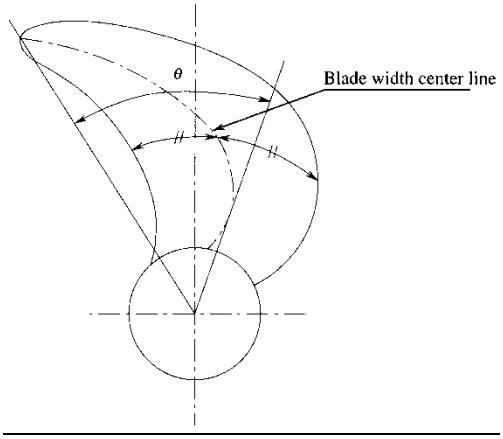
$t_{0.6}$: blade thickness at 0.6*R* as required in **(a)** above (*mm*)

(2) In cases where the skew angle exceeds 60 degrees

Based upon the precise calculation sheet of propeller strength submitted by the manufacturer or designer, blade thickness is to be determined by the Society on a case by case basis.

Fig. D7.1 and Fig. D7.2 have been renumbered to Fig. D7.2 and Fig. D7.3, and Fig. D7.1 has been added as follows.

Fig. D7.1 Definition of Skew Angle



~~2~~**3** The fillet radius between the root of a blade and the boss of the propeller, on the pressure side at the maximum blade thickness part, is to be not less than the value of R_0 given by the following formula:

$$R_0 = t_r + \frac{(e - r_B)(t_0 - t_r)}{e}$$

R_0 : Required radius of the fillet (cm)

t_r : Required thickness of blades at a radius of $0.25R$ (or $0.35R$ for a controllable pitch propeller) specified in **1** (cm)

t_0 : Same as that used in **1**

r_B : Boss ratio of propeller

e : 0.25 (or 0.35 for a controllable pitch propeller)

~~3~~**4** Special consideration will be given to the thickness of the blades or the radius of the fillet, notwithstanding the requirements in **1** ~~or~~to ~~2~~**3** above, provided that detailed data and calculations are submitted to the Society and considered appropriate.

Paragraph 7.2.2 has been amended as follows.

7.2.2 Controllable Pitch Propellers*

1 The thickness of the controllable pitch propeller blade and the fillet radius between the root of a blade and the boss of the propeller is to be in accordance with the requirements specified in **7.2.1**.

2 The diameter of blade fixing bolts of controllable pitch propellers is not to be less than the value calculated by the following formula~~:~~. However, in cases where documents deemed appropriate by the Society are submitted and it can be demonstrated that the blade fixing bolts satisfy the strength requirements specified in the Rules, this requirement may be dispensed with.

$$d = 0.55\sqrt{\frac{1}{\sigma_a n}\left(\frac{AK_3}{L} + F_c\right)}$$

where

d : Required diameter of blade fixing bolt (mm) (*See* **Fig. D7.1**)

A : Value given by the following formula, where H, N_0 and Z are the same as those specified in **7.2.1**:

$$A = 3.0 \times 10^4 \frac{H}{N_0 Z}$$

K_3 : Value given by the following formula:

$$K_3 = \left\{ \left(\frac{D}{P} \right)^2 \times (0.622 - 0.9x_0)^2 + (0.318 - 0.499x_0)^2 \right\}^{\frac{1}{2}}$$

x_0 : Ratio of the radius from centreline of the propeller shaft ~~at~~to the boundary between the "blade flange and pitch control gear" ~~to~~ and the propeller radius (*See* **Fig. D7.~~1~~2**). Where x_0>0.3, the ratio is to be taken as 0.3.

L : Mean value of $L_1$and L_2 (cm)

where L_1 and L_2 are the lengths of lines constructed from the centre of the bolts located on the edge of each side that are perpendicular to the line passing through the rotating centre of the flange at a pitch angle of β. (*See* **Fig. D7.~~2~~3**)

F_c : Centrifugal force (*N*) of propeller blade given by the following formula:

$$F_c = 1.10 \times mR'N_0^2$$

m : Mass of one blade (kg)

R' : Distance between the centre of gravity of the blade and the centreline of the propeller shaft (cm)

n : Number of bolts on the face side of blade

σ_a : Allowable stress of bolt material given by the following formula (N/mm^2):

$$\sigma_a = 34.7 \times \left(\frac{\sigma_B + 160}{600} \right)$$

σ_B : Specified Tensile strength of bolt material (N/mm^2)

~~W~~where σ_B >800 N/mm^2, it is to be taken as 800 N/mm^2.

Other symbols are the same as those given in the formula of **7.2.1-1**.

3 (Omitted)

4 The thickness of the flange for fitting the blade to the pitch control gear (the thickness as measured from the seat of fixing bolt or nut to the boundary face between the flange and the pitch control gear) is to be not less than the value calculated by the following formula:

$$t_f = 0.9d$$

where

t_f : Thickness of flange (*mm*) (*See* **Fig. D7.~~1.~~2**)

d : Required diameter of bolt calculated by the formula specified in **2** (*mm*)

(-5 to -9 are omitted.)

Fig. D7.~~1~~2 Measuring Method of Blade Fixing Bolt Dimensions

(Figure is omitted.)

Fig. D7.~~2~~3 Determination of *L*

(Figure is omitted.)

7.3 Force Fitting of Propellers

7.3.1 Pull-up Length*

Sub-paragraph -1 has been amended as follows.

1 In cases where a propeller is force fitted onto a propeller shaft without the use of a key, the pull-up length is to be in accordance with the following **(1)** to **(3)**:

(1) Pull-up length by force fitting is to be within the range of the lower and upper limits ~~of pull-up length are to be~~ as given by the following formulae. ~~For~~However, a taper ~~of~~ is not to be more than 1/15, ~~these limits of pull-up length are to be subject to the satisfaction of the Society:~~ and special consideration is required in cases where propellers are force fitted onto propeller shafts through sleeves.

$$L_1 = PK_E + K_C(C_b - C_0)$$

$$L_2 = K_E K_W \frac{({K_{R1}}^2 - 1)}{\sqrt{(3{K_{R1}}^4 + 1)}} + K_c(C_b - C_0)$$

$$L_3 = 19.6K_E({K_{R1}}^2 - 1) + K_c(C_b - C_0)$$

L_1 : Lower limit of pull-up length against slipping at the reference temperature 35 °C (mm)

L_2 : Upper limit of pull-up length against detrimental deformations at the reference temperature 0 °C (mm) (in cases other than the case of L_3 shown below)

L_3 : Upper limit of pull-up length against detrimental deformations at the reference temperature 0 °C (mm) (in cases where the material of boss is manganese bronze casting and K_{R1}<1.89)

K_W : ~~The v~~Value given by the following formula. ~~**Table D7.3**. In cases where the material of propeller boss is other than those specified in **Table D 7.3**, the value is to be determined by the Society in each case.~~For cast iron, the value is not to exceed 30 % of the nominal tensile strength.

$$K_W = 0.7\sigma_{0.2}$$

$\sigma_{0.2}$: Value of 0.2 % proof stress of propeller boss material as specified in **Table D7.3** (N/mm^2)

Table D7.3 has been added as follows.

Table D7.3 0.2 % proof stress of propeller boss material

Propeller boss material	0.2 % proof stress (N/mm^2)
*KHBsC*1	175
*KHBsC*2	
*KAlBC*3	245
*KAlBC*4	275

Note:

(1) For materials different from those specified in the above table, the value is to be as deemed appropriate by the Society.

K_{R1} : Rate of R_1 to R_0 (R_1/R_0)

K_{R2} : Rate of R_2 to R_0 (R_2/R_0)

R_0 : Radius of the propeller shaft at the midpoint of taper in the axial direction (mm)

R_1 : Radius of propeller boss at the determinant point of the propeller boss ratio (mm)

R_2 : Inner radius at the section corresponding to R_0 in the case of a hollow propeller shaft (mm). For solid propeller shafts, the value is to be 0.

C_b : Temperature of propeller boss at time of fitting propeller (°C)

C_0 : Reference temperature: 35 °C for L_1 (at which the space between boss and shaft tends to be loose) and 0 °C for L_2 and L_3 (at which the space between boss and shaft tends to shrink)

P : Value of minimum required surface pressure given by the following formula (N/mm_2):

~~$P = \frac{2.8T}{SB}\left\{2.8tan\alpha + \sqrt{0.0169 + B\left(\frac{F_V}{T}\right)^2}\right\}$~~ $P = \frac{qT}{SB}\left\{-qtan\alpha + \sqrt{\mu^2 + B\left(\frac{F_V}{T}\right)^2}\right\}$

q : Safety factor not to be less than 2.8 against friction slip at the reference temperature 35 °C

S : Contact area between propeller shaft and propeller boss on the drawing (mm^2)

α : Half angle of the taper at the propeller shaft cone part (rad)

B : ~~$0.0169 - 7.84tan^2\alpha$~~ Value given by the following formula:

$B = \mu^2 - q^2tan^2\alpha$

μ : Coefficient of friction, equal to 0.13

T : Thrust force given by the following formula (N)

$T = 1.76 \times 10^3(H/V_s)$

V_s : Ship speed at maximum continuous output (kt)

F_V : Tangential force acting on contact surface given by the following formula (N)

$$F_V = \frac{9.55cH}{N_0R_0} \times 10^4$$

c : Value given by one of following

i) ~~1.0 f~~For turbines ~~ships;~~, geared reciprocating internal combustion engine drives and electric drives, and for direct reciprocating internal combustion engine drives with hydraulic, electromagnetic or high elasticity couplings 1.0

ii) For ~~diesel ships,~~direct reciprocating internal combustion engine drives (except in the case of **i)** above)

1.2 or the value given by the following formula, whichever is greater. However, where a detailed report on the maximum torque acting on the fitted portion of the propeller under all operating conditions including transient conditions has been submitted to the satisfaction of the Society, it may comply with the provisions specified otherwise.

$$c = (0.194\ln D + 0.255)\left\{\left(\frac{N_C}{N_0}\right)^2 + 1.047\frac{Q_vN_0}{H} \times 10^{-2}\right\}$$

Q_V: Torsional vibratory torque acting on the fitted portion of the propeller at a rotational speed of resonant critical within the range of above 25 % of the number of maximum continuous revolutions (N-m)

H, N_0, D: Same as those specified in **7.2.1-1**, However, D is to be taken as 2.6 m for D <2.6 m and as 10.2 m for D >10.2 m.

N_c : Number of revolutions (rpm) at resonant critical divided by 100

K_E : Value given by the following formula (mm^3/N):

~~$K_E = \frac{R_0}{tan\alpha}\left\{\left(\frac{K_{R1}^2+1}{K_{R1}^2-1}\right)K_4 + 4.85\left(\frac{1+K_{R2}^2}{1-K_{R2}^2}\right) + K_5\right\} \times 10^{-6}$~~

~~In cases where the material of the propeller shaft is other than forged steel or the material of propeller boss is other than specified in **Table D7.3**, the value is to be determined by the Society as considered appropriate.~~

~~K_4 and K_5 : Values given in **Table D7.3**~~

$$K_E = \frac{R_0}{tan\alpha}\left\{\frac{1}{E_b}\left(\frac{K_{R1}^2+1}{K_{R1}^2-1}+\nu_b\right)+\frac{1}{E_s}\left(\frac{1+K_{R2}^2}{1-K_{R2}^2}-\nu_s\right)\right\}$$

ν_b : Poisson's ratio for propeller boss material as specified in **Table D7.4**

ν_s : Poisson's ratio for propeller shaft material as specified in **Table D7.5**

E_b : Modulus of elasticity of propeller boss material as specified in **Table D7.4** (N/mm^2)

E_s : Modulus of elasticity of propeller shaft material as specified in **Table D7.5** (N/mm^2)

Table D7.4 has been added as follows.

Table D7.4 Poisson's ratio, modulus of elasticity and coefficient of linear thermal expansion of propeller boss material

Material	Poisson's ratio	Modulus of elasticity (N/mm^2)	Coefficient of linear thermal expansion (mm/mm^oC)
*KHBsC*1	0.33	1.08×10^5	17.5×10^{-6}
*KHBsC*2			
*KAlBC*3		1.18×10^5	
*KAlBC*4			
Cast iron	0.26	0.98×10^5	12.0×10^{-6}
Cast steel	0.29	2.06×10^5	

Note:

(1) For materials different from those specified in the above table, the value is to be as deemed appropriate by the Society.

Table D7.5 has been added as follows.

Table D7.5 Poisson's ratio, modulus of elasticity and coefficient of linear thermal expansion of propeller shaft material

Material	Poisson's ratio	Modulus of elasticity (N/mm^2)	Coefficient of linear thermal expansion (mm/mm^oC)
Forged steel	0.29	2.06×10^5	12.0×10^{-6}

Note:

(1) For materials different from those specified in the above table, the value is to be as deemed appropriate by the Society.

K_C : Value given by the following formula (*mm* /°C):

~~$K_C = \left(K_6 + K_7 \frac{C_b - C_S}{C_b - C_0}\right)\left(\ell_0 - \frac{R_0}{\tan\alpha}\right) \times 10^{-5}$~~

$$K_C = \left\{(\lambda_b - \lambda_S) + \frac{(C_b - C_S)}{(C_b - C_0)}\lambda_S\right\}\left\{\ell_0 - \frac{R_0}{tan\alpha}\right\}$$

~~In cases where the material of the propeller shaft is other than forged steel or the material of propeller boss is other than specified in **Table D7.3**, the value is to be determined by the Society as considered appropriate.~~

C_S : Temperature of propeller shaft at time of fitting propeller (°C)

λ_b : Coefficient of linear thermal expansion of propeller boss material as specified in **Table D7.4** (*mm/mm*°C)

λ_S : Coefficient of linear thermal expansion of propeller shaft material as specified in **Table D7.5** (*mm/mm*°C)

ℓ_0 : Half length of the tapered part in the propeller boss hole in the axial direction (*mm*)

~~K_6 and K_7 : Values given in **Table D7.3**~~

(2) Prior to final pull-up according to **(1)** above, the contact area between the mating surfaces is to be checked. Non-contact bands extending circumferentially around the boss or over the full length of the boss are not acceptable.

(3) After final pull-up according to **(1)** above, the propeller is to be secured by a nut on the propeller shaft. The nut is to be secured to the shaft.

Table D7.3 has been deleted.

~~Table D7.3 Values of K_4, K_5, K_6, K_7 and K_w~~

~~Material of propeller boss~~	~~K_4~~	~~K_5~~	~~K_6~~	~~K_7~~	~~K_w~~
~~*KHBsC1*~~	~~9.27~~	~~1.65~~	~~0.55~~	~~1.20~~	~~123~~
~~*KHBsC2*~~	~~9.27~~	~~1.65~~	~~0.55~~	~~1.20~~	~~123~~
~~*KAlBC3*~~	~~8.49~~	~~1.40~~	~~0.55~~	~~1.20~~	~~172~~
~~*KAlBC4*~~	~~8.49~~	~~1.40~~	~~0.55~~	~~1.20~~	~~193~~

Chapter 8 TORSIONAL VIBRATION OF SHAFTINGS

8.1 General

Paragraph 8.1.1 has been amended as follows.

8.1.1 Scope

1 The requirements of this Chapter apply to power transmission systems for propulsion and propulsion shafting systems (except propellers), shafting systems for transmitting power from main propulsion machinery to generators, crankshafts of ~~diesel~~ reciprocating internal combustion engines used as main propulsion machinery and shafting systems of generating plants using ~~diesel~~ reciprocating internal combustion engines.

2 The requirements of this Chapter apply mutatis mutandis to the shafting systems of auxiliaries (hereinafter referred to in this Chapter as all auxiliaries excluding auxiliary machinery for specific use etc.) driven by ~~diesel~~ reciprocating internal combustion engines.

8.1.2 Data to be Submitted

Sub-paragraphs -1(2) to (4) have been amended as follows.

1 Torsional vibration calculation sheets covering the following items are to be submitted for approval:

((1) is omitted.)

(2) Calculation results of the torsional vibration stress at each resonant critical within a speed range up to 120% of the number of maximum continuous revolutions; and, in cases of ~~diesel installations~~ reciprocating internal combustion engines, those of the torsional vibration stress for the flank appearing in the speed range from 90 to 120% caused by a resonance of the first major order (i.e., the *n* th or n/2 th order where *n* denotes the number of cylinders of reciprocating internal combustion engines) having its critical speed above 120% of the number of maximum continuous revolutions.

(3) Arrangement of crank throws and firing order (in cases of ~~diesel installations~~ shafting systems driven by reciprocating internal combustion engines)

(4) For propulsion shafting systems intended to be continuously operated under one cylinder misfiring (i.e., no injection but with compression) condition of reciprocating internal combustion engines, calculation results of the torsional vibration stress with any one cylinder misfiring of giving rise to the highest torsional vibration stress.

8.2 Allowable Limit

Paragraph 8.2.1 has been amended as follows.

8.2.1 Crankshafts

The torsional vibration stresses on the crankshafts of ~~diesel~~ reciprocating internal combustion engines ~~used as main propulsion machinery~~ of ~~diesel~~ ships in which the reciprocating internal combustion engines are used as main propulsion machinery (excluding electric propulsion ships) are to be in accordance with the following requirements **(1)** through **(4)**:

(1) For continuous operation, when the number of revolutions is within the range of 80% to 100% of the number of maximum continuous revolutions, the torsional vibration stresses are not to exceed τ_1 given in following:

(a) For 4-stroke cycle in-line ~~diesel~~ engines or 4-stroke cycle Vee type ~~diesel~~ engines with

firing intervals of 45 degrees or 60 degrees, the value of τ_1 is given by the following formula:

$$\tau_1 = 45 - 24\lambda^2$$

(b) For 2-stroke cycle ~~diesel~~ engines or 4-stroke cycle Vee type ~~diesel~~ engines other than shown in **(a)** above, the value of τ_1 is given by the following formula:

$$\tau_1 = 45 - 29\lambda^2$$

τ_1 : Allowable limit of torsional vibration stresses for the range of $0.8 < \lambda \leq 1.0$ (N/mm^2)

λ : Ratio of the number of revolutions to the number of maximum continuous revolutions

(2) When the number of revolutions is within the range of 80% and below the number of maximum continuous revolutions, the torsional vibration stresses are not to exceed τ_2 given below. Furthermore, in cases where the stresses exceed the value calculated by the formula of τ_1 in **(1)**, the barred speed ranges specified in **8.3** are to be imposed.

$$\tau_2 = 2\tau_1$$

τ_2 : Allowable limit of torsional vibration stresses for the range of $\lambda \leq 0.8$ (N/mm^2)

λ : Ratio of the number of revolutions to the number of maximum continuous revolutions

(3) When the number of revolutions is within the range of the number of maximum continuous revolutions to 115%, the torsional vibration stresses are not to exceed τ_3 given in the following:

(a) For 4-stroke cycle in-line ~~diesel~~ engines or 4-stroke cycle Vee type ~~diesel~~ engines with firing intervals of 45 degrees or 60 degrees, the value of τ_3 is given by the following formula:

$$\tau_3 = 21 + 237(\lambda - 0.8)\sqrt{\lambda - 1}\ (1 < \lambda \leq 1.15)$$

(b) For 2-stroke cycle ~~diesel~~ engines or 4-stroke cycle Vee type ~~diesel~~ engines other than shown in **(a)** above, the value of τ_3 is given by the following formula:

$$\tau_3 = 16 + 237(\lambda - 0.8)\sqrt{\lambda - 1}\ (1 < \lambda \leq 1.15)$$

τ_3 : Allowable limit of torsional vibration stresses for the range of $1.0 < \lambda \leq 1.15$ (N/mm^2)

λ : Ratio of the number of revolutions to the number of maximum continuous revolutions

(4) In cases where the tensile strength of the shaft material exceeds 440 N/mm^2, or its yield strength exceeds 225 N/mm^2, the values of τ_1, τ_2 and τ_3 given in **(1)**, **(2)** and **(3)** may be increased by multiplying the factor f_m given in the following formula:

(a) For τ_1 and τ_3

$$f_m = 1 + \frac{2}{3}\left(\frac{T_s}{440} - 1\right)$$

(b) For τ_2

$$f_m = \frac{Y}{225}$$

where

f_m : Correction factor for allowable limit of torsional vibration stress concerning the shaft material

T_s : Specified tensile strength of the shaft material (N/mm^2). However, the value of T_s for calculating f_m is not to exceed 760 N/mm^2 for carbon steel forgings, or 1080 N/mm^2 for low alloy steel forgings.

Y : Specified yield strength of the shaft material (N/mm^2)

Paragraph 8.2.2 has been amended as follows.

8.2.2 Intermediate Shafts, Thrust Shafts, Propeller Shafts and Stern Tube Shafts*

1 For ~~diesel~~ ships in which reciprocating internal combustion engines are used as main propulsion machinery (excluding electric propulsion ships), the torsional vibration stresses on the intermediate shafts, thrust shaft, propeller shafts and stern tube shafts made of steel forgings (excluding stainless steel, etc.) are to be in accordance with the following requirements **(1)** and **(2)**. However, those shafts classified as either propeller shafts Kind 2 or stern tube shafts Kind 2 are to be deemed appropriate by the Society.

((1) and (2) are omitted.)

2 For ~~diesel~~ ships in which reciprocating internal combustion engines are used as main propulsion machinery (excluding electric propulsion ships), the torsional vibration stresses on the propeller shafts and stern tube shafts made of stainless steel forgings, etc. are to be in accordance with the following requirements **(1)** and **(2)**.

((1) and (2) are omitted.)

3 The allowable limits of torsional vibration stresses on the shafts made of materials other than specified in **-1** and **-2**, and the allowable limits of torsional vibration stresses on the intermediate shafts, thrust shafts, propeller shafts and stern tube shafts for ships in which steam turbines or ~~ships~~, gas turbines ~~ships~~ are used as main propulsion machinery, ~~and~~ for electric propulsion ships, or for ~~diesel~~ ships in which reciprocating internal combustion engines are used as main propulsion machinery which have electromagnetic slip couplings between main propulsion machinery and main propulsion systems are to be deemed appropriate by the Society.

8.2.3 Shafting System of Generating Plants

Sub-paragraphs -1 and -2 have been amended as follows.

1 The torsional vibration stresses on the crankshafts of ~~diesel~~ reciprocating internal combustion engines used for generating plants (hereinafter referred to in this Chapter as including propulsion generating plants used for electric propulsion ships) are to be in accordance with the following requirements **(1)** and **(2)**:

(1) When the number of revolutions is within the range of 90 % to 110 % of the number of maximum continuous revolutions, the torsional vibration stresses are not to exceed τ_1 given in the following:

(a) For 4-stroke cycle in-line ~~diesel~~ engines or 4-stroke cycle Vee type ~~diesel~~ engines with firing intervals of 45 degrees or 60 degrees, the value of τ_1 is given by the following formula:

$$\tau_1 = 21N/mm^2$$

(b) For 2-stroke cycle ~~diesel~~ engines and 4-stroke cycle Vee type ~~diesel~~ engines other than shown in **(a)** above, the value of τ_1 is given by the following formula:

$$\tau_1 = 16N/mm^2$$

((2) is omitted.)

2 The torsional vibration stresses on the generator shafts of generating plants using ~~diesel~~ reciprocating internal combustion engine are to be in accordance with the following requirements **(1)** and **(2)**:

((1) and (2) are omitted.)

Paragraph 8.2.5 has been amended as follows.

8.2.5 Avoidance of Major Criticals

The major criticals of one node vibration (e.g. the *n* th and *n* /2 th order for 4-stroke cycle and the *n* th order for 2-stroke cycle where *n* denotes the number of cylinders) in in-line ~~diesel~~ engines are not to exist, except when approval of the Society is specifically obtained, within the following speed ranges:

For main propulsion shafting system $0.8 \leq \lambda \leq 1.1$

For shafting system of generating plants $0.9 \leq \lambda \leq 1.1$

where

λ : Ratio of the number of revolutions at the major critical to the number of maximum continuous revolutions

Chapter 9 BOILERS, ETC. AND INCINERATORS

9.1 General

9.1.2 Terminology

Sub-paragraphs (3) and (4) have been amended as follows.

Terms used in this Part are defined as follows:

((1) and (2) are omitted.)

(3) "Exhaust gas boilers" are boilers which generates steam or hot water using only exhaust gases from ~~diesel~~ reciprocating internal combustion engines, have independent steam spaces or hot wells and have outlets for steam or hot water.

(4) "Exhaust gas economizers" are those equipment which generates steam or hot water using only exhaust gases from ~~diesel~~ reciprocating internal combustion engines and do not have independent steam spaces or hot wells.

((5) to (7) are omitted.)

9.13 Incinerators

9.13.3 Construction and Fittings*

Sub-paragraph (3) has been amended as follows.

The construction and fittings of incinerators are to comply with the requirements in the following **(1)** to **(9)**.

(1) Major parts of the combustion chamber are to be constructed out of effective material.

(2) Combustion chambers are to be so constructed as to ensure that harmful combustion gas or drainage will not leak.

(3) Uptakes from combustion chambers are to satisfy the following **(a)** to **(c)**:

(a) They are not to be connected to the exhaust gas pipes from ~~diesel~~ reciprocating internal combustion engines and gas turbines.

((b) and (c) are omitted.)

((4) to (9) are omitted.)

Chapter 13 PIPING SYSTEMS

13.5 Bilge and Ballast Piping

13.5.7 Bilge Suction Arrangements in Engine Rooms

Sub-paragraph -6 has been amended as follows.

6 Emergency bilge suction pipes for ships with steam turbines used as main propulsion machinery (excluding electric propulsion ships) are to comply with the following requirements:

(1) In ~~steam turbine~~ the above ships, an emergency bilge suction pipe with a screw-down non-return valve having a wheel handle which is extended above the floor grating in the engine room, is to be fitted to the suction end of the main circulating pump. The suction pipe of this pump is to be fed into a suitable level in the engine room in order to discharge bilge in case of emergency. The internal diameter of such a suction pipe is not to be less than two-thirds of the diameter of that of pump suction.

((2) and (3) are omitted.)

Sub-paragraph -7 has been amended as follows.

7 Emergency bilge suction pipes for ships with ~~diesel~~ reciprocating internal combustion engines or gas turbines used as main propulsion machinery (excluding electric propulsion ships) are to comply with the following requirements:

(1) In the above ships ~~with diesel engines or gas turbines used as main propulsion machinery~~, an emergency bilge suction pipe with a screw-down non-return valve having a wheel handle which is extended above the lower platform in the engine room is to be fitted to the main cooling water pump. The suction pipe is to be fed into a suitable level in the engine room to discharge bilge in case of emergency. The internal diameter of such suctions pipe is to be equal to that of pump suction.

((2) and (3) are omitted.)

13.9 Fuel Oil Systems

13.9.1 General*

Sub-paragraph -4 has been amended as follows.

4 Union joints used for any connections of fuel oil injection pipes of ~~diesel~~ reciprocating internal combustion engines or any pipes of burning systems of boilers are to be of rigid construction and to have metal contact capable of providing sufficient oil tightness.

13.9.4 Drip Trays and Drainage Systems*

Sub-paragraph -1 has been amended as follows.

1 Metal drip trays of a sufficient depth are to be provided under all equipment that uses or handles fuel oil such as ~~diesel~~ reciprocating internal combustion engines (~~except~~ excluding main propulsion machinery of ships other than electric propulsion ships), burners, fuel oil pumps, fuel oil heaters, fuel oil coolers and fuel oil filters as well as fuel oil tanks such as fuel oil settling and

service tanks. In cases where it is not practicable to provide metal drip trays, coamings are to be provided to hold any oil spillage.

Title of Paragraph 13.9.6 has been amended as follows.

13.9.6 Fuel Oil Systems for ~~Diesel~~ Reciprocating Internal Combustion Engines*

Sub-paragraphs -2 and -4 have been amended as follows.

1 Number and capacity of fuel oil supply pumps for the main propulsion machinery
((1) and (2) are omitted.)
2 Number and capacity of fuel oil supply pumps for ~~diesel~~ reciprocating internal combustion engines driving auxiliary machinery and electrical generators
(1) ~~Diesel~~ Reciprocating internal combustion engines for driving electrical generators and auxiliary machinery for which duplication is required are to be provided with main and stand-by fuel oil supply pumps of sufficient capacity to maintain the supply of oil at the maximum continuous output of the engine. These pumps are to be connected and ready for use.
(2) (Omitted)
3 (Omitted)
4 Fuel oil filters
(1) Fuel oil filters are to be provided for fuel oil supply piping lines of ~~diesel~~ reciprocating internal combustion engines.
(2) Fuel oil filters for ~~diesel~~ reciprocating internal combustion engines that are used as main propulsion machinery are to be capable of being cleaned without stopping the supply of filtered oil. The filters are to be provided with valves or cocks for depressurizing before being opened.
5 (Omitted)

13.12 Cooling Systems

13.12.1 Cooling Pumps*

Sub-paragraphs -1(1) and (2) have been amended as follows.

1 Number and capacity of cooling pumps for main propulsion machinery.
(1) Main propulsion machinery is to be provided with a main cooling pump of sufficient capacity to maintain the supply of water (oil) at the maximum continuous output of the machinery as well as a stand-by cooling pump of sufficient capacity to supply cooling water (oil) under the normal navigating conditions. However, the capacity of the stand-by circulating pumps of ships ~~having steam turbines as main propulsion machinery~~ in which steam turbines are used as main propulsion machinery is considered by the Society on a case-by-case basis. These pumps are to be connected and ready for use.
(2) In ~~steam turbine~~ ships with steam turbines used as main propulsion machinery, an adequately installed scoop arrangement may be used as the main cooling water pump. In such cases, the main condenser is to be so arranged as to be sufficiently cooled by other cooling systems while the ship runs at low speed, in addition to any cooling system performed by the stand-by cooling water pumps specified in **(1)** above.
((3) is omitted.)

Paragraph 13.12.3 has been amended as follows.

13.12.3 Cooling Systems for ~~Diesel~~ Reciprocating Internal Combustion Engines*

In cases where sea water is used for the direct cooling of the propulsion machinery, ~~diesel~~ reciprocating internal combustion engines driving electrical generators, or any auxiliary machinery for which duplication is required, strainers, which are arranged so as they are capable of being cleaned without stopping the supply of filtered cooling water to the respective engines, are to be provided between the sea suction valve and the cooling sea water pump.

Chapter 18 AUTOMATIC AND REMOTE CONTROL

18.2 System Design

18.2.2 Supply of Power

Sub-paragraph -3(2) has been amended as follows.

3 Supply of pneumatic pressure

The supply of control air is to be in accordance with the following:

((1) is omitted.)

(2) In cases where starting air reservoirs of ~~diesel~~ reciprocating internal combustion engines used as main propulsion machinery are used as control air reservoirs, pressure reducing valves are to be duplicated or a spare pressure reducing valve is to be provided on board.

((3) to (5) are omitted.)

18.2.7 Use of Computers*

Sub-paragraph -2(2) has been amended as follows.

2 Control systems, alarm systems and safety systems which constitute computer based systems are to comply with the following **(1)** to **(3)**:

((1) is omitted.)

(2) Back-up means

(a) In cases where one computer simultaneously performs fuel control (governor control, electronic injection control, etc.) and remote control of main propulsion machinery ~~in diesel or turbine ships, or~~ of ships in which reciprocating internal combustion engines, steam turbines or gas turbines are used as main propulsion machinery (excluding electric propulsion ships) or in cases where one computer simultaneously performs output control (rotational speed control, load control, etc.) and remote control of main propulsion machinery in electric propulsion ships, one of the following systems is to be provided in the case of computer failure. However, where this requirement is impracticable, relevant systems are to comply with requirements deemed appropriate by the Society.

(i) and ii) are omitted.)

((b) and (c) are omitted.)

((3) is omitted.)

18.3 Automatic and Remote Control of Main Propulsion Machinery or Controllable Pitch Propellers

18.3.2 Remote Control Devices for Main Propulsion Machinery or Controllable Pitch Propellers*

Sub-paragraph -1(3) has been amended as follows.

1 General

Remote control devices for main propulsion machinery or controllable pitch propellers are to comply with the following requirements:

((1) and (2) are omitted.)

(3) In cases where the speed of the ~~diesel~~ reciprocating internal combustion engines used as main propulsion machinery is controlled by governors, the governors are to be adjusted so that main propulsion machinery may not exceed 103 % of maximum continuous revolutions. These governors are to be capable of maintaining a safe minimum speed.

((4) to (6) are omitted.)

Sub-paragraph -4 has been amended as follows.

4 Remote starting of main propulsion machinery in ~~diesel~~ ships in which reciprocating internal combustion engines are used as main propulsion machinery (excluding electric propulsion ships)

Starting by means of remote control devices for main propulsion machinery is to comply with the following:

((1) to (4) are omitted.)

18.3.4 Safety Measures*

Sub-paragraph -1(3) has been amended as follows.

1 Safety measures for main propulsion machinery or controllable pitch propellers

Safety measures for main propulsion machinery or controllable pitch propellers are to comply with the following requirements:

((1) and (2) are omitted.)

(3) With respect to safety measures for main propulsion machinery driven by ~~diesel~~ reciprocating internal combustion engines, the requirements specified in **2.4.5-1** are to be applied.

Sub-paragraph -3 has been amended as follows.

3 Self-reversing ~~diesel~~ reciprocating internal combustion engines

Remote control devices for self-reversing ~~diesel~~ reciprocating internal combustion engines are to be at least provided with the following safety measures:

((1) to (3) are omitted.)

18.5 Automatic and Remote Control of Electric Generating Sets

18.5.1 General

Sub-paragraph -3 has been amended as follows.

3 In cases where ~~diesel~~ reciprocating internal combustion engines used to drive propulsion generators are remotely started, the number of starts is to conform to the required number specified in **2.5.3**.

Sub-paragraph -6 has been amended as follows.

6 With respect to safety measures for electric generating set driven by ~~diesel~~ reciprocating internal combustion engines, the requirements specified in **2.4.5-1** are to be applied.

Paragraph 18.5.2 has been amended as follows.

18.5.2 Emergency Source of Electric Power

Automatic or remote control devices for ~~diesel~~ reciprocating internal combustion engines driving emergency generators are to comply with the following requirements:

((1) and (2) are omitted.)

(3) Each ~~diesel~~ reciprocating internal combustion engine with a maximum continuous output of 220 *kW* or over is to be provided with an overspeed protective device specified in **2.4.1-4**.

(4) When devices, other than those referred to in **(3)**, are provided to shutdown ~~diesel~~ reciprocating internal combustion engines, means are to be provided to override those devices automatically during navigation.

((5) is omitted.)

Title of Table D18.2 has been amended as follows.

Table D18.2 Alarms for ~~Diesel~~ Reciprocating Internal Combustion Engines to Drive Emergency Generators

18.6 Automatic and Remote Control of Auxiliary Machinery

Paragraph 18.6.9 has been amended as follows.

18.6.9 ~~Diesel~~ Reciprocating Internal Combustion Engines

1 With respect to the safety measures for auxiliary machinery driven by ~~diesel~~ reciprocating internal combustion engines, the requirements specified in **2.4.5-1** are to be applied.

2 The requirements in **18.5.2** apply correspondingly to the automatic or remote control devices for emergency ~~diesel~~ reciprocating internal combustion engines other than those mentioned in **18.5.2**.

EFFECTIVE DATE AND APPLICATION (Amendment1-3)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Rules, the current requirements apply to ships for which the date of contract for construction is before the effective date.

Amendment 1-4

Chapter 1 GENERAL

1.3 General Requirements for Machinery Installations

1.3.1 General*

Sub-paragraph -10 has been renumbered to Sub-paragraph -11, and Sub-paragraph -10 has been added as follows.

10 Waterjet propulsion systems or azimuth thrusters are to comply with the requirements of **Chapter 19** and **Chapter 20**, respectively.

Sub-paragraph -11 has been amended as follows.

~~**10**~~**11** The exhaust gas treatment systems specified in the following **(1)** and **(2)** fitted onto machinery installations are to ~~be to the satisfaction of the Society~~ comply with the requirements of **Chapter 21** and **Chapter 22**, respectively.
(1) Selective catalytic reduction (SCR) systems
(2) Exhaust gas cleaning systems (EGCS) (excluding those specified in **2.1.1-5**)

EFFECTIVE DATE AND APPLICATION (Amendment 1-4)

1. The effective date of the amendments is 1 July 2020.
2. Notwithstanding the amendments to the Rules, the current requirements apply to waterjet propulsion systems, azimuth thrusters, SCR systems or EGCS whose applications for approval are submitted to the Society before the effective date installed on ships for which the date of contract for construction is before the effective date.

Amendment 1-5

Title of Chapter 1 has been amended as follows.

Chapter 1 ~~General~~ENERAL

1.3 General Requirements for Machinery Installations

Paragraph 1.3.10 has been added as follows.

1.3.10 Rating Plate for *A.C.* Generating Sets

A.C. generating sets ("generating set" means a system which is composed of alternators, reciprocating internal combustion engines, couplings, etc.), except for those sets consisting of a propulsion engine which also drives power take-off (PTO) generator(s), are to be installed with rating plates marked with at least the following information:

(1) the generating sets manufacturer's name or mark;
(2) the set serial number;
(3) the set date of manufacture (month/year);
(4) the rated power (both in *kW* and *KVA*) with one of the prefixes *COP*, *PRP* (or, only for emergency generating sets, *LTP*) as defined in *ISO* 8528-1:2018, where the rated power is to be appropriate for the actual use of the generator set;
(5) the rated power factor;
(6) the set rated frequency (*Hz*);
(7) the set rated voltage (*V*);
(8) the set rated current (*A*); and
(9) the mass (*kg*).

Chapter 8 TORSIONAL VIBRATION OF SHAFTINGS

8.1 General

8.1.2 Data to be Submitted

Sub-paragraph -2(3) has been added as follows.

2 Notwithstanding the requirements specified in **-1**, submission of torsional vibration calculation sheets may be omitted in the following cases provided that approval of the Society is obtained:

(1) In cases where the shafting system is of the same type as previously approved one.

(2) In cases where there is a slight alternation in the specifications of the vibration system, and the frequency and torsional vibration stress can be deduced with satisfactory accuracy on the basis of the previous results of calculations or measurements.

(3) In cases where the shafting system is for a generating set which has an engine power of less than 110 *kW.*

EFFECTIVE DATE AND APPLICATION (Amendment 1-5)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to *A.C.* generating sets whose applications for approval are submitted to the Society before the effective date installed on ships for which the date of contract for construction* is before the effective date.

* "contract for construction" is defined in the latest version of IACS Procedural Requirement (PR) No.29.

IACS PR No.29 (Rev.0, July 2009)

1. The date of "contract for construction" of a vessel is the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. This date and the construction numbers (i.e. hull numbers) of all the vessels included in the contract are to be declared to the classification society by the party applying for the assignment of class to a newbuilding.

2. The date of "contract for construction" of a series of vessels, including specified optional vessels for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the prospective owner and the shipbuilder.

For the purpose of this Procedural Requirement, vessels built under a single contract for construction are considered a "series of vessels" if they are built to the same approved plans for classification purposes. However, vessels within a series may have design alterations from the original design provided:

(1) such alterations do not affect matters related to classification, or

(2) If the alterations are subject to classification requirements, these alterations are to comply with the classification requirements in effect on the date on which the alterations are contracted between the prospective owner and the shipbuilder or, in the absence of the alteration contract, comply with the classification requirements in effect on the date on which the alterations are submitted to the Society for approval.

The optional vessels will be considered part of the same series of vessels if the option is exercised not later than 1 year after the contract to build the series was signed.

3. If a contract for construction is later amended to include additional vessels or additional options, the date of "contract for construction" for such vessels is the date on which the amendment to the contract, is signed between the prospective owner and the shipbuilder. The amendment to the contract is to be considered as a "new contract" to which **1.** and **2.** above apply.

4. If a contract for construction is amended to change the ship type, the date of "contract for construction" of this modified vessel, or vessels, is the date on which revised contract or new contract is signed between the Owner, or Owners, and the shipbuilder.

Note:
This Procedural Requirement applies from 1 July 2009.

Amendment 1-6

Title of Chapter 2 has been amended as follows.

Chapter 2 ~~DIESEL~~ RECIPROCATING INTERNAL COMBUSTION ENGINES

2.1 General

2.1.1 General*

Sub-paragraph -3 has been amended as follows.

3 For each type of ~~diesel~~ reciprocating internal combustion engines, an approval of use is to be obtained by the engine designer (hereinafter referred to "licensor" in this Chapter) as specified separately by the Society.

2.1.3 Drawings and Data*

Sub-paragraph -1(3) has been amended.

1 Drawings and data to be submitted are generally as follows:
((1) and (2) are omitted.)
(3) Drawings and data for the purpose of inspection and testing of ~~diesel~~ reciprocating internal combustion engines
  (a) A list containing all drawings and data submitted (including relevant drawing numbers and revision status)
  ((b) to (m) are omitted.)
  (n) Schematic layout or other equivalent drawings and data on the ~~diesel~~ reciprocating internal combustion engine of the following **i)** to **vii)** (Details of the system so far as supplied by the licensee such as~~:~~ main dimensions, operating media and maximum working pressures).
  (i) to vii) are omitted.)
  ((o) to (ao) are omitted.)

Paragraph 2.1.4 has been amended as follows.

2.1.4 Approval of ~~Diesel~~ Reciprocating Internal Combustion Engines

1 ~~Diesel~~ Reciprocating internal combustion engines are to be approved in accordance with the following **(1)** to **(6)**:
(1) Development of documents and data for engine production
  (a) Prior to the start of the ~~diesel~~ reciprocating internal combustion engine approval process in accordance with the following **(3)** and subsequent sub-paragraphs of this paragraph, a design approval is to be obtained as specified separately by the Society.
  (b) Each type of ~~diesel~~ reciprocating internal combustion engine is to be provided with a certificate of approval of use obtained by the licensor in accordance with **2.1.1-3**. For the first engine of a type or for those with no service records, the process of an approval of use and the approval process for production by the licensee may be performed simultaneously.
  (c) The licensor is to review the drawings and data of the ~~diesel~~ reciprocating internal combustion engine whose approval of use has been obtained for the application and

develop, if necessary, application specific drawings and data for production of ~~diesel~~ reciprocating internal combustion engines for the use of the licensee in developing the ~~diesel~~ reciprocating internal combustion engine specific production drawings and data listed in **2.1.3-1(3)**.

(d) If substantive modifications to the drawings and data of the ~~diesel~~ reciprocating internal combustion engine whose approval of use has been obtained have been made in the drawings and data of ~~diesel~~ reciprocating internal combustion engines to be produced, the affected drawings and data are to be resubmitted to the Society as specified separately by the Society.

(2) Drawings and data for the purpose of inspection and testing of ~~diesel~~ reciprocating internal combustion engines

(a) The licensee is to develop the drawings and data listed in **2.1.3-1(3)** and a comparison list of these drawings and data to the drawings and data of the ~~diesel~~ reciprocating internal combustion engine whose approval of use has been obtained by the licensor and submit these drawings and the comparison list to the Society.

(b) In applying **2.1.3-1(3)**, if there are differences in the technical content on the licensee's production drawings and data of the ~~diesel~~ reciprocating internal combustion engine compared to the drawings and data of the ~~diesel~~ reciprocating internal combustion engine whose approval of use has been obtained by the licensor, the licensee is to submit "Confirmation of the licensor's acceptance of licensee's modifications" approved by the licensor and signed by the licensee and licensor. If the licensor acceptance is not confirmed, the ~~diesel~~ reciprocating internal combustion engine manufactured by the licensee is to be regarded as a different engine type and is **2.1.1-3** is to apply to the ~~diesel~~ reciprocating internal combustion engine.

((c) and (d) are omitted.)

(e) The licensee or its subcontractors are to prepare to be able to provide the drawings and data specified in **(a)** and **(b)** above so that the Surveyor can use the information for inspection purposes during manufacture and testing of the ~~diesel~~ reciprocating internal combustion engine and its components.

((3) and (4) are omitted.)

(5) Engine assembly and testing

The licensee is to assemble and test the ~~diesel~~ reciprocating internal combustion engine according to the Society's technical rules each of the ~~diesel~~ reciprocating internal combustion engine assembly and testing procedure is to be witnessed by the Surveyor unless the manufacturer of the ~~diesel~~ reciprocating internal combustion engine is one approved in accordance with the **Rules for Approval of Manufacturers and Service Suppliers** and use of a mass production system is agreed between the manufacturer and the Society.

(6) Issue of certificates of ~~diesel~~ reciprocating internal combustion engines and components

((a) and (b) are omitted.)

2 In applying **-1** above, for those cases when a licensor - licensee agreement does not apply, a "licensor" is to be understood as the following **(1)** or **(2)**:

(1) The entity that has the design rights for the ~~diesel~~ reciprocating internal combustion engine type; or

(2) The entity that is delegated by the entity having the design rights of **(1)** above to modify the design.

3 Components of licensor's design which are covered by the certificate of approval of use of the relevant engine type are regarded as approved whether manufactured by the ~~diesel~~ reciprocating internal combustion engine manufacturer or sub-supplied.

4 (Omitted)

EFFECTIVE DATE AND APPLICATION (Amendment 1-6)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Rules, the current requirements apply to reciprocating internal combustion engines whose type is the same type of those for which the application for approval is submitted to the Society before the effective date.

Amendment 1-7

Title of Chapter 2 has been amended as follows.

Chapter 2 ~~DIESEL~~ RECIPROCATING INTERNAL COMBUSTION ENGINES

2.1 General

2.1.1 General*

Sub-paragraph -4 has been amended as follows.

4 Electronically-controlled ~~diesel~~ engines which are used as the main propulsion machinery are to be in accordance with the requirements specified otherwise by the Society in addition to those in this Chapter.

EFFECTIVE DATE AND APPLICATION (Amendment 1-7)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Rules, the current requirements apply to electronically controlled engines for which the application for approval is submitted to the Society before the effective date.

Amendment 1-8

Title of Chapter 2 has been amended as follows.

Chapter 2 ~~DIESEL~~ RECIPROCATING INTERNAL COMBUSTION ENGINES

2.1 General

2.1.1 General*

Sub-paragraph -5 has been amended as follows.

5 ~~Diesel~~ Reciprocating internal combustion engines fitted with exhaust gas recirculation (EGR) systems are to be in accordance with requirements specified ~~otherwise by the Society~~ in **Chapter 23** in addition to those in this Chapter.

EFFECTIVE DATE AND APPLICATION (Amendment 1-8)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Rules, the current requirements apply to EGR systems whose applications for approval are submitted to the Society before the effective date installed on ships for which the date of contract for construction is before the effective date.

Amendment 1-9

Title of Chapter 2 has been amended as follows.

Chapter 2 ~~DIESEL~~ RECIPROCATING INTERNAL COMBUSTION ENGINES

2.1 General

2.1.1 General*

Sub-paragraphs -5 and -6 have been renumbered to sub-paragraphs -6 and -7, and sub-paragraph -5 has been added as follows.

5 The requirements of exhaust driven turbochargers specified in this chapter also apply, in principle, to engine driven chargers.
~~5~~6 (Omitted)
~~6~~7 (Omitted)

2.1.3 Drawings and Data*

Sub-paragraph -1 has been amended as follows.

1 Drawings and data to be submitted are generally as follows:
(1) Drawings and data for approval
((a) to (f) are omitted.)
(g) The following drawings and data for exhaust driven turbochargers:
i) Category *A* turbochargers (upon request)
1) Sectional assembly (including principal dimensions and names of components)
2) Containment test report
3) Test procedures
ii) Category *B* turbochargers
1) Sectional assembly (including principal dimensions and materials of housing components for containment evaluation.)
2) Documentation of containment in the event of the disc fracture specified in **2.5.1-~~4~~6** ~~(only for category *B* or *C* turbochargers with novel design features or no service records)~~
3) Documentation of following operational data and limitations~~Particulars (only for category *B* or *C* turbochargers)~~
・Maximum permissible operating speed (*rpm*)
・Maximum permissible exhaust gas temperature at the turbine inlet
・Minimum lubrication oil inlet pressure
・Maximum lubrication oil outlet temperature
・Maximum permissible vibration levels (self- and externally generated vibrations)
・Alarm level for overspeed (levels are also to be indicated on engine control system diagrams)
・Alarm level for exhaust gas temperature at the turbine inlet (levels are also to be indicated on engine control system diagrams)

・Lubrication oil inlet pressure low alarm set point (levels are also to be indicated on engine control system diagrams)
・Lubrication oil outlet temperature high alarm set point (levels are also to be indicated on engine control system diagrams)

4) Diagram of lubrication oil systems (diagrams included in piping arrangements fitted to engines may be accepted instead)
5) Test report of type test (only for type tests)
6) Test procedure (only for type tests)

iii) Category *C* turbochargers
1) Drawings listed in **ii)** above
~~iv~~2) Drawings of the housing and rotating parts (~~only for category *C* turbochargers~~including details of blade fixing)
~~v~~3) Material specifications (~~only for category *C* turbochargers.~~including mechanical properties and chemical composition) of the parts mentioned in ~~**iv**~~**2)** above
~~vi~~4) Welding details and welding procedures for the parts mentioned in ~~**iv**~~**2)** above, if made of welded construction ~~(only for category *C* turbochargers with novel design features or no service records)~~

(2) Drawings and data for reference
((a) to (h) are omitted.)
(i) The following drawings and data for exhaust driven turbochargers (only for category *C* turbochargers):
i) Documentation of the safe torque transmission specified in **2.5.1-~~5~~6** when the disc is connected to the shaft by an interference fit ~~(only for category *C* turbochargers with novel design features or no service records)~~
ii) Information on expected lifespan (~~only for category *C* turbochargers with novel design features or no service records~~ Creep, low cycle fatigue and high cycle fatigue are to be considered.)
iii) Operation and ~~service~~ maintenance manuals ~~(only for category *C* turbochargers with novel design features or no service records)~~
(j) Other drawings and data deemed necessary by the Society
(3) (Omitted)

2.5 Associated Installations

Paragraph 2.5.1 has been amended as follows.

2.5.1 Exhaust Driven Turbochargers*

1 Manufacturers are to adhere to a quality system designed to ensure that designer specifications are met, and that manufacturing is in accordance with the approved drawings.

~~**1**~~**2** For main propulsion engine equipped with exhaust driven turbochargers, means are to be provided to ensure that the engine can be operated with sufficient power to give the ship a navigable speed in case of failure of one of the turbochargers.

~~**2**~~**3** Where the main propulsion engine cannot be operable only with the exhaust driven turbochargers in case of starting or low speed range, an auxiliary of scavenging air system is to be provided. For the event of failure of such an auxiliary system, proper means are to be provided so that the main propulsion engine can be brought into the condition that its output increases enough as the exhaust driven turbochargers show their function.

4 Exhaust driven turbochargers are to be designed to operate under the conditions given in **1.3.1-6** and **2.2.2-7**. Component lifetime and the alarm level for speed are to be based upon an air

inlet temperature of 45° C.

~~3~~**5** The air inlets of exhaust driven turbochargers ~~with novel design features or no service records~~ are to be fitted with filters.

~~4~~**6** Exhaust driven turbochargers ~~with novel design features or no service records~~ are to be capable of containment in the event of a rotor burst. This means that no parts are to penetrate the casing of exhaust driven turbochargers or escape through the air intake in the case of a rotor burst. It is to be assumed that the discs disintegrate in the worst possible way.

~~5~~**7** In the case of category *C* turbochargers ~~with novel design features or no service records~~ where the disc is connected to the shaft by an interference fit, calculations are to substantiate safe torque transmission during all relevant operating conditions such as maximum speed, maximum torque and maximum temperature gradient combined with minimum shrinkage amount.

~~6~~**8** For categories *B* and *C* turbochargers ~~with novel design features or no service records~~, the indications and alarms listed in the **Table D2.5** are to be provided. Indications may be provided at local locations, monitoring stations or control stations. Alarm levels may be equal to permissible limits, but are not to be reached when operating the engine at 110% power, or at any approved intermittent overload beyond 110 % in cases where the turbochargers are fitted to engines for which intermittent overload power is approved.

~~7~~**9** Turbochargers are to have compressor characteristics that allow the engines, for which they are intended, to operate without any audible high pitch vibrations or explosion-like noises from the scavenger area of the engine (hereinafter referred to as "surging" in this Part) during all operating conditions and also after extended periods of operation. For abnormal, but permissible, operation conditions such as misfiring and sudden load reduction, repeated surging (hereinafter referred to as "continuous surging") is not to occur.

10 Certificates for categories *B* and *C* turbochargers issued by the Society will, at a minimum, cite the applicable type approval.

11 Certification and test requirements specified in this chapter apply to the replacement of rotating parts and casings.

Paragraph 2.5.7 has been deleted.

~~**2.5.7 Engine Driven Chargers**~~

~~Engine driven chargers are, in principle, to be in accordance with the requirements of exhaust driven turbochargers specified in this chapter.~~

2.6 Tests

2.6.1 Shop Tests*

Sub-paragraph -6 has been amended as follows.

6 For categories *B* and *C* turbochargers ~~with novel design features or for those with no service records~~, tests are to be carried out to verify durability according to procedures deemed appropriate by the Society.

EFFECTIVE DATE AND APPLICATION (Amendment 1-9)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Rules, the current requirements apply to turbochargers with novel design features or no service records for which the application for approval is submitted to the Society before the effective date.

Amendment 1-10

Title of Chapter 2 has been amended as follows.

Chapter 2 ~~DIESEL~~ RECIPROCATING INTERNAL COMBUSTION ENGINES

2.2 Materials, Construction and Strength

2.2.1 Materials

Sub-paragraph -1 has been amended as follows.

1 Materials intended for the principal components of ~~diesel~~ reciprocating internal combustion engines and their non-destructive tests as well as surface inspections and dimension inspections are to conform to the requirements given in **Table D2.1**. However, with respect to ultrasonic testing as well as surface inspections and dimension inspections, submission or presentation of test results to the Surveyor may be considered sufficient. In cases where deemed necessary by the Society, tests or inspections may also be required for any parts not specified in **Table D2.1**.

2.2.2 Construction, Installation and General*

Sub-paragraph -2 has been amended as follows.

2 Where the principal components of a ~~diesel~~ reciprocating internal combustion engine are of welded construction, they are to comply with the requirements of **Chapter 11**.

Sub-paragraph -6(3) has been amended as follows.

6 Ventilation of crankcase, and any arrangement which could produce a flow of external air into the crankcase, is not permitted except in cases **(1)** to **(3)** below.
((1) and (2) are omitted.)
(3) In cases where trunk piston type dual fuel ~~diesel~~ reciprocating internal combustion engines are provided with crankcase ventilation for preventing the accumulation of leaked gas.

Sub-paragraph -7 has been amended as follows.

7 The ambient reference conditions for the purpose of determining the power of ~~diesel~~ reciprocating internal combustion engines are to be as follows:
Total barometric pressure: 0.1 *MPa*
Air temperature: 45 °C
Relative humidity: 60 %
Seawater temperature (charge air intercooler-inlet): 32 °C

Table D2.1 has been amended as follows.

Table D2.1 Application of Materials and Non-destructive Tests as well as Surface Inspections and Dimension Inspections to Principal Components of ~~Diesel~~ Reciprocating Internal Combustion Engines

(Table is omitted.)

Notes:

((1) to (4) are omitted.)

(5) Only for crosshead ~~diesel~~ reciprocating internal combustion engines.

((6) to (17) are omitted.)

2.4 Safety Devices

2.4.1 Speed Governors and Overspeed Protective Devices

Sub-paragraphs -1 to -4 have been amended as follows.

1 For ship in which ~~Each diesel~~ reciprocating internal combustion engines are used as main propulsion machinery (excluding electric propulsion ships), ~~in diesel ships~~ each of such reciprocating internal combustion engines is to be provided with a speed governor so adjusted to prevent the engine speed from exceeding the number of maximum continuous revolutions by more than 15 %.

2 In addition to this speed governor, each ~~diesel~~ reciprocating internal combustion engine as specified in **-1** above ~~used as main propulsion machinery in diesel ships~~ that has a continuous maximum output of 220 *kW* or above, and which can be declutched or which drives a controllable pitch propeller, is to be provided with a separate overspeed protective device. The overspeed protective device, including its driving gear, are to be independent from the governor required by **-1**, and be so adjusted that the engine speed may not exceed the number of maximum continuous revolutions by more than 20 %.

3 ~~Diesel~~ Reciprocating internal combustion engines used to drive generators are to be provided with the governors specified in the requirements in **2.4.2, Part H**. However, if a ~~diesel~~ reciprocating internal combustion engine which is used as main propulsion machinery ~~for~~ of an electric propulsion ship drives a generator used to supply electrical power exclusively to propulsion motors, the requirements specified in **5.1.2-2, Part H** are to be applied.

4 In addition to the speed governor, each ~~diesel~~ reciprocating internal combustion engine used as main propulsion machinery of electric propulsion ships and those ~~diesel~~ reciprocating internal combustion engines used to drive generators that have a maximum continuous output of 220 *kW* or above are to be provided with a separate overspeed protective device. The overspeed protective device, including its driving gear, are to be independent from the governor required by **-3**, and be so adjusted that the engine speed may not exceed the number of maximum continuous revolutions by more than 15 %.

Paragraph 2.4.2 has been amended as follows.

2.4.2 Alarm for Overpressure in the Cylinders

Each cylinder of ~~diesel~~ reciprocating internal combustion engines having a bore exceeding 230 *mm* is to be provided with an effective sentinel valve or other means for overpressure.

2.4.3 Protection against Crankcase Explosion*

Sub-paragraph -1 has been amended as follows.

1 ~~For diesel~~ Reciprocating internal combustion engines having a cylinder bore not less than 200 *mm* or a crankcase with a gross volume not less than 0.6 m^3 are to be provided with crankcase explosion relief valves of an approved type for preventing any overpressure in the event of an explosion within the crankcase. Crankcase explosion relief valves are to be in accordance with the following requirements:
((1) to (5) are omitted.)

2.4.5 Crankcase Oil Mist Detection Arrangements*

Sub-paragraph -1 has been amended as follows.

1 Crankcase oil mist detection arrangements are required for ~~diesel~~ reciprocating internal combustion engines of 2,250 *kW* maximum continuous power and above or having cylinders of more than 300 *mm* bore, and in cases of engine failure, the following means are to automatically be employed. However, in cases where alternative devices deemed appropriate by the Society are provided, such devices may be used instead of crankcase oil mist detection arrangements. In this case, the following means are also to be automatically employed.

(1) In the case of low speed ~~diesel~~ engines (a rated speed of less than 300 *rpm*), alarms are to activate and speeds be reduced. (However, in cases where alternative measures such as activating alarms to request such speed reductions are taken, the manual reduction of speeds may be accepted).
(2) In the case of medium speed ~~diesel~~ engines (a rated speed of 300 *rpm* and above, but less than 1,400 *rpm*) and high speed ~~diesel~~ engines (a rated speed of 1,400 *rpm* and above), alarms are to activate and ~~diesel~~ engines are to be stopped or have their fuel supply shut off.

2.5 Associated Installations

2.5.3 Starting Arrangements*

Sub-paragraph -4 has been amended as follows.

4 The starting arrangements of ~~diesel~~ reciprocating internal combustion engines which drive generators or auxiliaries are to be as deemed appropriate by the Society.

Paragraph 2.5.4 has been amended as follows.

2.5.4 Fuel Oil Arrangements

1 Where a ~~diesel~~ reciprocating internal combustion engine is mounted on an elastic support, flexible joints approved by the Society are to be provided at the connections between the engine and the fuel oil supply pipe.
2 The fuel oil arrangements for ~~diesel~~ reciprocating internal combustion engines are additionally to comply with the requirements in **13.9, Part D** and **4.2.2, Part R**.

2.5.5 Lubricating Oil Arrangements

Sub-paragraph -1 has been amended as follows.

1 The lubricating oil arrangements of ~~diesel~~ reciprocating internal combustion engines with a maximum continuous output exceeding 37 *kW* are to be provided with alarm devices which give visible and audible alarming in the event of failure of the supply of lubricating oil or an appreciable reduction in lubricating oil pressure. Also, devices to stop the operation of the engine automatically by lower pressure after such alarms are to be provided.

2.6 Tests

2.6.1 Shop Tests*

Sub-paragraphs -2 and -3 have been amended as follows.

2 For ~~diesel~~ reciprocating internal combustion engines, shop trials are to be carried out according to the test procedure deemed appropriate by the Society.
3 For ~~diesel~~ reciprocating internal combustion engines with novel design features or for those with no service records, tests are to be carried out to verify their durability according to the procedure deemed appropriate by the Society.

Note of Table D2.6 has been amended as follows.

Table D2.6 Hydrostatic Test Pressure

(Table is omitted.)

Notes:
((1) to (7) are omitted.)
(8) Only for crosshead ~~diesel~~ reciprocating internal combustion engines.
((9) and (10) are omitted.)

EFFECTIVE DATE AND APPLICATION (Amendment 1-10)

1. The effective date of the amendments is 1 July 2020.
2. Notwithstanding the amendments to the Rules, the current requirements apply to reciprocating internal combustion engines for which the application for approval is submitted to the Society before the effective date.

Amendment 1-11

Title of Chapter 2 has been amended as follows.

Chapter 2 ~~DIESEL~~ RECIPROCATING INTERNAL COMBUSTION ENGINES

2.2 Materials, Construction and Strength

2.2.1 Materials

1 Materials intended for the principal components of diesel engines and their non-destructive tests as well as surface inspections and dimension inspections are to conform to the requirements given in **Table D2.1**. However, with respect to ultrasonic testing as well as surface inspections and dimension inspections, submission or presentation of test results to the surveyor may be considered sufficient. In cases where deemed necessary by the Society, tests or inspections may also be required for any parts not specified in **Table D2.1**.

Table D2.1 has been amended as follows.

Table D2.1 Application of Materials and Non-destructive Tests as well as Surface Inspections and Dimension Inspections to Principal Components of Diesel Engines

Principal components			Cylinder bore D (*mm*)								
			$D \leq 300$			$300 < D \leq 400$			$400 < D$		
			I	II	III	I	II	III	I	II	III
1	Welded bedplate		○	○		○	○		○	○	
2	Bearing transverse girders (cast steel)		○	○		○	○		○	○	
3	Welded frame box		○	○		○	○		○	○	
4	Welded cylinder frames (5)		○	○		○	○		○	○	
5	Engine block (spheroidal graphite cast iron)(6)		○			○			○		
6	Cylinder liner					○(7)			○(7)		
7	Cylinder head (cast steel or forged steel)					○	○		○	○	
8	Piston crown (cast steel or forged steel)								○	○	
9	Crankshaft	made in one piece	○	○	○	○	○	○	○	○	○
		Web, pin and journal for all built-up and semi-built-up types	○	○	○	○	○	○	○	○	○
		Others (including coupling bolts)	○	○	○	○	○	○	○	○	○
10	Piston rod (5)								○	○	
11	Cross head (5)		○	○		○	○		○	○	
12	Connecting rods together with connecting rod bearing caps		○	○	○	○	○	○	○	○	○
13	Bolts and studs (for cylinder heads, connecting rods, main bearings)					○	○	*TR*(8)	○	○	*TR*(8)
14	Tie rod (5)		○	○	*TR*(8)	○	○	*TR*(8)	○	○	*TR*(8)
15	Fuel injection pump body		○(9)			○(9)			○(9)		
16	High pressure fuel injection pipes including common fuel rail		○			○			○		
17	High pressure common servo oil system		○			○			○		
18	Heat exchanger, both sides (10)					△			△		
19	Accumulator(11)		○			○			○		
20	Piping, pumps, actuators, etc. for hydraulic drive of valves (12)		○(13)			○(13)			○(13)		
21	Pipes, valves and fittings attached to engines classified in **Chapter 12** as either Group I or Group II. (excluding items listed in this table)		○			○			○		
22	Bearings for main, crosshead, and crankpin (12)		*TR*(14)	*TR*(15)	○	*TR*(14)	*TR*(15)	○	*TR*(14)	*TR*(15)	○
23	Turbine discs, blades, blower impellers and rotor shafts of exhaust driven turbochargers (16)	Category *A*	○(9)	~~⊖~~		○(9)	~~⊖~~		○(9)	~~⊖~~	
		Category *B*	○	○	○(17)	○	○	○(17)	○	○	○(17)
		Category *C*	○	○	○(17)	○	○	○(17)	○	○	○(17)
24	Casings of exhaust driven turbochargers (16)(18)	Category *A*	○(~~17~~9)			○(~~17~~9)			○(~~17~~9)		
		Category *B*	○			○			○		
		Category *C*	○			○			○		

Notes:

(1) Materials intended for the components marked by "○" or "*TR*" in Column I are to comply with the requirements in **Part K**. However, the components marked by "*TR*" in Column I may be in accordance with Note (9). In addition,

materials intended for the components marked by "△" in Column I are to comply with the requirements in **Chapter 10.**

(2) Materials intended for the components marked by "○"or "*TR*" in Column II are to be tested by a magnetic particle test or a liquid penetrant test as well as an ultrasonic test.

(3) Materials intended for the components marked by "○"or "*TR*" in Column III are to be tested by a surface inspection and a dimension inspection.

(4) For items marked by "*TR*", submission of a test report which compiles all test and inspection results in an acceptance protocol issued by the manufacturer may be accepted. The test report is to include the following. Tests or inspections may be carried out on samples from the current production.
(a) Signature of the manufacturer
(b) Statement that components comply with specifications stipulated by the manufacturer

(5) Only for crosshead diesel engines.

(6) Only when engine power exceeds 400 *kW*/*cyl*. Chemical composition analysis may be omitted.

(7) Materials may be in accordance with Note (9) except when used for steel parts.

(8) Only for threaded bolts and studs used for connecting rods or tie rods.

(9) Materials which comply with the requirements of national or international standards such as *ISO*, *JIS*, etc. may be used.

(10) Charge air coolers need only be tested on the water side.

(11) Only when capacity exceeds 0.5*l*.

(12) Only when engine power exceeds 800 *kW*/*cyl*.

(13) Materials intended for pumps and actuators may be in accordance with Note (9).

(14) Mechanical property test may be omitted.

(15) Magnetic particle tests and liquid penetrant tests may be omitted. An ultrasonic test is to be carried out for full contact between the base material and bearing metal

(16) In cases where the manufacturer has a quality system deemed appropriate by the Society, materials and non-destructive tests as well as a surface inspection and a dimension inspection for categories *A* and *B* turbochargers may not require the presence of a Society surveyor. In such cases, the submission or presentation of test records may be required by the Society.

(17) Surface inspection may be omitted.

(1~~7~~8) Chemical composition analysis may be omitted.

2.6 Tests

Paragraph 2.6.1 has been amended as follows.

2.6.1 Shop Tests*

1 For components or accessories specified in **Table D2.6**, hydrostatic tests are to be carried out on the water or oil side of the component at the pressures shown in the Table. In cases deemed necessary by the Society, tests may also be required for any components not specified in **Table D2.6**.

2 (Omitted)

3 (Omitted)

4 For rotating assemblies of exhaust driven turbochargers of categories *B* and *C*, dynamic balancing tests are to be carried out.

5 For the impellers and inducers of exhaust driven turbochargers of categories *B* and *C*, overspeed tests for a duration of 3 *minutes* at either of the following **(1)** or **(2)** are to be carried out ~~according to test procedures deemed appropriate by the Society~~. For forged impellers and inducers subject to quality control through an approved non-destructive test method, overspeed tests may be dispensed with.

(1) 120 % of the alarm level speed at room temperature; or

(2) 110 % of the alarm level speed at an inlet temperature of 45 °C when tested in the actual housing with the corresponding pressure ratio.

Table D2.6 has been amended as follows.

Table D2.6 Hydrostatic Test Pressure

Part		Cylinder bore *D* (*mm*)		Test Pressure[2](*MPa*)
		D ≤ 300	300<*D*	
Cylinder block (gray cast iron or spheroidal graphite cast iron) [3] [4]		○	○	1.5*P*
Engine block (gray cast iron or spheroidal graphite cast iron) [3] [4]		○	○	1.5*P*
Cylinder liner [4]			○	1.5*P*
Cylinder head (gray cast iron, spheroidal graphite cast iron, cast steel or forged steel)			○	1.5*P*
High pressure fuel line	Fuel injection pump body	*TR*[6]	○	1.5*P* or *P* +30, whichever is smaller
	fuel injection valves [5]			
	fuel injection pipes including common fuel rail [5]	*TR*[6]	○	
High pressure common servo oil system		*TR*[6]	○	1.5*P*
Turbocharger, cooling space [7]	Category *A*	~~○~~	~~○~~	0.4 or 1.5*P*, whichever is greater
	Category *B*	○	○	
	Category *C*	○	○	
Heat exchanger, both sides			○	1.5*P*
Exhaust gas valve cage [8]		○	○	1.5*P*
Accumulator [9]		○	○	1.5*P*
Piping, pumps, actuators, etc. for hydraulic drive of valves [10]		○	○	1.5*P*
Engine driven pumps (oil, water, fuel, bilge) [10]		○	○	1.5*P*
Piping system other than those listed in this Table		○	○	Apply the requirements in **12.6**

Notes:

(1) Materials intended for the components marked by "○"or "*TR*" are to be tested by hydrostatic test.

(2) *P* is the maximum working pressure (*MPa*).

(3) Only when engine power exceeds 400 *kW/cyl*.

(4) Hydrostatic tests are also required for those parts filled with cooling water that have the ability to contain water which is in contact with the cylinder or cylinder liner.

(5) Only when not autofretted.

(6) For items marked by "*TR*", submission of a test report which compiles all test and inspection results in an acceptance protocol issued by the manufacturer may be accepted. The test report is to include the following. Tests or inspections may be carried out on samples from the current production.

(a) Signature of the manufacturer

(b) Statement that components comply with specifications stipulated by the manufacturer

(7) In cases where the manufacturer has a quality system deemed appropriate by the Society, hydrostatic tests for categories ~~A and~~ *B* turbochargers may be substituted for by manufacturer tests. In such cases, the submission or presentation of test records may be required by the Society.

(8) Only for crosshead diesel engines.

(9) Only when capacity exceeds 0.5*l*.

(10) Only when engine power exceeds 800 *kW/cyl*.

EFFECTIVE DATE AND APPLICATION (Amendment 1-11)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Rules, the current requirements apply to turbochargers for which the application for approval is submitted to the Society before the effective date.

Amendment 1-12

Title of Chapter 2 has been amended as follows.

Chapter 2 ~~DIESEL~~ RECIPROCATING INTERNAL COMBUSTION ENGINES

2.3 Crankshafts

2.3.1 Solid Crankshafts*

Sub-paragraph -1 has been amended as follows.

1 The diameters of crankpins and journals are to be not less than the value given by the following formula:

(Omitted)

A and *B*:Coefficients given in **Table D2.2** and **Table D2.3** for engines having equal firing intervals (in the case of Vee engines, those with equal firing intervals on each bank.). Special consideration will be given to values *A* and *B* for ~~diesel~~ reciprocating internal combustion engines having unequal firing intervals or for those not covered by the Tables.

(Omitted)

EFFECTIVE DATE AND APPLICATION (Amendment 1-12)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Rules, the current requirements apply to crankshafts for which the application for approval is submitted to the Society before the effective date.

Amendment 1-13

Title of Chapter 2 has been amended as follows.

Chapter 2 ~~DIESEL~~ RECIPROCATING INTERNAL COMBUSTION ENGINES

2.5 Associated Installations

Note of Table D2.5 has been amended as follows.

Table D2.5 Alarms and Indications of Turbochargers

(Table is omitted.)

Notes:

((1) to (3) are omitted.)

(4) Separate sensors are to be provided when the lubrication oil system of the turbocharger is not integrated with the lubrication oil system of the ~~diesel~~ reciprocating internal combustion engine, or when it is separated from the ~~diesel~~ reciprocating internal combustion engine lubrication oil system by a throttle or pressure reduction valve.

((5) is omitted.)

EFFECTIVE DATE AND APPLICATION (Amendment 1-13)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Rules, the current requirements apply to turbochargers whose type is the same type of those for which the application for approval is submitted to the Society before the effective date.

Amendment 1-14

Chapter 3 STEAM TURBINES

3.2 Materials, Construction and Strength

3.2.2 General Construction

Sub-paragraph -6 has been amended as follows.

6 In steam turbines used ~~for the~~ as main propulsion machinery, steam strainers are to be provided at the turbine inlet or the inlet to the manoeuvring valves.

3.3 Safety Devices

3.3.1 Governors and Overspeed Protective Devices

Sub-paragraph -2 has been amended as follows.

2 In addition to this speed governor, ~~each steam turbine used as main propulsion machinery in steam turbine ships~~ for ships in which steam turbines are used as main propulsion machinery (excluding electric propulsion ships) which can be declutched, or which drives a controllable pitch propeller, each of such steam turbines is to be provided with a separate and independent speed governor in addition to the overspeed protective device specified in **-1** above. This additional speed governor is to be capable of controlling the speed of the unloaded turbine without bringing the overspeed protective device into action.

Paragraph 3.3.2 has been amended as follows.

3.3.2 Steam Shut-off Devices

1 ~~Main propulsion s~~Steam turbines used as main propulsion machinery are to be provided with devices which automatically shut off the steam supply to the ahead turbine (~~in~~ for steam turbines used as main propulsion machinery ~~in~~ of electric propulsion ships, the turbines used for that purpose) in the following cases:

(1) In the case of low lubricating oil pressure

(2) In the case of low main condenser vacuum

2 Steam ~~T~~turbines to drive generators or auxiliaries are to be provided with devices which automatically shut off the steam supply in the case of low lubricating oil pressure.

3 Arrangements are to be provided for shutting off the steam supply to steam turbines used as the main propulsion ~~turbines~~ machinery by suitable manually operated gears installed at the manoeuvring stand and at the turbine respectively. Manually operated gears for turbines to drive generators or auxiliaries are to be arranged in the vicinity of the turbines.

3.3.3 Lubricating Oil Supply System

Sub-paragraph -1 has been amended as follows.

1 Steam turbines used as ~~M~~main propulsion ~~turbines~~ machinery are to be provided with a satisfactory emergency supply of lubricating oil which comes into service automatically when the pressure drops below a predetermined pressure level. This emergency supply may be obtained from

a gravity tank or equivalent means (e.g. attached pump) with sufficient amount of oil to ensure adequate lubrication until the turbine is brought to rest.

EFFECTIVE DATE AND APPLICATION (Amendment 1-14)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Rules, the current requirements apply to steam turbines for which the application for approval is submitted to the Society before the effective date.

Amendment 1-15

Chapter 7 PROPELLERS

7.3 Force Fitting of Propellers

7.3.1 Pull-up Length*

Sub-paragraph -1 has been amended as follows.

1 In cases where a propeller is force fitted onto a propeller shaft without the use of a key, the lower and upper limits of pull-up length are to be as given by the following formulae. For a taper of more than 1/15, these limits of pull-up length are to be subject to the satisfaction of the Society:

(Omitted)

c: 1.0 for ships in which steam turbine or gas turbines are used as main propulsion machinery;

For ~~diesel~~ ships in which reciprocating internal combustion engines are used as main propulsion machinery, 1.2 or the value given by the following formula, whichever is greater. However, where a detailed report on the maximum torque acting on the fitted portion of the propeller under all operating conditions including transient conditions has been submitted to the satisfaction of the Society, it may comply with the provisions specified otherwise.

$$(0.194\ln D + 0.255)\left\{\left(\frac{N_C}{N_0}\right)^2 + 1.047\frac{Q_v N_0}{H} \times 10^{-2}\right\}$$

(Omitted)

EFFECTIVE DATE AND APPLICATION (Amendment 1-15)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Rules, the current requirements apply to propellers for which the application for approval is submitted to the Society before the effective date.

Amendment 1-16

Chapter 8 TORSIONAL VIBRATION OF SHAFTINGS

8.1 General

8.1.3 Measurements

Sub-paragraph -2 has been amended as follows.

2 In cases where the barred speed ranges specified in **8.3.1** are marked for ~~main diesel engines~~ reciprocating internal combustion engines used as main propulsion machinery, the following **(1)** and **(2)** are to be confirmed and recorded.
((1) and (2) are omitted.)

EFFECTIVE DATE AND APPLICATION (Amendment 1-16)

1. The effective date of the amendments is 1 July 2020.
2. Notwithstanding the amendments to the Rules, the current requirements apply to reciprocating internal combustion engines whose applications for approval are submitted to the Society before the effective date installed on ships for which the date of contract for construction is before the effective date.

Amendment 1-17

Chapter 11 WELDING FOR MACHINERY INSTALLATIONS

11.3 Post Weld Heat Treatment

11.3.1 Procedure of Post Weld Heat Treatment*

Table D11.1 has been amended as follows.

Table D11.1 Post Weld Heat Treatment Temperature

~~Category~~	Kind of steel	Minimum holding temperature (°C)
~~1~~	Carbon steel Carbon manganese steel $0.3M_0$ steel $0.5M_0$ steel $0.5Cr$-$0.5M_0$ steel $1Cr$-$0.5M_0$ steel $1\frac{1}{4}Cr$-$0.5M_0$ steel	600
~~2~~	$2\frac{1}{4}Cr$-$1M_0$ steel $5Cr$-$0.5M_0$ steel $0.5Cr$-$0.5M_0$-$0.5M_0$ steel	680

11.6 Welding of Piping

Title of Paragraph 11.6.1 has been amended as follows.

11.6.1 ~~Scope~~General

1 The requirements in **11.6** apply to the welding of pipes.

2 The requirements in **11.6.2**, **11.6.3** and **11.6.4** apply to the welding of pipes belonging to Group I and II specified in **Chapter 12** and valves and pipe fittings used for these pipes.

Paragraph 11.6.2 has been amended as follows.

11.6.2 ~~Alignment~~Assembling, etc. for Joints*

1 Edge preparation is to be in accordance with recognized standards and/or approved drawings. The preparation of the edges is to be preferably carried out by mechanical means. When flame cutting is used, care is to be taken to remove any oxide scales and notches due to irregular cutting by matching, grinding or chipping back to sound metal.

2 Joint preparations are to be appropriate to the welding process.

3 The maximum offset of joints between pipes is to be appropriate for the welding process and is not to exceed ~~1/4 of the pipe thickness~~ the maximum offset specified in **Table D11.6**.

4 Assembling for welding is to be appropriate and within prescribed tolerances. Tack welds are to be made with an electrode suitable for the base metal. Tack welds which form part of the finished weld are to be made using approved procedures. When welding materials require preheating, the same preheating is to be applied during tack welding.

Table D11.6 has been renumbered to Table D11.8, and Table D11.6 has been added as follows.

Table D11.6 Maximum offset of joints between pipes

		Diameter (inside diameter) and thickness of pipes during welding		
		Inside diameter less than 150 *mm*, and thickness up to 6 *mm*	Inside diameter less than 300 *mm*, and thickness up to 9.5 *mm* (excluding the left column)	Inside diameter 300 *mm* and over, or thickness over 9.5 *mm*
Maximum offset	Without backing ring	1.0 *mm* or 1/4 of thickness of pipe, whichever is less.	1.5 *mm* or 1/4 of thickness of pipe, whichever is less.	2.0 *mm* or 1/4 of thickness of pipe, whichever is less.
	With backing ring	0.5 *mm*		

Paragraph 11.6.3 has been amended as follows.

11.6.3 Preheating of Welds*

1 When welding pipes, dryness is to be ensured in all cases using suitable preheating if necessary.

2 ~~m~~Materials are to be ~~suitably~~ preheated to the minimum preheating temperature specified in **Table D11.7** in accordance with the kind of material and thickness of the ~~material~~welds. However, consideration is to be given to using a higher preheating temperature when a low hydrogen process is not used.

3 The preheating of materials not specified in **Table D11.7** is to be as deemed appropriate by the Society in accordance with the kind of material, welding consumable used and welding method.

Table D11.7 has been added as follows.

Table D11.7 Minimum Preheating Temperature

Kind of material	Thickness of weld (1) (t) (*mm*)	Minimum preheating temperature (°C)
$C + \frac{Mn}{6} \leq 0.4$ (2)	$t \geq 20$ (7)	50
$C + \frac{Mn}{6} > 0.4$ (2)	$t \geq 20$ (7)	100
0.3*Mo* steel 0.5*Mo* steel (3)	$t \geq 13$ (7)	100
1*Cr*-0.5M_0 steel (4) 1.25*Cr*-0.5M_0-0.75*Si* steel (5)	$t < 13$	100
	$t \geq 13$	150
2.25*Cr*-1M_0 steel (6) (8) 0.5*Cr*-0.5M_0-0.25*V* steel (8)	$t < 13$	150
	$t \geq 13$	200

Notes:

1. Excludes the thickness of any excess weld metal.
2. Corresponds to Grade1, Grade 2 and Grade 3 specified in **4.2, Part K**.
3. Corresponds to Grade 4, No.12 specified in **4.2, Part K**.
4. Corresponds to Grade 4, No.22 specified in **4.2, Part K**.
5. Corresponds to Grade 4, No.23 specified in **4.2, Part K**.
6. Corresponds to Grade 4, No.24 specified in **4.2, Part K**.
7. For welding at ambient temperatures below 0 °C, the minimum preheating temperature required is to be independent of thickness unless specially approved by the Society.
8. For these materials, preheating may be omitted for thicknesses up to 6 *mm* if the results of hardness tests carried out on welding procedure qualifications are considered acceptable by the Society.

Paragraph 11.6.4 has been amended as follows.

11.6.4 Post Weld Heat Treatment

1 After any welding, pipes of a thickness specified in **Table D11.~~6~~8** are to be subject to ~~post weld~~ stress relieving heat treatment ~~for relieving any residual stress according to~~ in accordance with the ~~grade~~ kind of material ~~used~~. The heat treatments are not to impair the specified properties of the materials, and verifications may be required to this effect as necessary.

2 Stress relieving heat treatment after welding for other than the oxy-acetylene welding process is required as specified in **Table D11.8** in accordance with the kind of material and thickness. In cases where oxy-acetylene welding is applied, the heat treatment as specified in **Table D11.9** in accordance with the kind of material is required.

3 The heat treatment temperature is to be 20 °C lower than the temperature of the final tempering treatment of the material or below.

~~2~~4 Regarding the post weld heat treatment of pipes and piping systems that are made of materials other than those given in ~~**1 above**~~ **Table D11.8**, treatment is to be made in accordance ~~to~~ with the ~~grade~~ kind of the base metal, the weld materials, the welding procedure, etc. as deemed appropriate by the Society.

Table D11.8 has been amended as follows.

Table D11.~~6~~8 ~~Pipes Requiring Post Weld~~ Stress Relieving Heat Treatment

~~Grade (Note 1)~~		~~Category in Table D11.1~~	~~Thickness of weld (t) (mm)~~
~~Grade 1, Grade 2 and Grade 3~~		~~1~~	~~$t \geq 15$~~
~~Grade 4~~	~~No.12~~	~~1~~	~~$t \geq 15$~~
	~~No.22 No.23~~	~~1~~	~~$t > 8$~~
	~~No.24~~	~~2~~	~~All (Note 2)~~

~~Notes:~~

~~1. Grades are as specified in **4.2, Part K.**~~

~~2. This treatment may be omitted if the thickness is 8 mm or less, the outside diameter is 100 mm or less and the design temperature is 450 °C or less.~~

Kind of material	Maximum thickness of weld [(1)] (t) (mm)	Minimum holding temperature (°C)
Carbon steel Carbon manganese steel[(2)]	$t \geq 15$[(7)(8)]	600
0.3*Mo* steel 0.5*Mo* steel[(3)]	$t \geq 15$[(7)]	
1*Cr*-0.5M_0 steel[(4)] 1.25*Cr*-0.5M_0-0.75*Si* steel[(5)]	$t > 8$	
2.25*Cr*-1M_0 steel[(6)] 0.5*Cr*-0.5M_0-0.25*V* steel	Any [(9)]	680

Notes:

1. Excludes the thickness of any excess weld metal.
2. Corresponds to Grade 1, Grade 2 and Grade 3 specified in **4.2, Part K**.
3. Corresponds to Grade 4, No.12 specified in **4.2, Part K**.
4. Corresponds to Grade 4, No.22 specified in **4.2, Part K**.
5. Corresponds to Grade 4, No.23 specified in **4.2, Part K**.
6. Corresponds to Grade 4, No.24 specified in **4.2, Part K**.

7. When steels with specified Charpy V notch impact properties at low temperature are used, the thickness above which post weld heat treatment is to be applied may be increased by special agreement with the Society.

8. Stress relieving heat treatment may be omitted up to 30 *mm* thickness by special agreement with the Society.

9. Heat treatment may be omitted for pipes having thicknesses not greater than 8 *mm*, diameters not greater than 100 *mm* and minimum service temperatures of 450 ºC.

Table D11.9 has been added as follows.

Table D11.9 Heat Treatment

Kind of material	Type and temperature of heat treatment (°C)
Carbon steel Carbon manganese steel(1)	Normalizing: from 880 to 940
0.3*Mo* steel 0.5*Mo* steel(2)	Normalizing: from 900 to 940
1*Cr*-0.5M_0 steel(3) 1.25*Cr*-0.5M_0-0.75*Si* steel(4)	Normalizing: from 900 to 960 Tempering: from 640 to 720
2.25*Cr*-1M_0 steel(5)	Normalizing: from 900 to 960 Tempering: from 650 to 780
0.5*Cr*-0.5M_0-0.25*V* steel	Normalizing: from 930 to 980 Tempering: from 670 to 720

Notes:

1. Corresponds to Grade 2, No.4 and Grade 3, No.4 specified in **4.2, Part K**.
2. Corresponds to Grade 4, No.12 specified in **4.2, Part K**.
3. Corresponds to Grade 4, No.22 specified in **4.2, Part K**.
4. Corresponds to Grade 4, No.23 specified in **4.2, Part K**.
5. Corresponds to Grade 4, No.24 specified in **4.2, Part K**.

Chapter 12 PIPES, VALVES, PIPE FITTINGS AND AUXILIARIES

12.4 Connection and Forming of Piping Systems

Paragraph 12.4.4 has been amended as follows.

12.4.4 Forming of Pipes and Heat Treatment after Forming*

1 Hot forming of pipes of Group I and Group II is to conform to the following requirements:

(1) Hot forming is to be generally carried out in a temperature range of 1000 °C – 850 °C, however the temperature may be decreased to 750 °C during the forming process.

(2) For ~~steel pipes of Grade 4 in **Table D11.6**~~ chromium-molybdenum steel and chromium-molybdenum-vanadium steel, stress relieving heat treatment is to be carried out ~~according to the requirements regarding the holding temperature and holding time for the pipes specified in **11.3.1.**~~ as specified in **Table D11.8** in accordance with the kind of material. For carbon steel, carbon-manganese steel and carbon-molybdenum steel, no subsequent heat treatment is required.

(3) In cases where the hot forming is carried outside the temperature range of **(1)** above, a subsequent new heat treatment as specified in **Table D11.9** is required.

2 When pipes of Group I and Group II are subjected to cold-forming, a suitable heat treatment is to be carried out ~~according to the pipe material, service environment, etc.~~ as specified in the following **(1)** and **(2)** in accordance with the kind of material with consideration given to any harmful plastic deformation due to cold-forming and development of residual stresses that may occur. For carbon steel and carbon-manganese steel with minimum tensile strengths of 320, 360 and 410 N/mm^2 (including Grade 1; Grade 2, No.2; Grade 2, No.3; Grade 3, No.2; and Grade 3, No.3 as specified in **4.2, Part K**), the heat treatment may be omitted.

(1) In cases where pipes are subjected to bending processes in such a manner that the bending radius of the pipe centreline is 4 times or less the outside diameter of the pipe, heat treatment as specified in **Table D11.9** is required.

(2) Stress relieving heat treatment as specified in **Table D11.8** is required for all materials except in the case of **(1)** above.

3 Regarding the forming and after-forming heat treatment for ~~steel~~ pipes other than those specified in ~~**4.2, Part K**~~**Table D11.8** ~~as well as pipes of materials other than steel~~, they are to be approved by the Society.

EFFECTIVE DATE AND APPLICATION (Amendment1-17)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Rules, the current requirements apply to the pipes used in ships for which the date of contract for construction is before the effective date.

Amendment 1-18

Chapter 13 PIPING SYSTEMS

13.10 Lubricating Oil Systems and Hydraulic Oil Systems

13.10.2 Lubricating Oil Pumps

Sub-paragraph -4 has been added as follows.

4 Number and capacity of lubricating oil pumps for waterjet propulsion systems and azimuth thrusters

Lubricating oil pumps for waterjet propulsion systems and azimuth thrusters are to comply with the requirements in **-1**. In this case the term "main propulsion machinery, propulsion shafting and power transmission systems" is to be read as "waterjet propulsion systems" or "azimuth thrusters" respectively.

13.10.4 Lubricating Oil Filters*

Sub-paragraphs -1 and -2 have been amended as follows.

1 In cases where a forced lubrication system (including gravity tanks) is adopted for the lubrication of machinery installations, lubricating oil filters are to be provided. Additionally, it is recommended to use strainers with magnets for waterjet propulsion systems and azimuth thrusters.

2 Filters used for the lubricating oil systems of the main propulsion machinery, power transmissions of propulsion shafting, ~~and~~ controllable pitch propeller systems, waterjet propulsion systems, and azimuth thrusters are to be capable of being cleaned without stopping the supply of filtered oil.

Chapters 21 and 22 have been renumbered to Chapters 24 and 25, and Chapters 19 and 20 have been added as follows.

Chapter 19 WATERJET PROPULSION SYSTEMS

19.1 General

19.1.1 Application

1 The requirements in this Chapter apply to waterjet propulsion systems intended for high speed engines used for main propulsion and steering (hereinafter referred to as "propulsion systems" in this Chapter).

2 The prime movers used for driving propulsion systems are to comply with the following requirements:

(1) Reciprocating internal combustion engines: **Chapter 2**

(2) Gas turbines: **Chapter 4**

3 The following requirements need not be applied to those propulsion systems without deflectors.

(1) **19.5.2-1**

(2) **19.5.3**

(3) **19.5.4-3**

(4) **19.6.2**

(5) **19.6.3(1), (2), (5), (6)** and **(7)**

(6) **19.7.1-1**, **-5** through **-10**

4 Special consideration will be given to propulsion systems of unconventional designs to which the requirements in this Guidance are not applicable.

19.1.2 Terminology

The terms used in this Chapter are defined as follows:

(1) "Propulsion systems" are systems, including the following **(a)** through **(d)** components, which receive water through inlet ducts and discharge water through nozzles at an increased velocity to produce propulsive thrust and steering.
   (a) Shafting (main shafts, bearings, shaft couplings, coupling bolts and sealing devices)
   (b) Water intake ducts
   (c) Waterjet pump units
   (d) Steering systems

(2) "Pump units" are made up of impellers, impeller casings, stators, stator casings, nozzles, bearings, bearing housing and sealing devices.

(3) "Impellers" are rotating assemblies provided with blades to give energy to the water.

(4) "Main shafts" are shafts that impellers are connected to.

(5) "Water intake ducts" are portions that lead water drawn from water intakes to impeller inlets.

(6) "Nozzles" are portions that inject rectified water from impellers.

(7) "Deflectors" are devices serving as rudders by leading water injected from nozzles either to port or to starboard.

(8) "Reversers" are devices to thrust ships so as to go astern by reversing flow directions of water injected from nozzles.

(9) "Stators" are assemblies composed of rows of stationary vanes that reduce any swirl added to the water by impellers.

(10) "Steering system" is a ship's directional control system, including the steering gear, steering gear control system and rudder (including the rudder stock) if any, or any equivalent system

(including deflectors, reversers and steering actuating systems driving defectors and/or reversers) for applying force on the ship hull to cause a change of heading or course. (*See* **Fig. D19.1** and **Fig. D19.2**)

(11) "Steering actuating system" consists of a steering gear power unit, a steering actuator and, for hydraulic or electrohydraulic steering gear, hydraulic piping.

(12) "Steering actuator" is a component which converts power into mechanical action to control the propulsion system as follows.

(a) In the case of electric steering: electric motor and driving pinion.

(b) In the case of electro hydraulic steering: hydraulic motor and driving pinion.

(13) "High speed engines" are either gas turbines or reciprocating internal combustion engines complying with the following condition:

$$(S \cdot n^2)/(1.8 \times 10^6) \geq 90$$

$$(\pi \cdot d_j \cdot n)/(6 \times 10^4) \geq 6$$

S : Length of stroke (*mm*)

n : Number of revolutions of engine at maximum continuous output (*rpm*)

d_j : Diameter of journal (*mm*)

(14) "Declared steering angle limits" are the operational limits in terms of maximum steering angle or equivalent, that are to be declared by the manufacturer / ship designer, also taking into account vessel speed or propeller torque/speed, or other limitations.

Fig. D19.1 Definition of steering system (in cases where two or more identical steering actuating systems are provided)

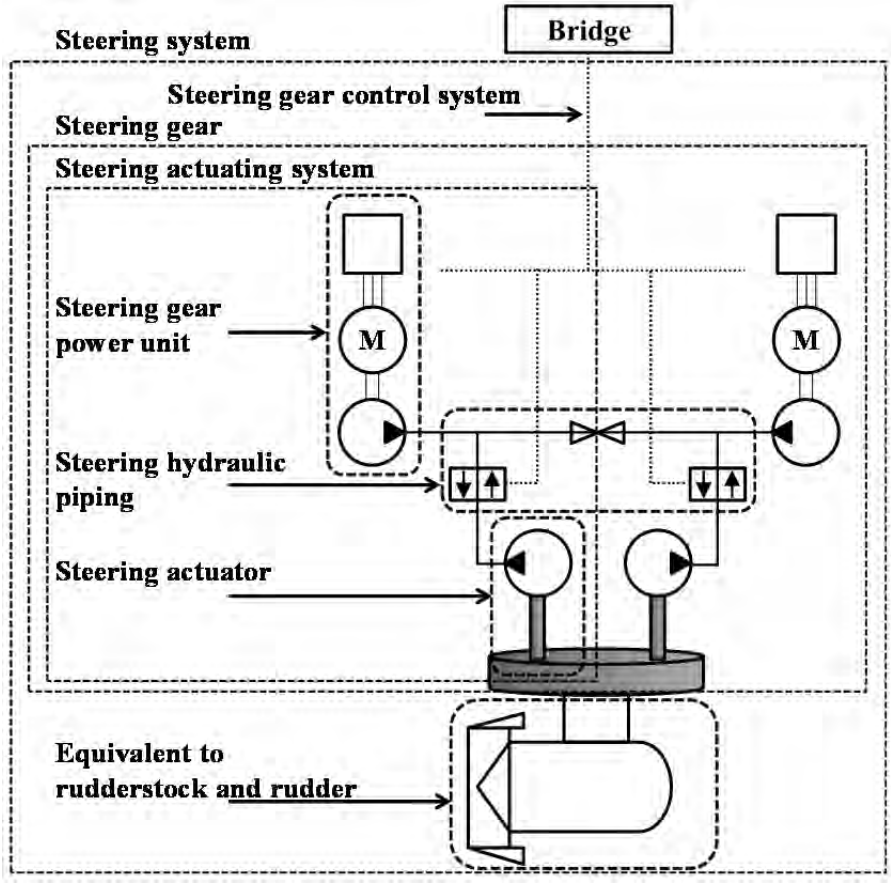
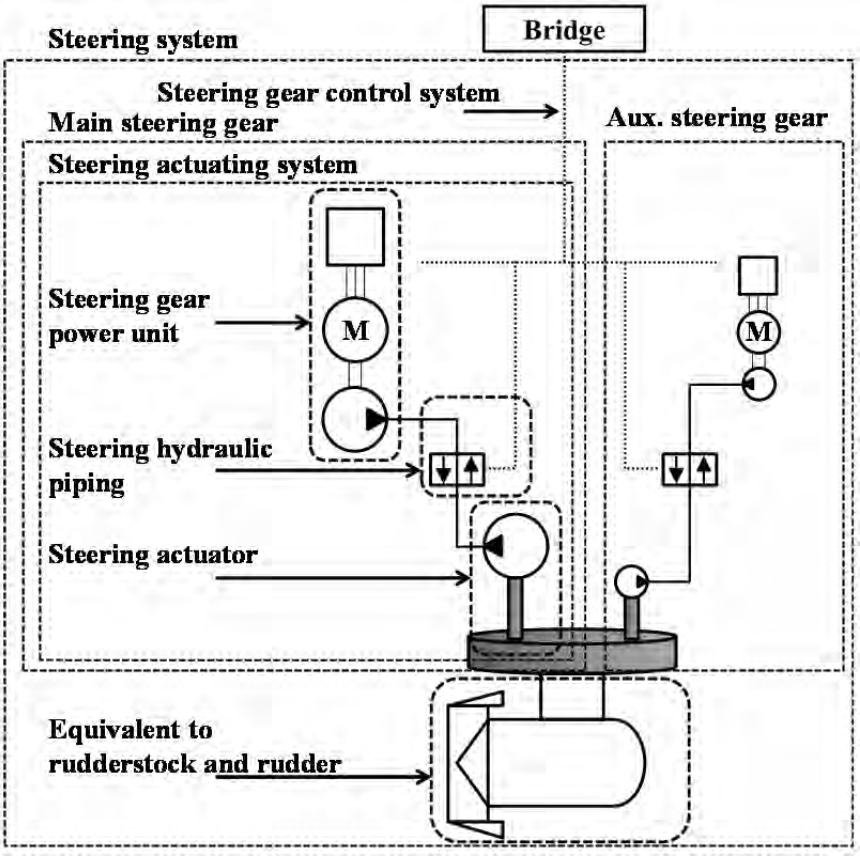


Fig. D19.2 Definition of steering system (in cases where a main steering gear and an auxiliary steering gear are provided)



19.1.3 Drawings and Data

Drawings and data to be submitted are generally as follows.

(1) Particulars
(2) Specifications
(3) Material specifications
(4) Details of welding procedures
(5) General arrangements and sectional assembly drawings (showing the materials and dimensions of various parts, including water intake ducts)
(6) Shafting arrangements (showing arrangements, shapes and construction of main engines, gears, clutches, couplings, main shafts, main shaft bearings and thrust bearings, sealing devices and impellers)
(7) Details of water intake ducts
(8) Construction of impellers (showing detailed blade profiles, the maximum diameter of blades from the centre of main shafts, number of blades, and material specifications)
(9) Details of bearings (including thrust bearings), in the case of roller bearings, together with specifications of such bearings and the calculation sheets for the life times of roller bearings
(10) Details of sealing devices (including waterjet pump unit sealing devices)
(11) Details of deflectors
(12) Details of reversers
(13) Details of steering actuators
(14) Piping diagrams (hydraulic systems, lubricating systems, cooling water systems, etc.)
(15) Arrangements of control systems and diagram of hydraulic and electrical systems (including

safety devices, alarm devices and automatic steering)
(16) Arrangements and diagrams of alternative sources of power
(17) Diagram of indication devices for deflector positions
(18) Torsional vibration calculation sheets and calculation sheets for bending natural frequencies when bending vibrations due to self-weight are expected
(19) Strength calculation sheets for deflectors and reversers, etc.
(20) Others items considered to be necessary by the Society

19.1.4 Display of Operating Instructions

Simple operating instructions with block diagrams showing the change-over procedures for propulsion systems and control systems are to be permanently displayed on navigation bridges and at auxiliary steering stations.

19.1.5 Operating and Maintenance Instructions for Propulsion Systems, etc.

Operating and maintenance instructions and engineering drawings for propulsion systems are to be provided and written in a language understandable by officers and crew members who are required to understand such information in the performance of their duties.

19.2 Number of Propulsion Systems and Auxiliary Steering Station

19.2.1 Number of Propulsion Systems

1 In general, a minimum of two propulsion systems are to be provided for ships.

2 Each steering system for a propulsion system is to be provided with a main steering gear and an auxiliary steering gear. The main steering gear and the auxiliary steering gear are to be so arranged that the failure of one of them will not render the other one inoperative.

3 Notwithstanding the requirements of **-2** above, in cases where each main steering system comprises two or more identical steering actuating systems, an auxiliary steering gear need not be fitted provided that each steering gear:
(1) is capable of satisfying the requirements in **19.5.1-1(2)** while operating with all steering gear steering actuating systems;
(2) is arranged so that after a single failure in its piping or in one of the steering actuating systems, steering capability can be maintained or speedily regained;
(3) The above capacity requirements apply regardless whether the steering systems are arranged with common or dedicated power units.

4 In special cases, a single propulsion system installation may be considered, notwithstanding the requirements specified in **-1** to **-3**, provided that the ship in question is not engaged in international voyages. In such cases, the functions of propulsion and steering are to be designed with redundancy in the following arrangements:
(1) A minimum of two prime movers are to be provided.
(2) A minimum of two steering actuating systems are to be provided.
(3) Electric supply is to be maintained or restored immediately in cases where there is a loss of any one of the main generators in service so that the functioning of at least one of the prime mover and steering system is maintained by the arrangements specified in **19.6.2-1(1)** or **(2)**.

19.2.2 Auxiliary Steering Stations

1 Auxiliary steering stations, in cases where deflectors are to be operable other than from navigation bridges, are to be provided.

2 Auxiliary steering stations are to comply with the following requirements:
(1) Auxiliary steering stations are to be enclosed compartments that are readily accessible, and, as far as possible, separated from machinery spaces.

(2) Auxiliary steering stations are to be provided with adequate space so as to permit propulsion systems to be operated effectively.
(3) Auxiliary steering stations are to be provided with suitable arrangements to ensure working access to steering positions. These arrangements are to include handrails and gratings or other non-slip surfaces to ensure suitable working conditions in the event of any hydraulic fluid leakage.

19.3 Materials and Welding

19.3.1 Materials

1 Materials used for the following components are to be adequate for their service conditions and are to comply with the requirements in **Part K**.
(1) Shafting (excluding bearings and sealing devices)
(2) Impellers
(3) Impeller casings, stator casings and bearing housings
(4) Water intake ducts which are a part of the shell plating (including shaft covers)
(5) Mounting flanges and bolts of waterjet pump units
(6) Deflectors and reversers (including pins)
(7) Hydraulic piping

2 The materials used for the following components are also to comply with the requirements below:
(1) Shafting: **6.2.1**
(2) Impellers: **7.1.3**
(3) Hydraulic pumps, hydraulic piping and steering actuators: **10.2.1**, **12.1.4** and **15.4.1**

19.3.2 Welding

In cases where principal components of propulsion systems are of welded construction, they are to comply with the requirements specified in **Chapter 11**.

19.4 Construction and Strength

19.4.1 Main Shaft

The minimum diameter of main shafts is to be not less than the values determined by the following formula:

$$d_s = k \sqrt[3]{\frac{H}{N_o}}$$

where
d_s : Required diameter of main shaft (*mm*)
H : Maximum continuous output of main engine (*kW*)
N_o : Number of revolutions of main shaft at maximum continuous output (*rpm*)
k : Values shown in **Table D19.1**

Table D19.1 Values of k according to Fitting Method

Shaft material		Position				
		Fitting parts of shafts with impellers and shaft couplings				Other parts
		Fitting method				
		Keyway	Spline	Flange Coupling	Force Fitting	
Carbon steel or low alloy steel	Shafts of Kind 2	105	108	102		105
	Shafts of Kind 1	Value in below note where $a_1 = 100$, or $a_2 = 80$	Value in below note where $a_1 = 102$, or $a_2 = 82$	Value in below note where $a_1 = 98$, or $a_2 = 78$		Value in below note where $a_1 = 100$, or $a_2 = 80$
Austenitic stainless steel						
Martensite precipitation hardened type stainless steel		80	82	78		80

Note:

$200 \leq \sigma_y \leq 400$: $k = a_1 - 0.1(\sigma_y - 200)$

$\sigma_y > 400$: $k = a_2$

where

σ_y : Yield point or 0.2% of proof stress of main shaft material (N/mm^2)

19.4.2 Shaft Couplings and Coupling Bolts

1 The minimum diameter of shaft coupling bolts at joining faces of couplings is to be not less than the value determined by the following formula:

$$d_b = 15300 \sqrt{\frac{H}{N_o}\left(\frac{1}{nDT_b}\right)}$$

where

d_b : Required diameter of shaft coupling bolt (mm)

n : Number of bolts

D : Pitch circle diameter (mm)

T_b : Specified tensile strength of bolt material (N/mm^2)

Other symbols used here are the same as those used in **19.4.1**

2 The thickness of shaft coupling flanges at pitch circles is not to be less than the required diameter of shaft coupling bolts determined by the formula in **-1** above. However, such a value is not to be less than 0.2 *times* the required diameter of the corresponding shaft.

3 Fillet radii at the base of flanges are not to be less than 0.08 *times* the diameter of their respective shafts in cases where fillets are not to be recessed in way of nuts and bolt heads.

19.4.3 Impeller Blades

The strength of impeller blades at their root is to be determined so that the following formula is satisfied. In such cases, the allowable stress value of the material is, in principle, to be 1/1.8 of the specified yield point (or 0.2% of proof strength).

$$S \geq \frac{5.8 \times 10^7 H}{Lt^2 Z N_o} + 2.2 \times 10^{-11} D^2 N_o^2$$

where

S : Allowable stress of impeller material (N/mm^2)

Z : Number of impeller blades

L : Width of impeller blade at root (mm)

t : Maximum thickness of impeller blade at root (mm)

D : Diameter of impeller (mm)

Other symbols used here are the same as those used in **19.4.1**

19.4.4 Water Intake Ducts, etc.

Suction water intake ducts, impeller casings and nozzles are to have strength enough to handle their design pressure, and consideration is to be given to any corrosion.

19.4.5 Sealing Devices

The materials, constructions and arrangements of sealing devices (excluding gland packing type sea water sealing devices) for shafting and waterjet pump units are to be approved by the Society.

19.4.6 Torsional Vibration and Bending Vibration of Main Shaft

1 General

(1) Notwithstanding the requirements specified in **19.1.3** concerning the submission of torsional vibration calculation sheets for main shafting systems, the submission of such sheets may be omitted in cases where shafting systems are of the same type as one that has been previously approved or it can be readily assumed that such shafting systems will not cause any excessive vibration stress.

(2) Measurements of torsional vibrations to confirm the correctness of estimated values are to be carried out. However, in cases where the submission of torsional vibration calculation sheets is omitted according to the requirements in **(1)**, or the Society considers that there is no critical vibration within the service speed range, the measurement of torsional vibrations may be omitted.

2 Allowable Limits

Torsional vibration stresses of main shafting systems are to be in accordance with the following **(1)** and **(2)** requirements within the service speed range of such shafting systems:

(1) Torsional vibration stresses within the range from 80% up to and including 105% of the number of maximum continuous revolutions are not to exceed τ_1 given in the following:

$$\tau_1 = A - B\lambda^2 \quad (0.8 < \lambda \leq 0.9)$$

or

$$\tau_1 = C \quad (0.9 < \lambda \leq 1.05)$$

where

τ_1 : Allowable limit of torsional vibration stresses for the range of $0.8 < \lambda \leq 1.05$ (N/mm^2)

λ : Ratio of the number of revolutions to the number of maximum continuous revolutions

A, B and C : Values shown in **Table D19.2**

In cases where the specified tensile strength of materials of carbon steel shafts or low alloy steel shafts of Kind 1 exceeds 400 N/mm^2, the value of τ_1 may be increased by multiplying it by the factor k_m given in the following formula:

$$k_m = \frac{T_s + 160}{560}$$

where

k_m : Correction factor

T_s : Specified tensile strength of main shaft material (N/mm^2)

(2) Torsional vibration stresses within the range of 80% or less than the number of maximum continuous revolutions of engines are not to exceed the value for τ_2 given below. In cases where torsional vibration stresses exceed the value calculated by the formula for τ_1 shown in **(1)**, barred speed ranges are to be imposed. In such cases, the formula for τ_1 is the one for the range where $\lambda \leq 0.9$.

$$\tau_2 = 2.3\tau_1$$

where

τ_2 : Allowable limit of torsional vibration stresses for the range where $\lambda \leq 0.8$ (N/mm^2)

3 Bending Vibrations

For main shafting systems of propulsion systems, consideration is to be given to natural vibrations due to the bending of shafting systems.

Table D19.2 Values of A, B and C

	Carbon steels or low alloy steels		Austenitic stainless steels	Martensite precipitation hardened type stainless steels
	Shafts of Kind 1	Shafts of Kind 2		
A	24.3	9.0	26.4	39.6
B	24.1	6.2	26.4	37.1
C	4.8	4.0	5.0	9.6

19.5 Steering Systems

19.5.1 Capability of Steering Gear

1 The main steering gear is to be:

(1) of adequate strength and capable of steering the ship at the maximum ahead service speed specified in **2.1.8, Part A,** which is to be demonstrated;

(2) capable of changing direction of the propulsion system from one side to the other at declared steering angle limits at an average turning speed of not less than 2.3°/s with the ship running ahead at the speed specified in **2.1.8, Part A**;

(3) for all ships, operated by power; and

(4) so designed that they will not be damaged at maximum astern speed; this design requirement need not be proved by trials at maximum astern speed and declared steering angle limits.

2 The auxiliary steering gear is to be:

(1) of adequate strength and capable of steering the ship at navigable speed and of being brought speedily into action in an emergency;

(2) capable of changing direction of the propulsion system from one side to the other at declared steering angle limits at an average turning speed of not less than 0.5°/s with the ship running ahead at one half of the maximum ahead service speed specified in **2.1.8** or 7 *knots*, whichever is the greater; and

(3) for all ships, operated by power where necessary to meet the requirements of Regulation 29.4.2, Chapter II-1, *SOLAS* and in any ship having power of more than 2,500 *kW* propulsion power per propulsion system.

3 Reversers are to be such that they enable the ship to go astern with sufficient steering under normal circumstances, and they are to have astern power to provide effective braking for ships when changing from ahead to astern runs.

19.5.2 General Construction

1 Design pressures of the scantlings of piping and other components of steering actuating systems subject to internal hydraulic pressure are to be at least 125% of the maximum working pressure expected under the worst permissible operating condition, taking into account any pressure which may exist in the low pressure side of the system. Design pressures are not to be less than relief valve setting pressures.

2 Reversers are to have sufficient strength against any thrusts at maximum astern power output.

3 The construction and strength of hydraulic pumps and hydraulic systems are to comply with the requirements in **10.5**, **12.2.1**, **12.3**, **12.4.2** through **12.4.4** and **12.5.1**.

4 The arrangements of piping, relief valves and measuring devices for hydraulic systems and

the construction of liquid level indicators are to comply with the requirements in **13.2.1** and **13.8.4**.

19.5.3 Steering Actuators

1 The strength of steering actuators is to comply with the requirements specified in **15.4.4**.

2 The construction of oil seals in steering actuators is to comply with the requirements specified in **15.4.5**.

19.5.4 Steering Actuating Systems

1 Suitable arrangements to maintain the cleanliness of hydraulic fluid are to be provided after taking into consideration the type and design of the steering actuating system.

2 Arrangements for bleeding air from steering actuating systems are to be provided where necessary.

3 Relief valves are to be fitted to any parts of steering actuating systems which can be isolated and in which pressure can be generated from power sources or from external forces. Setting pressures of relief valves are not to be less than 125% of the maximum working pressure expected in the protected part. Minimum discharge capacities of relief valves are not to be less than 110% of the total capacity of pumps which provide power for steering actuators; under such conditions, however, no rise in pressure is to exceed 10% of the setting pressure. In this regard, due consideration is to be given to any anticipated extreme ambient conditions in respect of oil viscosity.

4 Low level alarms are to be provided for hydraulic fluid tanks to give the earliest practicable indication of fluid leakage from steering actuating systems. These alarms are to be audible and visual, and are to be given on navigation bridges and at other positions from which main engines are normally controlled.

5 In cases where flexible hoses are used for steering actuating systems, the construction and strength of such flexible hoses are to comply with the requirements specified in **15.4.6**.

19.5.5 Stoppers

1 Propulsion systems are to be provided with stoppers for deflectors in order to limit steering angles.

2 Propulsion systems are to be provided with positive arrangements, such as limit switches, for stopping deflectors before coming into contact with any stoppers. These arrangements are to be activated by the actual movements of deflectors and not through control systems for steering. Mechanical links may be used for this purpose.

19.6 Electric Installations

19.6.1 General

For items not specified in this section **19.6**, the requirements specified in **Part H** are to apply.

19.6.2 Maintenance of Electric Supply

1 Main sources of electric power are to be so arranged that electric supplies to relevant equipment are maintained or restored immediately in the case of a loss of any one of the generators in service so as to ensure the functions of propulsion and steering of at least one of the propulsion systems, its associated control systems and its indication devices of steering gear by the following arrangements:

(1) In cases where electrical power is normally supplied by one generator, adequate provisions are to be made for automatic starting and connecting to main switchboards of standby generators of sufficient capacity to maintain the functions of the above with automatic restarting of important auxiliaries including sequential operations in cases where there is a loss of electrical power of the generator in operation.

(2) If electrical power is normally supplied by more than one generator simultaneously in parallel operations, provisions are to be made to ensure that, in cases where there is a loss of electrical power of one of generating sets, the remaining ones are kept operational so as to maintain the functions required by **1** above. (See **2.3.6, Part H**)

2 In cases where the propulsion power exceeds 2,500 *kW* per thruster unit, an alternative source of power is to be provided in accordance with the following:

(1) The alternative source of power is to be either:
  (a) An emergency source of electric power; or
  (b) An independent source of power located in the steering gear compartment and used only for this purpose.

(2) Any alternative source of power is to be capable of automatically supplying alternative power within 45 *seconds* to the steering gear (including its associated control system) and the indication devices for the steering gear. In such cases, the alternative source of power is to be capable of changing direction of the ship's directional control system from one side to the other at declared steering angle limits at an average turning speed of not less than 0.5°/*s* with the ship running ahead at one half of the speeds specified in **2.1.8, Part A** or 7 *knots*, whichever is greater. Alternative sources of power are to have enough capacity for the continuous operation of such systems for at least 30 *minutes* in every ship of 10,000 *gross tonnage* or more, and for at least 10 *minutes* in every other ship.

(3) Automatic starting arrangements for generators or prime movers of pumps used as the independent source of power specified in **(1)(b)** are to comply with the requirements for starting devices and performance in **3.4.1, Part H**.

19.6.3 Electrical Installations for Steering Systems

In cases where hydraulic pumps for steering actuating systems are driven by electric motors, electrical installations for steering and reversing systems are to comply with the following requirements:

(1) Each steering system is to be served by at least two exclusive circuits fed directly from main switchboards. One of these circuits, however, may be supplied through the emergency switchboard.

(2) Cables used in those exclusive circuits required in **(1)** are to be separated, as far as practicable, throughout their length.

(3) Audible and visual alarms are to be given on navigation bridges in the event of any power failure to electric motors for hydraulic pumps.

(4) Means for indicating that electric motors for hydraulic pumps are running are to be installed on navigation bridges and positions from which main engines are normally controlled.

(5) Short circuit protection and overload alarms are to be provided for such circuits and motors respectively. Overload alarms are to be both audible and visible and are to be situated in conspicuous positions in places from which main engines are normally controlled.

(6) Protection against excess current, including starting currents, if provided, is to be for not less than twice the full load current of those motors or circuits so protected, and is to be arranged to permit the passage of the appropriate starting currents.

(7) In cases where a three-phase supply is used, alarms are to be provided that will indicate failure of any one of the supply phases. Such alarms are to be both audible and visible and are to be situated in conspicuous positions in places from which main engines are normally controlled.

19.7 Controls

19.7.1 General

1 Propulsion systems are to be capable of being brought into operation and being controlled on navigation bridges.

2 Steering systems are to be capable of being controlled from the auxiliary steering stations specified in **19.2.2**. Means are to be provided in such auxiliary steering stations for disconnecting any control systems, operable from navigation bridges, from the steering systems they serve.

3 Reversing systems are to be controlled in local control stations for main propulsion or in auxiliary steering stations. Means are to be provided in local control stations for main propulsion or in auxiliary steering stations for disconnecting any control systems, operable from navigation bridges, from reversing systems they serve.

4 In the event of any failure of remote control devices for reversing systems, preset positions of reversers are to be maintained until control over of such systems can be established at local control stations for main propulsion or at auxiliary steering stations.

5 Independent control devices are to be provided for propulsion systems. In cases where multiple propulsion systems are designed to operate simultaneously, they may be controlled by a single device such as a joystick.

6 Those control devices specified in **-5** are to be so designed that the failure of one such control device does not result in the failure of another control device.

7 Cables and pipes of control systems are to be separated, as far as practicable, throughout their length.

8 In cases where control systems are electric, they are to be served by its own separate circuit supplied directly from switchboard busbars supplying that power circuits for the propulsion systems at a point on the switchboard adjacent to the supply to the power circuits for the propulsion systems.

9 Short circuit protection only is to be provided for control supply circuits.

10 Audible and visual alarms are to be given on navigation bridges and at positions from which main engines are normally controlled in the event of any failure of control systems or electrical power supplies to such control systems.

11 Means of communication are to be provided between navigation bridges and all control stations, including auxiliary steering stations.

12 Propulsion systems for ships provided with automatic steering are to be capable of immediate change-overs from automatic to manual steering.

13 For those items concerned with safety, alarms and control devices for propulsion systems not specified in **19.7.1**, the requirements specified in **18.1** through **18.3** and **18.7** are to apply.

19.7.2 Indication Devices

1 Indication devices for deflector positions

(1) Deflector positions are to be indicated on navigation bridges and in auxiliary steering stations.

(2) Indication devices for deflector positions are to be independent of control systems.

2 Indication devices for reverser positions

Reverser positions are to be indicated on navigation bridges, at control stations (including auxiliary steering stations) and at monitoring stations for propulsion systems.

3 Indication devices for impeller speed

Impeller speeds are to be indicated on navigation bridges, at control stations (including auxiliary steering stations) and at monitoring stations for propulsion systems.

19.8 Piping

19.8.1 Lubricating Oil Systems

1 Lubricating oil systems for propulsion systems are to comply with relevant requirements specified in **13.10**.

2 Lubricating oil arrangements for propulsion systems are to be provided with alarm devices which give visible and audible alarms on navigation bridges and at positions from which main engines are normally controlled in the event of any failure of the supply of lubricating oil or an appreciable reduction of lubricating oil pressure.

19.9 Tests

19.9.1 Shop Tests

1 For impeller casings, stator casings and bearing housings, hydrostatic tests at pressures 1.5 *times* design pressure are to be carried out.

2 For impellers, dynamic balancing tests are to be carried out.

3 For forward bearing tubes of main shafts and sealing device tubes, hydrostatic tests of at pressures of at least 0.2 *MPa* or 1.5 *times* design pressure, whichever is higher, are to be carried out.

4 For steering actuating systems, the tests specified in **15.5.1** are to be carried out.

5 For control, safety and alarm devices, performance tests are to be carried out.

19.9.2 Tests after Installation On Board

1 For hydraulic piping systems, leak tests at pressures at least equal to the maximum working pressure are to be carried out after installation on board.

2 For sealing devices for waterjet pump units, leak tests at working oil pressure are to be carried out.

3 Operation tests of propulsion systems are to be carried out.

Chapter 20 AZIMUTH THRUSTERS

20.1 General

20.1.1 Application

1 The requirements in this Chapter apply to azimuth thrusters intended for main propulsion (hereinafter referred to as "thrusters" in this Chapter).

2 The prime movers for driving thrusters are to comply with the following requirements:

(1) Reciprocating internal combustion engines: **Chapter 2**

(2) Gas turbines: **Chapter 4**

(3) Electric motors: **Chapter 2** and **5, Part H**

3 Special consideration will be given to those thrusters of unconventional design to which the requirements in this Guidance are not applicable.

20.1.2 Terminology

The terms used in this Guidance are defined as follows:

(1) "Thrusters" are propulsion units which control ship direction through steering functions enabled by their own capability of azimuthing. Thrusters include the following components:
  (a) Propellers;
  (b) Propeller shafts;
  (c) Gears, clutches and gear shafts for transmission of propulsion torque (when integrated in thrusters);
  (d) Azimuth thruster casings; and
  (e) Steering system.

(2) "Azimuth thruster casings" are watertight structures that include steering columns (or struts), propeller pods, propeller nozzles and nozzle supports.

(3) "Azimuth steering gear" is a device for applying steering torque to thrusters, and include electric motors, hydraulic pumps, hydraulic systems, hydraulic motors and gear assemblies for azimuth steering gear.

(4) "Steering system" is a ship's directional control system, including the steering gear, steering gear control system and rudder (including rudder stocks) if any, or any equivalent system (including azimuth steering gear) for applying force on the ship hull to cause a change of heading or course.(*See* **Fig. D20.1** and **Fig. D20.2**)

(5) "Steering actuating system" consists of a steering gear power unit, a steering actuator and, for hydraulic or electrohydraulic steering gear, hydraulic piping.

(6) "Steering actuator" is a component which converts power into mechanical action to control the propulsion system as follows.
  (a) In the case of electric steering: electric motor and driving pinion.
  (b) In the case of electro hydraulic steering: hydraulic motor and driving pinion.

(7) "Declared steering angle limits" are the operational limits in terms of maximum steering angle or equivalent, that are to be declared by the manufacturer / ship designer, also taking into account vessel speed or propeller torque/speed, or other limitations.

Fig. D20.1 Definition of steering system (in cases where two or more identical steering actuating systems are provided)

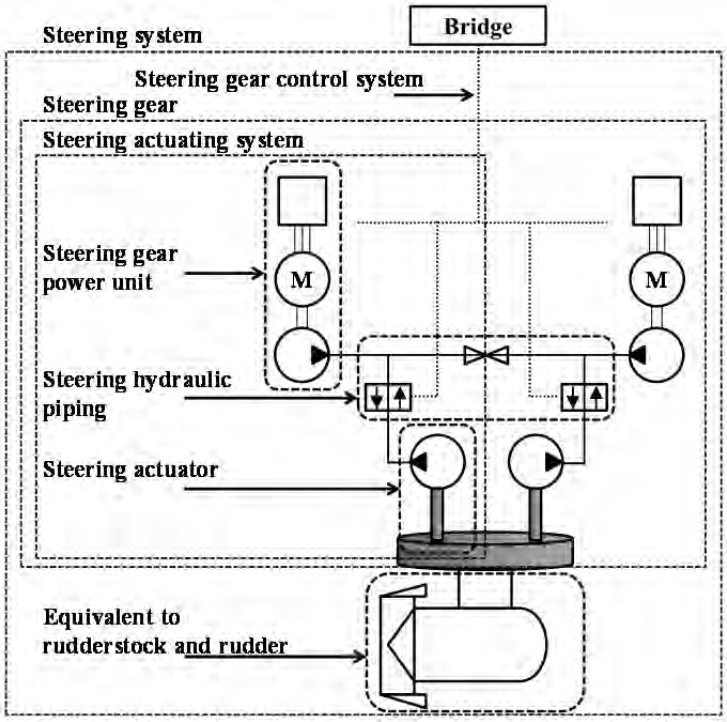
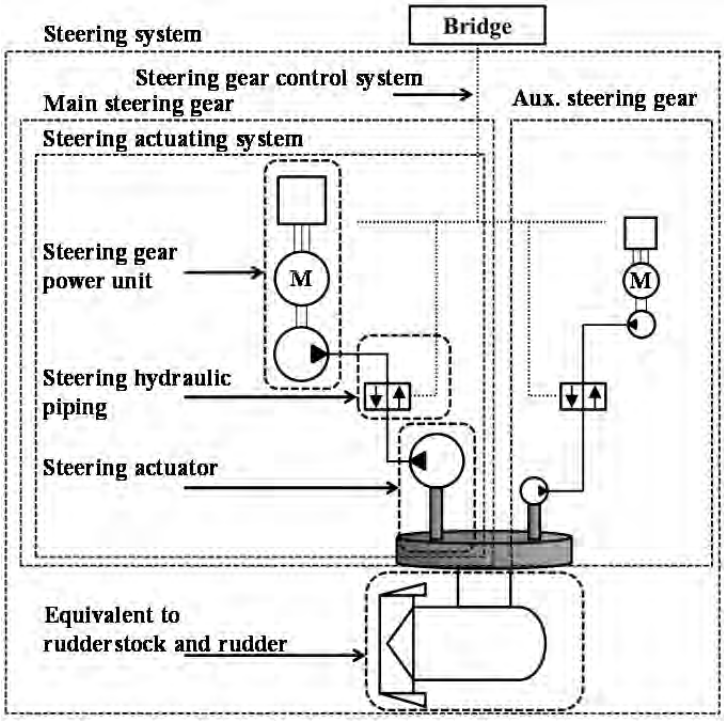


Fig. D20.2 Definition of steering system (in cases where a main steering gear and an auxiliary steering gear are provided)



20.1.3 Drawings and Data

Drawings and data to be submitted are generally as follows.

(1) Particulars
(2) Specifications
(3) Material specifications
(4) Details of welding procedures for principal components
(5) General arrangements and sectional assembly drawings
(6) Shafting arrangements (details of propeller shafts, gears, clutches, gear shafts, shaft couplings, bearings and sealing devices and propellers, together with specifications and service life calculations of roller bearings, torsional vibration calculations and propeller pull-up length calculation sheets)
(7) Details of azimuth thruster casings
(8) Drawings of azimuth steering gear (details of actuating systems, gear assemblies, bearings and sealing devices for azimuth steering gear)
(9) Piping diagrams (hydraulic systems, lubricating systems, cooling water systems, etc.)
(10) Arrangements of control systems and diagram of hydraulic and electrical systems (including safety devices, alarm devices and automatic steering)
(11) Arrangements and diagrams of alternative sources of power
(12) Diagrams of indication devices for azimuth angles
(13) Strength calculations
(14) When a vibration measurement system specified in **20.4.3(1)** is being used, the following **(a)** and **(b)** documents:
    (a) Function descriptions for vibration measurement systems
    (b) Management manuals including the following **i)** through **iii)**
        i) List of the bearings for vibration measurements and measurement points
        ii) Guidance for measurements (including the way for taking signals from casings)
        iii) Guidance for the analysis and the evaluation of measurement results
(15) When a Fe-density measurement system specified in **20.4.3(2)** is being used, the following **(a)** and **(b)** documents:
    (a) Function descriptions for Fe-density measurement systems
    (b) Management manuals including the following **i)** through **iii)**
        i) Guidance for lubricating oil sampling
        ii) Guidance for Fe-density measurements
        iii) Guidance for the analysis and the evaluation of measurement results
(16) Other plans and documents considered necessary by the Society

20.1.4 Display of Operating Instructions

Simple operating instructions with block diagrams showing change-over procedures for thrusters and control systems are to be permanently displayed on navigation bridges and in azimuth thruster compartments.

20.1.5 Operating and Maintenance Instructions for Thrusters, etc.

Operating and maintenance instructions and engineering drawings for thrusters are to be provided and written in a language understandable by officers and crew members who are required to understand such information in the performance of their duties.

20.2 Number and Position of Thrusters

20.2.1 Number of Thrusters

1 In general, a minimum of two thrusters is to be provided for ships.

2 Each of the steering systems of thrusters is to be provided with a main steering gear and an auxiliary steering gear. The main steering gear and the auxiliary steering gear are to be so arranged that the failure of one of them will not render the other one inoperative.

3 Notwithstanding the requirements of **-2** above, in cases where each main steering system comprises two or more identical steering actuating systems, an auxiliary steering gear need not be fitted provided that each steering gear:

(1) is capable of satisfying the requirements in **20.5.1-1(2)** while operating with all steering gear steering actuating systems;

(2) is arranged so that after a single failure in its piping or in one of the steering actuating systems, steering capability can be maintained or speedily regained;

(3) The above capacity requirements apply regardless whether the steering systems are arranged with common or dedicated power units.

4 In special cases, a single thruster installation may be subject to consideration and deemed acceptable, notwithstanding the requirements specified in **-1** to **-3**. In such cases, the functions of propulsion and steering are to be designed with redundancy as in the following arrangements:

(1) A minimum of two prime movers are to be provided.

(2) A minimum of two independent azimuth steering gear are to be provided. However, such azimuth steering gear may have only one gear wheel.

(3) Electric supply is to be maintained or restored immediately in the cases where there is a loss of any one of the main generators in service so that the functioning of at least one of the prime mover and steering system, is maintained by the arrangements specified in **20.6.2-1(1)** and **(2)**.

20.2.2 Position of Thrusters

1 Thrusters are to be installed in readily accessible enclosed compartments and be separated, as far as possible, from any machinery spaces.

2 Azimuth thruster compartments are to be of sufficient space as to permit thrusters to be operated effectively.

3 Azimuth thruster compartments are to be provided with suitable arrangements to ensure working access to azimuth steering gear machinery and controls. These arrangements are to include handrails and gratings or other non-slip surfaces to ensure suitable working conditions in the event of any hydraulic fluid leakage.

4 The locations where the following equipment are provided and which comply with the requirements specified in **20.7.1-2** may be deemed as azimuth thruster compartments.

(1) Instruments specified in **20.7.1-9**

(2) Communication means specified in **20.7.1-11**

(3) Gyro repeaters required in Regulation 19.2.5.2, Chapter V, *SOLAS*

20.3 Materials and Welding

20.3.1 Materials

1 The materials used for the following components are to be adequate for their service conditions and are to comply with the requirements in **Part K**.

(1) Gears, clutches, gear shafts and all principal components of shafting

(2) Propellers and blade fixing bolts of controllable pitch propellers

(3) Hydraulic piping of controllable pitch propellers and azimuth steering gear

(4) Azimuth thruster casings

(5) Gears and gear shafts for azimuth steering gear

(6) Bedplates for supporting thrusters

2 The materials used for the following components are also to comply with the requirements below:

(1) Gears, clutches, gear shafts and all principal components of shafting: **5.2.1** and **6.2.1**

(2) Propellers and blade fixing bolts of controllable pitch propellers: **7.1.3**

(3) Hydraulic piping of controllable pitch propellers and azimuth steering gear: **12.1.4**

20.3.2 Welding

In cases where the principal components of thrusters are of welded construction, they are to comply with the requirements specified in **Chapter 11**.

20.4 Construction and Strength

20.4.1 General

1 The installation and construction of thrusters are to be such that ship stability is not adversely affected even when sea water enters azimuth thruster casings and floods compartments where they are installed.

2 Sealing devices are to be provided in cases where thrusters penetrate hull structures to prevent any sea water from entering ships.

20.4.2 Gears, Clutches, Gear Shafts, etc.

The construction and strength of gears, clutches, gear shafts and etc. for propulsion are to comply with the requirements specified in **Chapter 5**. The construction and strength of bevel gears and gears for azimuth steering gear are to comply with recognised standards.

20.4.3 Propeller Shafts, Bearings and Sealing Devices of Propeller Shafts

The construction and strength of propeller shafts, bearings and sealing devices of propeller shafts are to comply with the requirements specified in **Chapter 6**. When roller bearings are used for the propeller shaft bearings and where a propeller shaft Kind 1*C* is being used, the system specified in the following **(1)** or **(2)** may be used instead of the temperature sensors and the temperature recorder specified in **6.2.11**. In this case, the executive management is to use their experience and knowledge to determine the criteria for each parameter for the ship (including the criteria for alarm and abnormal conditions).

(1) Vibration measurement system to measure vibration of power transmission system in the azimuth thrusters specified in the following **(a)** through **(c)**. Where the system is fixed type, the environmental tests specified in **18.7.1(1)** are to be carried out.
   (a) The measurement is to be carried out regularly at intervals not exceeding 3 *months*.
   (b) Measurement points and the relevant data described in the guidance for measurement in the management manual specified in **20.1.3(14)(b)** are to be recorded appropriately.
   (c) A trend display and frequency analysis of the measurement data are to be provided.

(2) Fe-density measurement system of lubricating oil in the azimuth thruster casings specified in the following **(a)** and **(b)**. Where the system is fixed type, the environmental tests specified in **18.7.1(1)** are to be carried out. In principle, sampling is to be carried out during navigation. Where the sampling can only be conducted at anchor, the sampling is to be carried out in 30 *minutes*, in principle, after the thrusters stop.
   (a) Sampling is to be carried out regularly at intervals not exceeding 3 *months*.
   (b) The measurement data is to be the amount of Fe per hour, considering the change of new lubricating oil. A trend display of the data is to be provided.

20.4.4 Propellers

The construction and strength of propellers are to comply with the requirements specified in **Chapter 7**.

20.4.5 Torsional Vibration of Shafting

Calculations for torsional vibration of shafting are to comply with the requirements specified in **Chapter 8**.

20.4.6 Strengthening for Navigation in Ice

Thrusters in ships intended to be registered with the ice-strengthened class notation are to comply with the requirements specified in **Chapter 8, Part I**.

20.5 Steering Systems

20.5.1 Capability of Steering Gears

1 The main steering gear is to be:

(1) of adequate strength and capable of steering the ship at the maximum ahead service speed specified in **2.1.8, Part A** which is to be demonstrated;

(2) capable of changing direction of the thruster from one side to the other at declared steering angle limits at an average turning speed of not less than 2.3°/*s* with the ship running ahead at the speed specified in **2.1.8, Part A**;

(3) In addition to the requirements specified in **(2)** above, the rate of turning for the azimuth steering gear is to be not less than 1.0 *rpm* in static conditions of ships if astern power is obtained by turning thrusters.

(4) for all ships, operated by power; and

(5) so designed that they will not be damaged at maximum astern speed; this design requirement need not be proved by trials at maximum astern speed and declared steering angle limits.

2 The auxiliary steering gear is to be:

(1) of adequate strength and capable of steering the ship at navigable speed and of being brought speedily into action in an emergency;

(2) capable of changing direction of the thruster from one side to the other at declared steering angle limits at an average turning speed of not less than 0.5°/*s* with the ship running ahead at one half of the maximum ahead service speed specified in **2.1.8, Part A** or 7 *knots*, whichever is the greater; and

(3) for all ships, operated by power where necessary to meet the requirements of Regulation 29.4.2, Chapter II-1, *SOLAS* and in any ship having power of more than 2,500 *kW* propulsion power per thruster.

20.5.2 Construction

1 Design pressures for calculations to determine the scantlings of piping and other components of steering actuating systems of azimuth steering gear subject to internal hydraulic pressure are to be at least 125% of the maximum working pressure expected under the worst permissible operation conditions after taking into account any pressure which may exist in low pressure sides of such systems. Design pressures are not to be less than relief valve setting pressures.

2 The construction and strength of the hydraulic pumps and hydraulic systems are to comply with the requirements in **10.5**, **12.2.1**, **12.3**, **12.4.2** through **12.4.4** and **12.5.1**.

3 The installation of piping and arrangements of relief valves as well as measuring devices for hydraulic systems and the construction of liquid level indicators are to comply with the requirements in **13.2.1** and **13.8.4**.

20.5.3 Hydraulic Systems

Hydraulic power-actuated azimuth steering gear is to be provided with the following arrangements:

(1) Suitable arrangements to maintain the cleanliness of hydraulic fluids are to be provided after

taking into consideration the types and designs of such hydraulic systems.

(2) Arrangements for bleeding air from hydraulic systems are to be provided where necessary.

(3) Relief valves are to be fitted to any part of hydraulic systems which can be isolated and in which pressure can be generated from power sources or from external forces. Setting pressures of such relief valves are not to be less than 125% of the maximum working pressure expected in such protected parts. Minimum discharge capacities of relief valves are not to be less than 110% of the total capacity of pumps which provide power for hydraulic motors; under such conditions, however, no rise in pressure is to exceed 10% of the setting pressure. In this regard, due consideration is to be given to any anticipated extreme ambient conditions in respect of oil viscosity.

(4) Low level alarms are to be provided for hydraulic fluid tanks in order to give the earliest practicable indication of any hydraulic fluid leakage. These alarms are to be audible and visual, and are to be given on navigation bridges and at other positions from which main engines are normally controlled.

(5) In cases where flexible hoses are used for hydraulic systems, the construction and strength of such flexible hoses are to comply with the requirements specified in **15.4.6**.

20.5.4 Sealing Devices

Sealing devices for steering parts of azimuth steering gear are to be approved by the Society in their materials, construction and arrangement.

20.6 Electric Installations

20.6.1 General

1 Each steering system is to be served by at least two exclusive circuits fed directly from main switchboards. One of these circuits, however, may be supplied through the emergency switchboard.

2 Cables used in those exclusive circuits required in **-1** are to be separated, as far as practicable, throughout their length.

3 Audible and visual alarms are to be given on navigation bridges and at positions from which main engines are normally controlled in the event of any power failure to electric motors for propulsion and steering.

4 For items not specified in this section **20.6**, those requirements specified in **Part H** are to apply.

20.6.2 Maintenance of Electric Supply

1 In cases where any generators in service are lost, main sources of electric power are to be so arranged that electric supplies to any relevant equipment are maintained or restored immediately so as to ensure the functions of propulsion and steering of at least one thruster, its associated control systems and indication devices for azimuth angles by the following arrangements:

(1) In cases where electrical power is normally supplied by one generator, adequate provisions are to be made for the automatic starting and the connecting to main switchboards of standby generators of sufficient capacities to maintain the functions of the above with automatic restarting of important auxiliaries, including sequential operations, in cases of loss of electrical power to generators in operation.

(2) If electrical power is normally supplied by more than one generator simultaneously in parallel operations, provisions are to be made to ensure that, in cases of loss of electrical power to one of such generating sets, the remaining ones are kept operational so as to maintain the functions required by **1** above. (See **2.3.6, Part H**)

2 In cases where propulsion power exceeds 2,500 *kW* per thruster, an alternative source of power is to be provided in accordance with the following:

(1) The alternative source of power is to be either:
  (a) An emergency source of electric power; or
  (b) An independent source of power located in the steering gear compartment and used only for this purpose.

(2) Any alternative source of power is to be capable of automatically supplying alternative power within 45 *seconds* to the steering gear (including its associated control system) and the indication devices for the steering gear. In such cases, the alternative source of power is to be capable of changing direction of the ship's directional control system from one side to the other at declared steering angle limits at an average turning speed of not less than 0.5°/*s* with the ship running ahead at one half of the speeds specified in **2.1.8, Part A** or 7 *knots*, whichever is greater. Alternative sources of power are to have enough capacity for the continuous operation of such systems for at least 30 *minutes* in every ship of 10,000 *gross tonnage* or more, and for at least 10 *minutes* in every other ship.

(3) Automatic starting arrangements for generators or prime movers of pumps used as the independent source of power specified in **(1)(b)** are to comply with the requirements for starting devices and performance in **3.4.1, Part H**.

20.6.3 Electrical Installations for Azimuth Steering Gear

Electrical installations for azimuth steering gear are to comply with the following requirements:

(1) Means for indicating that electric motors for steering are running are to be installed on navigation bridges and positions from which main engines are normally controlled.

(2) Short circuit protection and overload alarms are to be provided for such circuits and motors respectively. Overload alarms are to be both audible and visible and are to be situated in conspicuous positions in places from which main engines are normally controlled.

(3) Protection against excess current, including starting currents, if provided, is to be for not less than twice the full load current of those motors or circuits so protected, and is to be arranged to permit the passage of the appropriate starting currents.

(4) In cases where a three-phase supply is used, alarms are to be provided that will indicate failure of any one of the supply phases. Such alarms are to be both audible and visible and are to be situated in conspicuous positions in places from which main engines are normally controlled.

20.7 Controls

20.7.1 General

1 Thrusters are to be capable of being brought into operation and being controlled from navigation bridges.

2 Azimuth steering gear is to be capable of being controlled from azimuth thruster compartments. Means are to be provided in azimuth thruster compartments for disconnecting any control system operable from navigation bridges from the steering system it serves.

3 Independent control devices are to be provided for thrusters. In cases where multiple thrusters are designed to operate simultaneously, they may be controlled by a single device such as a joystick.

4 Those control devices specified in **-3** are to be so designed that the failure of one such control device does not result in the failure of another control device.

5 Cables and pipes of control systems are to be separated, as far as practicable, throughout their length.

6 In cases where control systems are electric, they are to be served by its own separate circuit supplied from a power circuit for the thrusters from a point within the azimuth thruster

compartment, or directly from switchboard busbars supplying that power circuits for thrusters at a point on the switchboard adjacent to the supply to the power circuits for the thrusters.

7 Short circuit protections are only to be provided for control supply circuits.

8 Audible and visual alarms are to be given on navigation bridges and at positions from which main engines are normally controlled, in the event of any failure of control systems or of electrical power supplies to such control systems.

9 The following instruments are to be provided on navigation bridges and at all control stations of thrusters

(1) Indication devices for propeller speed and direction of rotation in the cases of solid propellers

(2) Indication devices for propeller speed and pitch position in the case of controllable pitch propellers

(3) Indication devices for azimuth angle

10 Indication devices for azimuth angle specified in **-9(3)** are to be independent of control systems.

11 Means of communication are to be provided between navigation bridges and all control stations for thrusters.

12 Thrusters for ships provided with automatic steering are to be capable of immediate change-overs from automatic to manual steering.

13 For those items concerned with safety, alarms and control devices for thrusters not specified in **20.7.1**, the requirements specified in **18.1** through **18.3** and **18.7** are to apply.

20.8 Piping

20.8.1 Lubricating Oil Systems

1 Lubricating oil systems for thrusters are to comply with relevant requirements specified in **13.10**.

2 Lubricating oil arrangements of thrusters are to be provided with alarm devices which give visible and audible alarms on navigation bridges and at positions from which main engines are normally controlled in the event of any failure of the supply of lubricating oil or any appreciable reduction of lubricating oil pressure.

20.8.2 Cooling Systems

Cooling systems for thrusters are to comply with the requirements specified in **13.12** (in this case the term “main propulsion machinery” is to be read as “thrusters”).

20.9 Additional Requirements for Thrusters which Incorporate Electric Motors in Propeller Pods

20.9.1 General

1 Means to detect the ingress of sea water into propeller pods is to be provided, and audible and visual alarms are to be given on navigation bridges and at positions from which main engines are normally controlled. Means for discharging sea water from propeller pods is to be provided.

2 Fire detection and alarm systems are to be provided in propeller pods in cases where the pods can be accessed.

3 In cases where cooling fans are provided for propulsion motors, main cooling fans with sufficient capacities at the maximum output of propulsion motors as well as auxiliary cooling fans with sufficient capacities at the normal output of propulsion motors are to be provided. These cooling fans are to be arranged so that they can be easily changed over. However, such auxiliary fans may be omitted provided that exclusive cooling fans are provided for thrusters.

4 In cases where cooling fans are provided for propulsion motors, a means of control is to be provided for stopping such fans and closing any inlets and outlets of air for such fans from safe positions in the case of fire.

20.10 Tests

20.10.1 Shop Tests

1 For gears, the tests specified in **5.5.1** are to be carried out.

2 For propeller shaft sleeves, the tests specified in **6.3.1(2)** are to be carried out.

3 For propellers, the tests specified in **7.4.1** are to be carried out.

4 For azimuth steering gear, the following tests are to be carried out.

(1) The tests specified in **15.5.1**.

(2) The tests specified in **5.5.1** for gears.

5 For azimuth thruster casings, after assembly, pressure tests at the larger of 0.2 *MPa* and the following pressure of a water head equivalent to 1.5*D* or 2*d*, whichever is smaller, are to be carried out. However, airtight tests at pressures of 0.05 *MPa* for propeller nozzles may be acceptable.

where

D : The depth of ship (*m*)

d : The design maximum load draught (*m*)

6 For safety and alarm devices, performance tests are to be carried out.

20.10.2 Tests after Installation On Board

1 For sealing devices for propeller shafts and azimuth steering gear, leak tests for the sealing devices are to be carried out at working oil pressure after installation on board.

2 For azimuth steering gear, leak tests for hydraulic systems are to be carried out at pressures at least equal to maximum working pressure after installation on board. However, when it is difficult to carry out such tests after installation on board, such tests may be carried out as shop tests.

3 Operation tests of thrusters are to be carried out.

4 Function tests on those arrangements specified in **20.9.1** are to be carried out (excluding those discharging devices specified in **20.9.1-1**).

Chapter 24 has been amended as follows.

Chapter ~~21~~24 SPARE PARTS, TOOLS AND INSTRUMENTS

~~21~~24.1 General

~~21~~24.1.1 Scope

1 The requirements in this Chapter apply to spare parts, tools and instruments for machinery installations.

2 The term "machinery installations" used in this Chapter is defined as follows:

(1) ~~Diesel~~ Reciprocating internal combustion engines used ~~for~~ as main propulsion machinery

(2) ~~Diesel~~ Reciprocating internal combustion engines used to drive generators or auxiliary machinery essential for main propulsion

(3) Steam turbines used ~~for~~ as main propulsion machinery

(4) Steam turbines used to drive generators or auxiliary machinery essential for main propulsion

(5) Main propulsion shafting~~s~~

(6) Boilers

(7) Pumps and air compressors

(8) Waterjet propulsion systems

(9) Azimuth thrusters

3 Since the requirements for the various spare parts and tools used for ships depend on a variety of different things: the respective regulations of the countries of their flag administration, their purpose/use, the kinds of machinery installations employed, the navigation routes they follow, etc., the requirements in this Chapter may not be applicable in all cases. However, as a rule, the spare parts and tools specified in this Chapter are to be provided for engine rooms, boiler rooms, or any other appropriate places in a ship.

4 Any spare parts, tools and instruments for machinery installations not specified in this Chapter are to be as deemed appropriate by the Society.

5 Spare parts and tools for electrical installations are to comply with the requirements in **3.8 in Part H**.

6 Spare parts for ventilating fans of ships carrying liquefied gases or dangerous chemicals in bulk are to comply with the requirements in **Chapter 12, Part N** or **Chapter 3, Part S** respectively.

~~21~~24.1.2 Documentation

The ship's owner or shipbuilder is to submit, for approval, a list showing the number of specified spare parts, tools and instruments for machinery installation, that are actually provided on board.

~~21~~24.2 Spare Parts, Tools and Instruments

~~21~~24.2.1 Spare Parts

1 Spare parts for ~~diesel~~ reciprocating internal combustion engines used ~~for~~ as main propulsion machinery are given in **Table D~~21~~24.1**.

2 Spare parts for ~~diesel~~ reciprocating internal combustion engines used to drive generators (except emergency generators) or any auxiliary machinery essential for main propulsion are given in **Table D~~21~~24.2**.

3 Spare parts for steam turbines used ~~for~~ as main propulsion machinery and steam turbines used to drive generators (except emergency generators) or any auxiliary machinery essential for main propulsion are given in **Table D~~21~~24.3**.

4 Spare parts for main propulsion shaftings~~s~~ are given in **Table D~~21~~24.4**.

5 Spare parts for main boilers, essential auxiliary boilers, boilers to supply steam for fuel oil heating necessary for the operation of main propulsion machinery or continuous cargo heating as well as thermal oil installations for essential use are given in **Table D~~21~~24.5**. However, no spare parts are required, if stand-by means are provided to ensure that normal service conditions and cargo heating are maintained, even in cases where there is a failure of any boilers (other than the main boiler), or of any thermal oil installations.

6 Spare parts for pumps and air compressors (other than those for emergency use) which are classified as auxiliary machinery essential for main propulsion as well as for bilge pumps are given in **Table D~~21~~24.6**.

7 The spare parts for waterjet propulsion systems are to be in accordance with the following:

(1) Ball bearings: 1 set for each type and each size

(2) Pumps: spare parts specified in **Table D24.6**

8 Spare parts for azimuth thrusters are to be in accordance with the following:

(1) Hydraulic motors: bearings and sealing devices 1 set for each pump type and each pump size

(2) Pumps: bearings and sealing devices 1 set for each pump type and each pump size

~~7~~9 Spare parts for the machinery installations listed in the **Tables D~~21~~24.1** to **D~~21~~24.6** are those required for each single set of such machinery installations. In cases where two or more sets of machinery installations of the same type and same service have been installed on a ship, only one set of spare parts for such machinery installations may be acceptable.

However, the number of water gauge glasses of round type and flat type is required to be the number in **Table D~~21~~24.5** for each boiler; and, the number of flat type water gauge frames is required to be one for every two boilers.

~~8~~10 Notwithstanding the requirement specified in **~~7~~9** above, no spare parts are required for any machinery installations specified in the following **(1)** and **(2)**:

(1) Machinery installations whose number exceeds that required under the Rules and which have capacity that is adequate with respect to the normal service conditions of the ship.

(2) Pumps classified as auxiliary machinery essential for main propulsion, which have stand-by pumps that have a capacity that is adequate with respect to the normal service conditions of the ship.

~~21~~24.2.2 Tools and Instruments

The required tools and instruments for a single ship are given in **Table D~~21~~24.7**.

Table D~~21~~24.1 Spare Parts for ~~Diesel~~ Reciprocating Internal Combustion Engines Used ~~for~~ as Main Propulsion Machinery

Item	Spare parts	Number required
Main bearings	Main bearings or shells for one bearing of each size and type fitted, complete with shims, bolts and nuts	1 set
Cylinder liner	Cylinder liner, complete with joint rings and gaskets	1
Cylinder cover	Cylinder cover, complete with all valves, joint rings and gaskets For engine without cylinder cover, the respective valves	1
	Cylinder cover bolts and nuts, for one cylinder	1/2 set
Cylinder valves	Exhaust valves, complete with casings, seats, springs and other fittings for one cylinder	2 sets
	Air inlet valves, complete with casing, seats, springs and other fittings for one cylinder	1 set
	Starting air valve, complete with casing, seat, springs and other fittings	1
	Relief valve, complete with casting, springs and other fittings	1
	Fuel valves, complete with castings, springs and other fittings for one engine *Note: Engines with three or more fuel valves per cylinder: two fuel valves complete per cylinder, and other fuel valves excluding casings.	1 set*
Connecting rod bearings	Bottom end bearings or shells of each size and type fitted, complete with shims, bolts and nuts	1 set
	Top end bearings or shells of each size and type fitted, complete with shims, bolts and nuts	1 set
Pistons	Crosshead type: Piston of each type fitted, complete with piston rod, stuffing box, skirt, rings, studs and nuts	1
	Trunk piston type: Piston of each type fitted, complete with skirt, rings, studs, nuts, gudgeon pin and connecting rod	1
Piston rings	Piston rings for one cylinder	1 set
Pistons cooling devices	Telescopic cooling pipes and fittings or equivalent for one cylinder unit	1 set
Chain for camshaft drives	Chain drive: Separate links with pins and rollers of each size and type fitted	6
Cylinder lubricator	Lubricator, complete, of the largest size, with its driving chain or gear wheel	1
Fuel injection pumps	Fuel injection pump complete, or, when replacement at sea is practicable, a complete set of working parts for one pump (plunger, sleeve, valves, springs, etc.)	1
Fuel injection piping	High pressure fuel pipe of each size shape fitted, complete with couplings	1

Table D~~21~~24.1 Spare Parts for ~~Diesel~~ Reciprocating Internal Combustion Engines Used ~~for~~ as Main Propulsion Machinery (continued)

Item	Spare parts	Number required
Scavenge blowers (including turbo chargers)	Rotors, rotor shafts, bearings, nozzle rings and gear wheels or equivalent working parts if other type (see Note)	1 set
Scavenging system	Suction and delivery valves for one pump of each type fitted, complete	1 set
Reduction and or reversing gear	Complete bearing bush of each size fitted in the gear case assembly	1 set
	Roller or ball bearing, complete, of each size fitted in the gear case assembly	1 set
Gaskets and packings	Special gaskets and packings of each size and type fitted for cylinder cover and cylinder liner for one cylinder	-

Note:
The spare parts for scavenge blowers (including turbo chargers) may be omitted where it has been demonstrated, at the builder's test bench, for one engine of the type concerned, that the engine can be manoeuvred satisfactorily with one blower out of action. However, in this case the requisite blanking and blocking arrangements for running with one blower out of action are to be available on board.

Table D~~21~~24.2 Spare Parts for ~~Diesel~~ Reciprocating Internal Combustion Engines ~~to Drive~~ Driving Generators or Auxiliary Machinery Essential for Main Propulsion

Item	Spare parts	Number required
Main bearings	Main bearings of shells of each size and type fitted, complete with shims, bolts and nuts	1 set
Cylinder valves	Exhaust valves, complete with casings, seats, springs and other fittings for one cylinder	2 sets
	Air inlet valves, complete with casings, seats, springs and other fittings for one cylinder	1 set
	Starting air valve, complete with casting, seat, springs and other fittings	1
	Relief valve, complete with casing, springs and other fittings	1
	Fuel valves of each size and type fitted, complete with casings, springs and other fittings for one engine	1/2 set
Connecting rod bearings	Bottom end bearings or shells of each size and type fitted, complete with shims, bolts and nuts for one cylinder	1 set
	Top end bearings or shells of each size and type fitted, complete with shims, bolts and nuts for one cylinder	1 set
	Trunk piston type: Gudgeon pin with bush for one cylinder	1 set
Piston rings	Piston rings, for one cylinder	1 set
Piston cooling devices	Telescopic cooling pipes and fittings or their equivalent for one cylinder	1 set
Fuel injection pumps	Fuel injection pump (complete). Or, when replacement at sea is practicable, a complete set of working parts for one pump (plunger, sleeve, valves, springs, etc.)	1
Fuel injection piping	High pressure fuel pipe of each size and shape fitted, complete with couplings	1
Gaskets and packings	Special gaskets and packings of each size and type fitted, for cylinder cover and cylinder liner for one cylinder	1 set

Table D~~21~~24.3 Spare Parts for Steam Turbines

Item	Spare parts	Number required
Main bearings	Bearings of each size for rotor shaft and reduction gear shaft	1 set for each shaft
Rotor thrust bearings	Pads (including adjusting lines and rings) for one face	1 set*
Turbine shaft sealing rings	Carbon sealing rings, with springs, for each size and type	1 set
Oil filters	Strainer baskets or inserts for filters of each size and type Applicable to those of special design	1 set

*Note:

For ~~main~~ steam turbines used as main propulsion machinery, in cases where the pads of one face differ from those of the other, a complete set of pads is to be provided.

Table D~~21~~24.4 Spare Parts for Main Shaftings~~s~~

Spare parts	Number required
Main thrust bearing :	
Pads for one face of Michell type thrust blocks	1 set for each size*
Complete thrust shoe for one face of solid ring types	1 for each size*
Inner and outer race with rollers of roller thrust bearings	1 for each size

*Note:

In cases where the pads of one face differ from those of the other, a complete set of pads is to be provided.

Table D~~21~~24.5 Spare Parts for Boilers and Thermal Oil Installations

Spare parts	Number required
Safety valve spring of each size including superheater safety valve springs	1
Oil burner nozzles, complete for one boiler	1 set
Round type water gauge glasses including packings	12
Flat type water gauge glasses	2
Flat type water gauge frames	1

Table D~~21~~24.6 Spare Parts for Pumps and Air Compressors

Item	Spare parts	Number required
Piston pumps	Valves with seats and springs of each size fitted	1 set
	Piston rings of each type and size for one piston	1 set
Centrifugal and gear type pumps	Bearings of each type and size	1
	Rotor sealings of each type and size (Parts liable to deteriorate, such as packings, sleeves)	1
Air Compressors	Piston rings of each type and size	1 set
	Suction and delivery valves and their springs of each size	1/2 set

Notes:

1. Pumps and air compressors including those for remote or automatic control systems.
2. Gear type pumps including vane pumps and screw pumps.

Table D~~21~~24.7 Tools and Instruments

Description	Spare parts	Number required
Boiler required spare parts in the requirement in **~~21~~24.2.1-5**	Tube stoppers or plugs of each size, including those for superheater tubes and economizer tubes *Note: In the case of cylindrical boilers, half of them are to be those which can be used from the burner side.	For water tube boilers: 12 for each size For other type of boilers: 12 in total*
All boilers	Standard pressure gauges *Note: Gauge testers will be acceptable.	1*
	Water testers *Note: Two salinometers will be acceptable.	1 set*
Special tools and instruments for machinery installation maintenance or repair work		1 set

Chapter 25 has been amended as follows.

Chapter ~~22~~25 SPECIAL REQUIREMENTS FOR MACHINERY INSTALLED IN SHIPS WITH RESTRICTED AREA OF SERVICE AND SMALL SHIPS

~~22~~25.1 General

~~22~~25.1.1 Scope

The requirements in this Chapter apply to machinery to be installed in ships with a gross tonnage less than 500 *tons* and intended for registry with restricted areas of service in place of any relevant requirements found in the Chapters up to and including **Chapter ~~21~~24**.

~~22~~25.2 Modified Requirements

~~22~~25.2.1 Ships with Class Notation "*Coasting Service*" or Equivalent

1 The provisions of spare units for any of the machinery or devices in the following **(1)** to **(7)** need not to be installed on board provided that two sets of such machinery of nearby the same capacity are installed on board with a total capacity sufficient enough to obtain the maximum continuous output of main propulsion machinery or the maximum evaporative capacity of main and essential auxiliary boilers, and the capacity of one unit of either machinery set is sufficient enough for ships to obtain navigable speed.

(1) The pressure source for driving the clutches of power transmission systems used for main propulsion specified in **5.2.4-3**.
(2) Hydraulic pumps used for the pitch control gears of controllable pitch propellers specified in **7.2.2-8**.
(3) Fuel oil supply pumps specified in **13.9.6-1** and **-2**.
(4) Burning systems for boilers specified in **13.9.7-1** and **-2**.
(5) Lubricating oil pumps specified in **13.10.2-1** and **-2**.
(6) Cooling water (oil) pumps for main propulsion machinery specified in **13.12.1-1** and **-2**.
(7) Feed water systems specified in **13.15.1-1** and **-2**.

2 In the requirements specified in **13.9.6-1(2)**, **13.10.2-1(2)**, and **13.12.1-1(3)** the requirements to provide a complete set of the spare pump do not apply.

3 The requirement specified in **15.3.1-4~~.~~** and **20.9.1-3** need not apply.

4 For ships with the Class Notation "*Coasting Service*" or equivalent, which are not engaged in international voyages, or whose gross tonnage is less than 500 *tons*, the following requirements may be applied in addition to the requirements given in **-1** to **-3** above.

(1) The requirements specified in **1.3.1-5** need not apply.
(2) The requirements specified in **1.3.8** need not apply. (however, only for those ships not engaged in international voyages)
(3) The requirements specified in **1.3.9** need not apply.
(4) Appropriate devices specified in **5.2.4-3** may be replaced with emergency fixing bolts for clutches to enable the ship to obtain navigable speed.
(5) Appropriate devices specified in **7.2.2-8**, may be replaced with propeller pitch-fixing devices to enable the ship to obtain a navigable speed.
(6) The requirements specified in **13.5.10**, **13.6.1-5**, **13.8.5**, **13.9.1-6** and **13.9.1-7** need not apply.
(7) The requirements specified in **15.1.5** need not apply.
(8) The requirements specified in **15.2.4-5** and **-6** need not apply (excluding those cases where any provision of auxiliary steering gear has been omitted according to the requirements in

15.2.1-2).

(9) The requirements for alternative source of powers specified in **15.2.6** need not apply.

(10) The requirements in **15.2.7-1** and **-7** need not apply.

(11) The requirements for overload for circuits and motors specified in **15.2.7-5** need not apply.

(12) A means of communication between the navigating bridge and the steering gear compartment specified in **15.2.9** may be replaced with an appropriate alternative means.

(13) The requirements in **15.3.1-3** need not apply.

(14) The requirements specified in **19.1.5**, **19.5.4-4**, **19.6.2**, **19.6.3(2)**, **19.6.3(5)** (only those requirements concerned with overload alarms of motors), **19.6.3(7)**, and **19.7.1-7** need not apply.

(15) Notwithstanding the requirements of **19.6.3(1)**, each steering system may be served separately by exclusive circuits fed directly from main switchboards. In cases where three or more propulsion systems are provided, these exclusive circuits may be composed of at least two systems. In addition, one of these circuits may be supplied through the emergency switchboard.

(16) The requirements specified in **20.2.5**, **20.5.3(4)**, **20.6.1-2**, **20.6.2**, **20.6.3(2)** (only those requirements concerned with overload alarms of motors), **20.6.3(4)**, and **20.7.1-5** need not apply.

(17) Notwithstanding the requirements of **20.6.1-1**, each steering system may be served separately by exclusive circuits fed directly from main switchboards. In cases where three or more propulsion systems are provided, these exclusive circuits may be composed of at least two systems. In addition, one of these circuits may be supplied through the emergency switchboard.

~~22~~25.2.2 Ships with the Class Notation "*Smooth Water Service*" or Equivalent

1 In addition to the requirements specified in **~~22~~25.2.1-1**, **-2** and **-3** above, the buffer arrangements specified in **15.4.9** may be omitted.

2 For ships with an upper stock diameter of not more than 120 *mm* as calculated by the formula in **Chapter 3, Part C** (however, in cases where K_S is less than 1, calculations are to be made with a material factor K_S = 1.), the provisions of the auxiliary steering gear specified in **15.2.1** above may be omitted in cases where spare parts for consumables, such as packing and bearings, are provided for power-driven main steering gear or in cases where spare steering wires are provided for manually-powered main steering gear.

3 For ships with the Class Notation "*Smooth Water Service*" or equivalent which are not engaged in international voyages, or whose gross tonnage is less than 500 *tons*, the following requirements may apply in addition to the requirements specified in **~~22~~25.2.1-1** to **-4**, **~~22~~25.2.2-1** and **-2**.

(1) Notwithstanding the requirements in **1.3.1-4**, the provision of one unit or one set each of the machinery specified in **~~22~~25.2.1-1(1)** to **(7)** may be accepted, provided that each has such a capacity sufficient for the main propulsion machinery to obtain the maximum continuous output and for the main and essential auxiliary boiler to obtain the maximum evaporative capacity.

(2) The requirements for fuel oil transfer pumps specified in **13.9.3** may be modified to one set of pumps driven independent sources of power.

(3) Notwithstanding the requirement in **1.3.1-3**, the requirements for two or more starting air compressors specified in **13.13.3** may be modified to one starting air compressor driven by an independent source of power.

~~22~~25.2.3 Ships with a Gross Tonnage less than 500 *Tons*, etc.

1 For ships with a gross tonnage less than 500 *tons*, the requirements specified in **~~22~~25.2.1-3**

and **-4(1)**, **(3)** and **(6)** through **(13)** above may be complied with. Moreover, the buffer arrangements specified in **15.4.9** may be omitted.

2 For ships which are not engaged on international voyages or whose gross tonnage is less than 500 *tons*, the requirements specified in **13.4.1-4** and **13.8.6** need not apply.

3 For ships which are not engaged on international voyages and whose gross tonnage is not less than 500 *tons*, where deemed appropriate by the Society taking account of various conditions of such ships related to the navigation, the requirements specified in **13.8.5** need not apply.

~~22~~25.3 Spare Parts, Tools and Instruments for Ships with Restricted Areas of Service

~~22~~25.3.1 Spare Parts, Tools and Instruments and etc. for Ships with Class Notation "*Coasting Service*" or Equivalent

Spare parts for machinery installed in ships with a Class Notation of "*Coasting Service*" or equivalent may comply with the requirements specified in **Table D~~22~~25.1**. Furthermore, for ships equipped with 2 or more ~~diesel~~ reciprocating internal combustion engines or steam turbines for main propulsion and for ships equipped with 2 or more main generators, spare parts for ~~diesel~~ reciprocating internal combustion engines or steam turbines for main propulsion or to drive main generators are not required.

~~22~~25.3.2 Spare Parts for Ships with Class Notation "*Smooth Water Service*" or Equivalent

Spare parts for the machinery installed in ships with a Class Notation of "*Smooth Water Service*" may comply with the requirements specified in **Table D~~22~~25.2**. Furthermore, for ships equipped with 2 or more ~~diesel~~ reciprocating internal combustion engines or steam turbines for main propulsion and for ships equipped with 2 or more main generators, spare parts for ~~diesel~~ reciprocating internal combustion or steam turbines for main propulsion or to drive main generators are not required.

Table D~~22~~25.1 Spare Parts for Coasting Service Ships

Area of service	Table No. and Paragraph No. in **Chapter ~~21~~24**		Items and types of spares		Quantity
Coasting Service	**Table D~~21~~24.1**		Cylinder liner, cylinder cover, piston, camshaft driving gear, cylinder lubricator, scavenging air blower (including turbocharger) scavenging air system, reduction gear, reversing gear		Omitted
		Table D~~21~~24.2	Main bearing, piston cooling system		
			Cylinder-mounted valve	Starting air valve, relief valve	
				Exhaust gas valve, fuel injector	For one cylinder
			Connecting rod bearing		Lower half of small end bearing metal, upper half of big end bearing metal, one piece each
	Table D~~21~~24.3 and **Table D~~21~~24.4**		All items and all types		Omitted
	Table D~~21~~24.5		Cylindrical water gauge glass		6 pieces
			Flat water gauge glass		One piece
	Table D~~21~~24.6		Centrifugal pump, gear pump, air compressor		Omitted
	24.2.1-7		Ball bearings, Pumps		
	24.2.1-8		Hydraulic motors, Pumps		
	Table D~~21~~24.7		Standard pressure gauge		
			Tube plug	Water tube boiler	4 pieces each
				Other types of boiler	4 pieces in total

Table D~~22~~25.2 Spare Parts for Smooth Water Service Ships

Area of service	Table No. and Paragraph No. in **Chapter ~~21~~24**	Items and types of spares		Quantity
Smooth Water Service	**Table D~~21~~24.1** and **Table D~~21~~24.2**	Connecting rod bearing		Lower half of small end bearing metal, upper half of big end bearing metal, one piece each
		All items excluding connecting rod bearing		Omitted
	Table D~~21~~24.3 and **Table D~~21~~24.4**	All items and all types		
	Table D~~21~~24.5	Safety valve spring, complete set of oil burner		
		Cylindrical water gauge glass		3 pieces
		Flat water gauge glass		One piece
	Table D~~21~~24.6	Centrifugal pump, gear pump, air compressor		Omitted
	24.2.1-7	Ball bearings, Pumps		
	24.2.1-8	Hydraulic motors, Pumps		
	Table D~~21~~24.7	Standard pressure gauge		
		Tube plug	Water tube boiler	2 pieces for each type
			Other types of boiler	2 pieces in total

EFFECTIVE DATE AND APPLICATION (Amendment 1-18)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Rules, the current requirements apply to waterjet propulsion systems or azimuth thrusters whose applications for approval are submitted to the Society before the effective date installed on ships for which the date of contract for construction is before the effective date.

Amendment 1-19

Chapter 13 PIPING SYSTEMS

13.16 Exhaust Gas Piping Arrangements

Paragraph 13.6.1 has been amended as follows.

13.16.1 Exhaust Gas Pipes from ~~Diesel~~ Reciprocating Internal Combustion Engines and Gas Turbines*

1 In principle, the exhaust gas pipes from two or more ~~diesel~~ reciprocating internal combustion engines are not to be connected together except in the following **(1)** and **(2)** cases. In addition, the exhaust gas pipes from ~~diesel~~ reciprocating internal combustion engines and gas turbines as well as the exhaust gas pipes from two or more gas turbines are, in principle, not to be connected together.

(1) In cases where exhaust gas pipes of two or more ~~diesel~~ reciprocating internal combustion engines are connected to common silencers and effective means are provided to prevent any exhaust gas from returning into the cylinders of non-operating reciprocating internal combustion engines.

(2) In cases where exhaust gas pipes of two or more ~~diesel~~ reciprocating internal combustion engines are connected to common exhaust gas cleaning systems ~~deemed appropriate by the Society~~ which comply with **Chapter 22**.

2 Exhaust gas piping lines are to be arranged so that water does not enter the cylinders of ~~diesel~~ reciprocating internal combustion engines or gas turbines. In particular, exhaust gas piping lines that are led overboard near the water line are to be so arranged to prevent water from being siphoned into the line.

3 Boiler uptakes and exhaust piping lines from ~~diesel~~ reciprocating internal combustion engines are not to be connected together except in the following **(1)** and **(2)** cases. In addition, boiler uptakes and the exhaust gas pipes from gas turbines are not to be connected together except in case **(1)**.

(1) In cases where boilers or gas turbines are arranged to utilize waste heat from ~~diesel~~ reciprocating internal combustion engines.

(2) In cases where boiler uptakes and exhaust piping lines from ~~diesel~~ reciprocating internal combustion engines are connected to common exhaust gas cleaning systems ~~deemed appropriate by the Society~~ which comply with **Chapter 22**.

EFFECTIVE DATE AND APPLICATION (Amendment 1-19)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Rules, the current requirements apply to EGCS whose applications for approval are submitted to the Society before the effective date installed on ships for which the date of contract for construction is before the effective date.

Amendment 1-20

Chapter 16 WINDLASSES AND MOORING WINCHES

16.2 Windlasses

16.2.3 Materials and Fabrication*

Sub-paragraph -2(4) has been amended as follows.

1 Materials

Materials used in the construction of torque-transmitting and load-bearing components of windlasses are to comply with the following requirements:

((1) to (3) are omitted.)

2 Welded fabrication

Welded fabrication is to comply with the following requirements:

(1) Weld joint designs, the degree of non-destructive examination of welds and post-weld heat treatment, if any, are to be indicated in the drawings and data specified in **16.2.2(1)**.

(2) Welding procedures and related specifications are to be qualified in accordance with requirements of standards recognized by the Society or the requirements of **Chapter 11**.

(3) Each welder to be engaged in the welding work is to pass the qualification tests specified in **Part M** (including initial and renewal tests) with respect to each required welder qualification depending on the applicable welding process and materials to be welded. In addition, each welder is to obtain a qualification certificate issued by the Society.

(4) Welding consumables are to be type-approved by the Society in accordance with the requirements in **Part M**. In cases where compliance with this requirement, however, is deemed impractical, welding consumables that satisfy the following **(a)** and **(b)** may be accepted.

(a) Welding consumables that conform to standards recognized by the Society; and

(b) Welding consumables subjected to deposited weld metal tests, the results of which are deemed appropriate by the Surveyor

EFFECTIVE DATE AND APPLICATION (Amendment1-20)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Rules, the current requirements apply to windlass other than those which fall under the following:

(1) windlasses for which the application for approval is submitted to the Society on or after the effective date;

(2) windlasses used on ships for which the date of contract for construction* is on or after the effective date.

* "contract for construction" is defined in the latest version of IACS Procedural Requirement (PR) No.29.

IACS PR No.29 (Rev.0, July 2009)

1. The date of "contract for construction" of a vessel is the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. This date and the construction numbers (i.e. hull numbers) of all the vessels included in the contract are to be declared to the classification society by the party applying for the assignment of class to a newbuilding.

2. The date of "contract for construction" of a series of vessels, including specified optional vessels for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the prospective owner and the shipbuilder.

For the purpose of this Procedural Requirement, vessels built under a single contract for construction are considered a "series of vessels" if they are built to the same approved plans for classification purposes. However, vessels within a series may have design alterations from the original design provided:

(1) such alterations do not affect matters related to classification, or

(2) If the alterations are subject to classification requirements, these alterations are to comply with the classification requirements in effect on the date on which the alterations are contracted between the prospective owner and the shipbuilder or, in the absence of the alteration contract, comply with the classification requirements in effect on the date on which the alterations are submitted to the Society for approval.

The optional vessels will be considered part of the same series of vessels if the option is exercised not later than 1 year after the contract to build the series was signed.

3. If a contract for construction is later amended to include additional vessels or additional options, the date of "contract for construction" for such vessels is the date on which the amendment to the contract, is signed between the prospective owner and the shipbuilder. The amendment to the contract is to be considered as a "new contract" to which **1.** and **2.** above apply.

4. If a contract for construction is amended to change the ship type, the date of "contract for construction" of this modified vessel, or vessels, is the date on which revised contract or new contract is signed between the Owner, or Owners, and the shipbuilder.

Note:

This Procedural Requirement applies from 1 July 2009.

Amendment 1-21

Chapters 21 to 23 have been added.

Chapter 21 SELECTIVE CATALYTIC REDUCTION SYSTEMS AND ASSOCIATED EQUIPMENT

21.1 General

21.1.1 Application

1 The requirements in this Chapter apply to selective catalytic reduction systems (hereinafter referred to as "SCR systems") and associated equipment.

2 Urea based ammonia (e.g., AUS 40 - 40%/60% urea/water aqueous urea solution specified in *ISO* 18611-1) is to be used as reductant agent in SCR systems. In cases where another reductant agent is used, however, special consideration is to be given to such systems in accordance with their respective designs as well as the following **(1)** and **(2)**:

(1) Aqueous ammonia (28% or less concentration of ammonia by weight) is not to be used as a reductant agent in SCR systems except in cases where it can be demonstrated that it is not practicable to use a urea based reductant agent.

(2) Anhydrous ammonia (99.5% or greater concentration of ammonia by weight) is not to be used as a reductant agent in SCR systems except in cases where the flag administration agrees to its use and the following **(a)** and **(b)** can be demonstrated:

(a) It is not practicable to use an aqueous urea solution.

(b) It is not practicable to use an aqueous ammonia.

3 In cases where a reductant agent specified in **(1)** or **(2)** of **-2** above is used, arrangements for its loading, carriage and use are to be derived from a risk based analysis.

4 In addition to the requirements in this Chapter, the Society may apply special requirements as instructed by the flag administration of the ship or the governments of sovereign nations whose waters the ship navigates.

21.1.2 Terminology

The terms used in this Chapter are defined as follows:

(1) "SCR system" means a system consisting of a SCR chamber and a reductant agent injection system.

(2) "SCR chamber" means an integrated unit containing one or more catalyst blocks into which flows exhaust gas from diesel engines without outflow and which receives its supply of the reductant agent from a reductant agent injection system.

(3) "Catalyst block" means a block of certain dimensions through which exhaust gas passes and which contains catalysts on its inside surfaces which reduce the NOx content of exhaust gas.

(4) "Reductant agent injection system" means a system which consists of equipment such as pumps for supplying reductant agents to nozzles, nozzles for injecting reductant agents and device(s) for controlling the flow rates of the reductant agents injected by the nozzles.

21.1.3 Drawings and Data to be Submitted

Drawings and data to be submitted are generally as follows:

(1) Plans and documents for approval

(a) Particulars

(b) Specifications

(c) Material specifications

(d) General arrangement

(e) SCR chamber construction, including the arrangement of catalyst blocks
(f) Reductant agent storage tank construction and their arrangements
(g) Ventilation systems for compartments installed with equipment for using or handling reductant agent, such as its storage tanks, or for the compartments specified in **21.4.2-3**.
(h) Detailed arrangements of injection nozzles of reductant agent injection systems
(i) Piping diagram
(j) Arrangements of control systems and diagram of hydraulic and electrical systems, including safety systems and alarm systems
(k) Plans and documents concerning automation
i) List of measuring points
ii) List of alarm points
iii) Control systems and safety systems (list of controlled objects and controlled variables, list of conditions for safety systems, and kinds of control energy sources such as self-actuated, pneumatic and electric)
(l) The construction, arrangement and diagrams of electrical systems, including safety systems and alarm systems, of exhaust gas heating devices, if fitted
(m) Plans and documents for the control and monitoring systems of SCR systems, if the ships are provided with monitoring and control systems for periodically unattended machinery spaces.
(n) Other drawings considered necessary by the Society

(2) Plans and documents for reference
(a) Operation manual for SCR systems
(b) Operation manual for automatic control and safety systems
(c) Documents related to allowable back pressure
(d) Documents related to any studies and corresponding results explaining cases where bypass pipes are not fitted for SCR systems in accordance with **21.3.1-2(1)**
(e) Engineering analysis such as Failure Mode Effect Analysis (FMEA)
(f) Other drawings considered necessary by the Society

21.2 Design

21.2.1 General Requirements

1 In addition to the requirements in this Chapter, pipes, valves, pipe fittings and auxiliaries are to satisfy the requirements in **Chapter 12**. In such cases, the term "sea water" is to be read as "reductant agent".

2 In addition to the requirements in this Chapter, air pipes and sounding pipes are to satisfy the requirements in **13.6** and **13.8**. In such cases, the term "fuel oil" is to be read as "reductant agent".

3 In addition to the requirements in this Chapter, the control systems, safety systems and alarm systems of reductant agent injection systems are to satisfy the requirements in **Chapter 18**.

4 Appropriate means are to be provided to allow continuous proper operation of diesel engines which are connected to SCR systems in case where a single component of the system or associated equipment fails or becomes otherwise inoperable.

21.2.2 Material

1 SCR systems and related piping systems for reductant agents, tanks, and other components (including pumps, valves, vents, other parts and their joints) which may come into contact with the reductant solution are to be of a suitable grade of non-combustible compatible material established to be suitable for the application.

2 Material used for exhaust gas heating devices are to be deemed appropriate by the Society.

21.3 SCR systems

21.3.1 SCR chamber

1 Consideration of Exhaust Gas Allowable Back Pressure and Temperature

SCR chambers suitable for diesel engines are to be installed, and the systems are to be arranged on exhaust gas pipes so that the back pressure and temperature do not exceed the allowable limits specified by the diesel engine manufacturer.

2 Changeover of Exhaust Gas Pipes

(1) In cases of SCR system failure as well as any blocking or clogging of SCR chambers, bypass pipes are to be provided except for such diesel engines connected to systems that can be satisfactory operated under the possible operating ranges of the engines without bypass pipes in the event of back pressure increases due to such a failure or blocking or clogging.

(2) For diesel engines with changeover arrangements from exhaust gas pipes in which a SCR chamber is installed to bypass pipes, changeover devices for those pipes are to be fitted at the branch positions of the pipes.

(3) The devices specified in **(2)** above are to be fitted with appropriate means to prevent the simultaneous closing of the exhaust pipes in which the SCR chamber is installed and bypass pipes, such as interlock devices so that the proper operation of the diesel engines emitting exhaust gas will be maintained.

(4) The devices specified in **(2)** above are to be provided with indicators which show which exhaust gas pipe is being used. These indicators are to be fitted at both local positions and control stations of SCR systems.

3 Maintenance Considerations

(1) Catalyst blocks are to be arranged so that they can be easily replaced.

(2) Sufficient space for replacing catalyst blocks is to be provided on board ship.

4 Maintaining the Quality of Catalytic Reactions

Consideration is to be given to SCR chambers so that any degradation of catalytic reactions due to the adherence of soot, etc. is prevented.

21.3.2 Reductant Agent Injection Systems

1 Injection Control

Reductant agent injection systems are to be fitted with interlock devices so that the reductant solution cannot be injected in cases where the temperature of exhaust gas at the inlet of the SCR chamber is below the design temperature specified by the manufacturer.

2 Injection Amount Monitoring

Arrangements are to be provided to monitor the amount of reductant agent injected during use of the SCR system at control stations.

3 Injection Position

The reductant agent is to be injected so that hydrolysis is achieved after the injection and the appropriate denitration reaction is produced in the chamber.

4 Safety Devices and Alarm Devices

The reductant agent injection system is to be fitted with alarm devices and safety devices to stop the injection of reductant agent when the temperature at the outlets of engines or the inlets of SCR chambers exceed preset levels in order to avoid any self-ignition of ammonia gas caused by abnormal increases in exhaust gas temperatures.

21.4 Requirements for Construction and Arrangements, etc.

21.4.1 Construction and Arrangement

1 Reductant agent storage tanks may be located within the engine room.

2 Reductant agent storage tanks are 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 reductant agent tank are maintained to avoid any impairment of the reductant agent during storage.

3 The reductant agent 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.

4 Storage tanks for reductant agents as well as any equipment using or handling reductant agents, such as reductant agent injection systems, are to be so arranged to prevent the spread of any spillage in the compartments where they are installed. For example, drip trays of a sufficient size are to be provided under such tanks and equipment.

5 Where reductant agent is stored in tanks which form part of the ship's hull, the following **(1)** to **(6)** are to be considered during the design and construction:

(1) These tanks may be designed and constructed as integral part of the hull, (e.g. double bottom, wing tanks).

(2) These tanks are to be coated with appropriate anti-corrosion coating.

(3) These tanks are to be designed and constructed as per the structural requirements applicable to hull and primary support members for deep tank construction after taking into account the specific gravity of reductant agent.

(4) These tanks are to be fitted with but not limited to level gauge, temperature gauge, high temperature alarm, low level alarm, etc.

(5) These tanks are to be segregated by cofferdams, void spaces, pump rooms, empty tanks or other similar spaces so as to not be located adjacent to accommodation or service spaces, cargo spaces containing cargoes which react with reductant agent in a hazardous manner as well as any food stores, oil tanks and fresh water tanks.

(6) These tanks are to be included in the ship's stability calculation.

6 Piping for reductant agent and venting systems are to be independent of other ship service piping and/or systems.

7 Piping systems for reductant agent are not to pass through or to extend into accommodation, service spaces, or control stations.

8 Piping systems for reductant agents are not to pass through or extend into any storage tanks for other liquids, except in cases where deemed appropriate by the Society.

9 The piping systems for reductant agents, excluding those near reductant agent injection nozzles, are not to be located immediately above or near equipment operating at high temperatures such as boilers, steam pipelines and exhaust gas pipes, etc. which are required to be insulated. As far as practicable, such piping systems are to be arranged far from hot surfaces, electrical installations and other sources of ignition.

10 In cases where a reductant agent is produced from solid matter on board, the solid matter is to be stored at an appropriate location in consideration of the storage conditions specified by the manufacturer.

21.4.2 Closing Devices and Shut-down Systems

1 Reductant agent supply piping, which, if damaged, would allow reductant agent to escape from storage tanks situated above the double bottom, is to be fitted with a cock or valve directly on the tank capable of being closed from a safe position outside the space in which such tanks are situated in the event of a fire occurring in such a space. In the case of storage tanks situated in any shaft or pipe tunnel or similar space, valves on the tank are to be fitted, but an additional valve on the pipe or pipes outside the tunnel or similar space may be so fitted as to prevent the reductant

agent from escaping in the event of fire. If such an additional valve is fitted in a machinery space, the valve is to be capable of being operated from a position outside said machinery space.

2 Reductant agent supply pumps are to be provided with stopping devices installed inside the space in which they are installed and, in addition, in a location outside such a space which will not be cut off in the event of fire in said space.

3 In cases where exhaust gas heating devices fitted with burners and blowers are installed, stopping devices for the burners and blowers are to be installed inside the space in which they are installed and, in addition, in a location outside such a space which will not be cut off in the event of fire in said space.

21.4.3 Ventilation Systems

1 If storage tanks for reductant agent or equipment for using or handling reductant agent, such as reductant agent injection systems, is installed in a closed compartment, the area is to be served by an effective mechanical supply and exhaust ventilation system 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 and is to be maintained in operation continuously except when the storage tank is empty and has been thoroughly air purged. If the ventilation stops, an audible and visual alarm is to be provided outside the compartment adjacent to each point of entry and inside the compartment, together with a warning notice requiring the use of such ventilation.

2 Notwithstanding the requirements specified in **-1** above, where storage tanks for reductant agent or equipment for using or handling reductant agent, such as the reductant agent injection systems are 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 equipment and is to be maintained in operation continuously except when the storage tank is empty and has been thoroughly air purged.

3 In cases where reductant agent is stored within tanks which form part of the ship's hull, ventilation systems for enclosed compartments normally entered by ship personnel which are located adjacent to such tanks are to be in accordance with the following **(1)** or **(2)**:

(1) In cases where the tanks are adjacent to the engine room, the requirements of **-2** above apply.

(2) In cases where the tanks are adjacent to enclosed compartments normally entered by ship personnel, the requirements of **-1** above apply.

21.4.4 Venting Systems of Reductant Agent Storage Tank

1 Reductant agent storage tanks are to be arranged so that they can be emptied of urea, purged and vented.

2 The vent pipes of reductant agent storage tanks are to terminate in a safe location on the weather deck in consideration of the emission of ammonia gas from the vent outlets in the event of fire near the tanks. Tank venting systems are to be arranged to prevent entrance of water into reductant agent storage tanks.

21.4.5 Safety Devices and Alarm Devices

1 In cases where changeover devices for exhaust gas pipes are fitted, devices which automatically open bypass sides of the changeover devices in the event of any of the following **(1)** and **(2)** failures are to be fitted. The above changeover devices are also to be operated within allowable limits of engine back pressure.

(1) Abnormal increases of the exhaust gas pressures at the inlet or the differential pressures across the catalyst blocks

(2) Abnormal increase of the exhaust gas temperature at the outlet

2 Alarm devices, to be activated in the event of any of the abnormal conditions given in **Table D21.1**, are to be provided at control stations.

3 SCR systems are to be fitted with monitoring devices at control stations, and these devices are to be capable of indicating the information listed in the following **(1)** to **(4)**:

(1) Liquid levels in tanks for reductant agent

(2) Temperatures in tanks for reductant agent

(3) Exhaust gas temperatures at inlets

(4) Pressures at inlets or differential pressures across catalyst block

4 In addition to the requirements given in **-1** to **-3** above, additional safety, alarm and monitoring systems may be required to be fitted based upon engineering analysis results, such as Failure Mode Effect Analysis (FMEA), for SCR systems.

Table D21.1 Alarm points for SCR system(1)

Monitored Variables	
Liquid levels in tank for reductant agent	H L
Temperature in tank for reductant agent	H L
Exhaust gas pressure at inlet (2)	H
Exhaust gas temperature at inlet	H L
Exhaust gas temperature at outlet(3)	H
Power loss of control, alarm, monitoring or safety devices	○

Notes:

(1) "H" and "L" mean "high" and "low". "○" means abnormal condition occurred.

(2) Differential pressure across catalyst block may be accepted in lieu.

(3) Alarms may be omitted in cases where means are provided to prevent damage by soot fire.

21.5 Electrical Installations

21.5.1 General

1 Capacities of main sources of electrical power are to cover maximum electric demand during SCR system operation, including normal seagoing conditions, cargo loading and unloading conditions, and departure and arrival conditions.

2 For items not specified in **-1** above, electrical installations are to comply with relevant requirements specified in **Part H**.

21.6 Exhaust Gas Heating Device

21.6.1 General

1 In cases where exhaust gas heating devices equipped with burners are installed for the purpose of raising the temperatures of the exhaust gas from engines, the requirements in **21.6.2**, **21.6.3** and **21.6.4** are to be complied with.

2 Exhaust gas heating devices which are not equipped with burners are to conform to requirements deemed appropriate by the Society.

21.6.2 Construction and Arrangement

1 Exhaust gas heating devices are to be so arranged that the pressure in exhaust gas pipes does not exceed the exhaust gas allowable back pressure specified by the engine manufacturer.

2 Appropriate measures are to be taken to prevent the frames of burners from coming in direct contact with the exhaust gas from the engines.

3 Appropriate measures are to be taken to prevent any unburnt fuel from engines from entering into exhaust gas heating devices when the SCR system is not in use. In cases where an on-off damper is installed in the flue gas line of the exhaust gas heating device, an indicator which shows the condition of the damper is to be provided.

4 Temperature measurement devices for the combustion gas at the outlets of exhaust gas heating devices or the exhaust gas at the inlets of SCR chambers are to be provided.

5 A blower of adequate capacity is to be so provided that the temperature of the exhaust gas rises to the required level.

6 Combustion chambers and gas flue lines of exhaust gas heating device are to comply with the following **(1)** and **(2)**:

(1) Main parts of combustion chambers are to be constructed with appropriate materials.

(2) Means to inspect and clean combustion chambers and flue lines are to be provided.

7 The construction and control of burners are to comply with the following **(1)** to **(5)**:

(1) The fuel supply is to be appropriately controlled so that the temperature of the exhaust gas from engines is heated to a temperature in which the catalysis is able to effectively function.

(2) They are to be so arranged that the combustion chamber is capable of being pre-purged before ignition.

(3) They are to be so arranged that the fuel supply does not precede the operation of the ignition system in cases where an automatic ignition system is adopted.

(4) They are to be capable of controlling the amount of fuel supplied in cases where an automatic fuel supply system is provided.

(5) The ignition of the main burner and pilot burner, etc. is to follow their planned sequence in cases where an automatic combustion control device is provided.

21.6.3 Installation Considerations

1 Exhaust gas heating devices are to be so installed as to minimize the effects of the following loads or external forces:

(1) ship motions or any vibrations caused by machinery installations;

(2) external forces caused by the piping or any other supports fitted onto the exhaust gas heating device; and

(3) thermal expansions due to temperature fluctuation.

21.6.4 Safety Devices and Alarm Devices

1 Each exhaust gas heating device is to be fitted with a safety device which automatically shuts off the fuel supply to all burners in any of the following **(1)** and **(2)** cases:

(1) when the temperature of combustion gas at the outlet of the exhaust gas heating device or exhaust gas temperature at the inlet of SCR chamber is above or below the preset temperature for normal operation of the SCR system; or

(2) when the flame is extinguished.

2 Each exhaust gas heating device is to be fitted with an alarm device which operates in any of the following **(1)** to **(6)** cases:

(1) when the temperature of combustion gas at the outlet of the exhaust gas heating device or exhaust gas temperature at the inlet of SCR chamber is above or below the preset temperature for normal operation of the SCR system;

(2) when the flame is extinguished;

(3) when the power supply to the alarm device is stopped;

(4) when the fuel injection pressure to the furnace falls, in the case where fuel supply is of pressure injection type;

(5) when the blowers stop; or

(6) other cases deemed necessary by the Society.

21.7 Safety and Protective Equipment

21.7.1 General

For the protection of crew members, the ship is to have on board at least the following suitable protective equipment and installations. Locations and numbers of the equipment and installations are to be derived from the detailed installation arrangements. Locations where such equipment is stored or installed are to be clearly marked so as to be easily identifiable.

(1) Personnel protective equipment
  (a) Large apron of chemical-resistant material
  (b) Special gloves with long sleeves
  (c) Suitable footwear
  (d) Suitable protective equipment consisting of coveralls and tight-fitting goggles or face shields or both
(2) Self-contained breathing apparatus (capable of functioning for at least 30 minutes)
(3) Eyewash
(4) Safety shower
(5) Stretcher

21.8 Tests

21.8.1 Tests at Facilities (Shop tests)

1 Reductant agent independent storage tanks are to be subjected to hydrostatic tests at a pressure corresponding to a water head of 2.5 *m* above the top plate.

2 After completion of the fabrication process, piping, valves and pipe fittings, containing reductant agent, the design pressure of which exceeds 0.35 *MPa* are to be subjected to hydrostatic tests together with the welded fittings at a pressure equal to 1.5 times the design pressure.

3 The pressure parts of reductant agent supply pumps are to be subjected to hydrostatic tests at a pressure equal to 1.5 times the design pressure or 0.2 *MPa*, whichever is greater. Tests carried out in the presence of the Surveyor may be replaced by manufacturer's tests. In such cases, submission or presentation of test records may be required by the Society.

4 For reductant agent supply pumps, shop trials are to be carried out according to test procedures deemed appropriate by the Society.

5 Electrical motors and their corresponding control gears used for pumps fitted on SCR systems are to be tested in accordance with relevant requirements in **Part H**. Shop tests for electrical motors whose continuous rated capacities are less than 100 *kW* and their corresponding control gears may be replaced by manufacturer tests. In such cases, submission or presentation of test records may be required by the Society.

21.8.2 Tests after Installation On Board

1 In cases where reductant agent is carried in tanks which form part of the ship's hull, the tanks are to be subjected to hydrostatic tests in accordance with **2.1.5(1), Part B**. Where the specific gravities of the liquids used for the tests are less than those of the reductant agent, an appropriate additional head is to be considered.

2 After installation on board, SCR systems are to be tested in accordance with the following **(1)** to **(4)**:

(1) Piping systems for reductant agent are to be subjected to leak tests at pressures equal to 1.5 times the design pressure or 0.4 *MPa*, whichever is greater.
(2) Operation tests of SCR systems are to be carried out at maximum quantities of emitted exhaust gas.
(3) Performance tests for control, safety and alarm devices are to be carried out

(4) Operation tests for changeover devices of exhaust gas pipes and the corresponding indicators are to be carried out.

Chapter 22 EXHAUST GAS CLEANING SYSTEMS AND ASSOCIATED EQUIPMENT

22.1 General

22.1.1 Application

1 The requirements in this Chapter apply to exhaust gas cleaning systems and associated equipment installed to reduce sulphur oxides and particular matter emitted from fuel oil combustion units such as reciprocating internal combustion engines and boilers, and which use sodium hydroxide solutions.

2 In cases where exhaust gas cleaning systems which use chemical agents other than those specified in **-1** above are used, special consideration is to be given to such systems in accordance with their respective designs.

3 In cases where exhaust gas cleaning systems which do not use chemical agents are used, the term "liquids containing sodium hydroxide solutions" is to be read as "liquids which have passed through scrubber chambers" ; this, however, does not apply to **-4**, **-9** and **-10** of **22.4.1**.

4 Exhaust gas cleaning systems and associated equipment used in exhaust gas recirculation systems are to comply with **Chapter 23**.

5 In addition to the requirements in this Chapter, the Society may apply special requirements as instructed by the flag administration of the ship or the governments of sovereign nations whose waters the ship navigates.

22.1.2 Terminology

The terms used in this Chapter are defined as follows:

(1) "Exhaust gas cleaning system" means a system which consists of storage tanks for residues, etc., washwater supply pumps, sodium hydroxide solution supply pumps, washwater injection systems and scrubber chambers.

(2) "Scrubber chamber" means an integrated unit which discharges the washwater, into which flows exhaust gas from fuel oil combustion units and which receives the washwater supply from the washwater injection system.

(3) "Washwater" means freshwater or sea water (including cases where sodium hydroxide is added) which is injected into scrubber chambers or exhaust gas inlets, and includes liquids which have passed through scrubber chambers.

(4) "Washwater injection systems" means a system which consists of equipment such as pumps for supplying washwater to nozzles, nozzles for spraying washwater and devices for controlling the flow rates.

(5) "Residue" means a substance generated by exhaust gas cleaning systems resulting from the cleaning of exhaust gas, except for any liquids allowed to be discharged overboard.

22.1.3 Drawings and Data to be Submitted

Drawings and data to be submitted are generally as follows:

(1) Plans and documents for approval
  (a) Particulars
  (b) Specifications
  (c) Material specifications
  (d) General arrangement
  (e) Construction of scrubber chamber
  (f) Construction of storage tanks for sodium hydroxide solution/liquid containing sodium hydroxide solution and their arrangements.
  (g) Ventilation systems for compartments installed with equipment for using or handling

sodium hydroxide solutions, such as storage tanks, or for the compartments specified in **22.4.2-3**

(h) Piping diagram

(i) Arrangements of control systems and diagrams of hydraulic and electrical systems, including safety systems and alarm systems

(j) Plans and documents concerning automation

i) List of measuring points

ii) List of alarm points

iii) Control systems and safety systems (list of controlled objects and controlled variables, list of conditions for safety systems, and kinds of control energy sources such as self-actuated, pneumatic and electric)

(k) Plans and documents for the control and monitoring systems of exhaust gas cleaning systems, if the ships are provided with monitoring and control systems for periodically unattended machinery spaces

(l) Other drawings considered necessary by the Society

(2) Plans and documents for reference

(a) Operation manual for exhaust gas cleaning systems

(b) Operation manual for automatic control and safety systems

(c) Documents related to allowable back pressure

(d) Documents related to any studies and corresponding results explaining cases where bypass pipes are not fitted for exhaust gas cleaning systems in accordance with **22.3.1-3(1)**

(e) Engineering analysis such as Failure Mode Effect Analysis (FMEA)

(f) Other drawings considered necessary by the Society

22.2 Design

22.2.1 General Requirements

1 In addition to the requirements in this Chapter, pipes, valves, pipe fittings and auxiliaries are to satisfy the requirements in **Chapter 12**. In such cases, the term "sea water" is to be read as "liquids containing sodium hydroxide solutions". However, pipes containing sodium hydroxide solutions only are to be classified as Group I.

2 In addition to the requirements in this Chapter, air pipes and sounding pipes are to satisfy the requirements in **13.6** and **13.8** (excluding **13.6.1-5** and **13.6.2-3**). In such cases, the term "fuel oil" is to be read as "liquids containing sodium hydroxide solutions".

3 In addition to the requirements in this Chapter, the control systems, safety systems and alarm systems of exhaust gas cleaning systems are to satisfy the requirements in **Chapter 18**.

4 Appropriate means are to be provided to allow continuous proper operation of fuel oil combustion units such as reciprocating internal combustion engines and boilers which are connected to exhaust gas cleaning systems in case where a single component of the system or associated equipment fails or becomes otherwise inoperable.

22.2.2 Material

Materials used for exhaust gas cleaning systems are to be selected in consideration of notch ductility at operating temperatures and pressures, their corrosive effects and the possibility of hazardous reactions.

22.3 Exhaust Gas Cleaning Systems

22.3.1 Construction of Exhaust Gas Cleaning Systems

1 Considerations for exhaust gas allowable back pressure and temperature

Exhaust gas cleaning systems suitable for fuel oil combustion units are to be installed, and the systems are to be arranged so that the back pressure and temperature do not exceed the allowable limits specified by the fuel oil combustion unit manufacturer.

2 Considerations for exhaust gas heating

Exhaust gas cleaning systems are to be provided with suitable means to ensure the systems do not suffer any damage caused by exhaust gas heating even when the exhaust gas cleaning system is not cleaning exhaust gas with washwater, or are to be provided with devices at their exhaust gas inlets to shut down the exhaust gas supply.

3 Changeover of exhaust gas pipes

(1) In cases of exhaust gas cleaning system failure as well as any blocking or clogging of scrubber chambers, bypass pipes are to be provided except for such fuel oil combustion units connected to systems that can be satisfactory operated under the possible operating ranges of the units without bypass pipes in the event of back pressure increases due to such a failure or blocking or clogging.

(2) For fuel oil combustion units with changeover arrangements from exhaust gas pipes in which a scrubber chamber is installed to bypass pipes, changeover devices for those pipes are to be fitted at the branch positions of the pipes.

(3) The devices specified in **(2)** above are to be fitted with appropriate means to prevent the simultaneous closing of the exhaust pipes in which the scrubber chamber is installed and bypass pipes, such as interlock devices so that the proper operation of the fuel oil combustion units emitting exhaust gas will be maintained.

(4) The devices specified in **(2)** above are to be provided with indicators which show which exhaust gas pipe is being used. These indicators are to be fitted at both local positions and control stations.

4 Prevention of reverse flow of washwater

Exhaust gas cleaning systems are to be fitted with appropriate means to prevent the reverse flow of washwater from scrubber chambers to fuel oil combustion units.

5 Arrangement of pipes for overboard discharges

Pipes for overboard discharges of washwater used in exhaust gas cleaning systems are to be entirely separate from other pipes. The position and direction of the discharge is to be arranged so as to preserve the integrity of hull and propeller, etc.

6 Prohibition of connection of exhaust gas pipes

In principle, exhaust gas pipes of fuel oil combustion units, such as reciprocating internal combustion engines and boilers, are not to be connected to common exhaust gas cleaning systems except where exhaust pipes of more than one fuel oil combustion units are required to be connected to common exhaust gas cleaning systems and the systems satisfy the following requirements in addition to **-3**.

(1) The exhaust gas cleaning systems are to be fitted with appropriate devices to prevent the reverse flow of exhaust gas to fuel oil combustion units such as other engines and boilers.

(2) The devices specified in **(1)** above are to be fitted with appropriate means to prevent the simultaneous closing of the bypass pipes and the exhaust pipes in which the scrubber chamber is installed, such as interlock devices so that the proper operation of the fuel oil combustion units, such as engines and boilers, emitting exhaust gas will be maintained.

(3) The devices specified in **(1)** above are to be provided with indicators which show which exhaust gas pipe is being used. These indicators are to be fitted at both local positions and control stations.

(4) Safety measures are to be provided for preventing the propagation of fire between fuel oil combustion units, such as reciprocating internal combustion engines and boilers, connected to common exhaust gas cleaning systems.

22.4 Requirements for Construction and Arrangements, etc.

22.4.1 Construction and Arrangement

1 Sodium hydroxide solution storage tanks may be located within the engine room.

2 Sodium hydroxide solution storage tanks are 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.

3 Drip trays of a sufficient size are to be provided under storage tanks for liquids containing sodium hydroxide solutions as well as any equipment using or handling such liquids, such as pumps, to prevent the spread of any spillage in the compartments where they are installed.

4 The drip trays specified in **-3** above are to be fitted with drain pipes which lead to appropriate tanks, such as residue tanks, which are fitted with high level alarm, or are to be fitted with alarms for leak detection.

5 Where sodium hydroxide solution is stored in tanks which form part of the ship's hull, the following **(1)** to **(6)** are to be considered during the design and construction:

(1) These tanks may be designed and constructed as integral part of the hull, (e.g. double bottom, wing tanks).

(2) These tanks are to be coated with appropriate anti-corrosion coating.

(3) These tanks are to be designed and constructed as per the structural requirements applicable to hull and primary support members for deep tank construction after taking into account the specific gravity of sodium hydroxide solution.

(4) These tanks are to be fitted with but not limited to level gauge, temperature gauge, high temperature alarm, high and low level alarm, etc.

(5) These tanks are to be segregated by cofferdams, void spaces, pump rooms, empty tanks or other similar spaces so as to not be located adjacent to accommodation or service spaces, cargo spaces containing cargoes which react with sodium hydroxide solutions in a hazardous manner as well as any food stores, oil tanks and fresh water tanks.

(6) These tanks are to be included in the ship's stability calculation.

6 Piping for liquids containing sodium hydroxide solutions and venting systems are to be independent of other ship service piping and/or systems.

7 Piping systems for liquids containing sodium hydroxide solutions are not to pass through or to extend into accommodation, service spaces, or control stations.

8 Piping systems for liquids containing sodium hydroxide solutions are not to pass through or to extend into any storage tanks for other liquids, except where deemed appropriate by the Society.

9 Piping systems for liquids containing sodium hydroxide solutions, excluding those near nozzles spraying washwater, are to be so arranged to prevent any outflows or leakage from the piping system from coming into contact with any high temperature equipment surfaces. Such piping systems are especially not to be located immediately above or near equipment such as boilers, steam pipes or exhaust gas pipes.

10 Storage tanks for liquids containing sodium hydroxide solutions are to satisfy the following requirements:

(1) The tanks are to be so arranged to prevent liquids containing sodium hydroxide solutions escaping or leaked from the tanks from coming into contact with high temperature equipment surfaces. Such tanks are especially not to be located immediately above or near equipment such as boilers, steam pipes or exhaust gas pipes.

(2) In cases where shore connections with standard couplings are fitted onto filling-up pipe lines, proper protection against any spraying of sodium hydroxide solutions, such as effective enclosures, is to be provided in consideration of the sodium hydroxide solution spraying out during filling-up operations.

11 Discharge pipes from storage tanks for liquids containing sodium hydroxide solutions are to be fitted with stop valves directly on the tank.

12 Piping systems for sodium hydroxide solutions which, if damaged, would allow the solution to escape from storage tanks are to be fitted with cocks or valves directly onto the tank. Such cocks or valves are to be capable of being closed from accessible positions even in the event of solution leakages.

13 Residue tanks are to satisfy the following requirements:

(1) Residues removed from washwater used in scrubber chambers are to be stored in tanks independent of the oil residue (sludge) tanks fitted in accordance with **Chapter 2, Part 3 of the Rules for Marine Pollution Prevention Systems**. In addition, such residues are to be discharged to appropriate reception facilities.

(2) Manholes or access holes in a sufficient size are to be provided at such locations that each part of the tank can be cleaned without difficulties.

(3) Tank capacities are to be decided in consideration of the number and kinds of installed exhaust gas cleaning systems as well as the maximum number of days between ports where residue can be discharged ashore.

22.4.2 Ventilation Systems

1 If storage tanks for sodium hydroxide solutions or equipment for using or handling sodium hydroxide solutions, such as solution supply pumps, is installed in a closed compartment, the area is to be served by an effective mechanical supply and exhaust ventilation system 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. If the ventilation stops, an audible and visual alarm shall be provided outside the compartment adjacent to each point of entry and inside the compartment, together with a warning notice requiring the use of such ventilation.

2 Notwithstanding the requirements specified in **-1** above, where storage tanks for sodium hydroxide solutions or equipment for using or handling sodium hydroxide solutions, such as the solution supply pump are 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 equipment and is to be maintained in operation continuously except when the storage tank is empty and has been thoroughly air purged.

3 In cases where sodium hydroxide solutions are stored within tanks which form part of the ship's hull, ventilation systems for enclosed compartments normally entered by ship personnel which are located adjacent to such tanks are to be capable of giving at least 20 air changes per hour and of being operated from outside the compartment in accordance with the following **(1)** or **(2)**:

(1) In cases where the tanks are adjacent to the engine room, the requirements of **-2** above apply.

(2) In cases where the tanks are adjacent to enclosed compartments normally entered by ship personnel, the requirements of **-1** above apply.

22.4.3 Safety Devices and Alarm Devices

1 Exhaust gas cleaning systems are to be fitted with safety devices which are capable of automatically stopping exhaust gas washwater supply pumps and sodium hydroxide solution pumps in the event of any of the following failures:

(1) Abnormal increase of the liquid level in the scrubber

(2) Abnormal increase of the pressure at the inlet or the differential pressure across the scrubber

chamber (in cases where changeover devices for exhaust gas pipes are not fitted)

2 In cases where changeover devices for exhaust gas pipes are fitted, devices capable of automatically opening bypass sides of changeover devices in the event of any of the following failures are to be fitted.

(1) Abnormal increase of the liquid level in the scrubber

(2) Abnormal increase of the exhaust gas pressure at the inlet or the differential pressure across the scrubber chamber

(3) Abnormal increase of the exhaust gas temperature at the outlet

3 Alarm devices, to be activated in the event of any of the abnormal conditions given in **Table D22.1**, are to be provided at control stations.

4 Exhaust gas cleaning systems are to be fitted with monitoring devices at control stations, and these devices are to indicate the information listed in **(1)** to **(5)**:

(1) Liquid levels in scrubber chambers

(2) Liquid levels in tanks for sodium hydroxide solutions

(3) Temperatures in tanks for sodium hydroxide solutions

(4) Exhaust gas temperatures at outlets

(5) Pressures at inlets or differential pressures across scrubber chambers

5 In addition to the requirements given in **-1** to **-3** above, additional safety, alarm and monitoring systems may be required to be fitted based upon engineering analysis results, such as Failure Mode Effect Analysis (FMEA), for exhaust gas cleaning systems.

Table D22.1 Alarm points for exhaust gas cleaning system(1)

Monitored Variables	
Liquid level in scrubber chamber	H
Temperature of washwater supply (in cases where the washwater includes sodium hydroxide solutions)	H
Liquid levels in tank for sodium hydroxide solution	H L
Temperature in tank for sodium hydroxide solution	H L
Exhaust gas pressure at the inlet (2)	H
Exhaust gas temperature at the outlet	H
Power loss of control, alarm, monitoring or safety devices	○

Notes:

(1) "H" and "L" mean "high" and "low". "○" means abnormal condition occurred.

(2) Differential pressure across scrubber chamber may be accepted in lieu.

22.5 Electrical Installations

22.5.1 General

1 Capacities of main sources of electrical power are to cover maximum electric demand during exhaust gas cleaning system operation, including normal seagoing conditions, cargo loading and unloading conditions, and departure and arrival conditions.

2 For items not specified in **-1** above, electrical installations are to comply with relevant requirements specified in **Part H**.

22.6 Safety and Protective Equipment

22.6.1 General

1 For the protection of crew members, the safety and protective equipment specified in **(1)** to **(4)** is to be stored at locations outside the compartment containing the exhaust gas cleaning system and easily accessible in the event of any leakages of liquids containing sodium hydroxide solutions.

The safety and protective equipment is to cover all skin so that no part of the body is unprotected. The locations at which the equipment is stored are to be clearly marked so as to be easily identifiable.

(1) Large apron of chemical-resistant material

(2) Special gloves with long sleeves

(3) Suitable footwear

(4) Suitable protective equipment consisting of coveralls and tight-fitting goggles or face shields or both

2 Eyewash and safety showers are to be located in the vicinity of sodium hydroxide solution filling stations and sodium hydroxide solution supply pumps.

22.7 Tests

22.7.1 Tests at Facilities (Shop tests)

1 Sodium hydroxide solution independent storage tanks are to be subjected to hydrostatic tests at a pressure corresponding to a water head of 2.5 *m* above the top plate.

2 After completion of the fabrication process, piping, valves and pipe fittings, for liquids containing sodium hydroxide solutions, design pressure of which exceeds 0.35 *MPa* are to be subjected to hydrostatic tests together with the welded fittings at a pressure equal to 1.5 times the design pressure.

3 The pressure parts of sodium hydroxide solution supply pumps and washwater supply pumps are to be subjected to hydrostatic tests at a pressure equal to 1.5 times the design pressure or 0.2 *MPa*, whichever is greater. Tests carried out in the presence of the Surveyor may be replaced by manufacturer's tests. In such cases, submission or presentation of test records may be required by the Society.

4 For sodium hydroxide solution supply pumps and washwater supply pumps, shop trials are to be carried out according to test procedures deemed appropriate by the Society.

5 Electrical motors and their corresponding control gears used for sodium hydroxide solution supply pumps and washwater supply pumps are to be tested in accordance with relevant requirements in **Part H**. Shop tests for electrical motors whose continuous rated capacities are less than 100 *kW* and their corresponding control gears may be replaced by manufacturer tests. In such cases, submission or presentation of test records may be required by the Society.

22.7.2 Tests after Installation On Board

1 In cases where sodium hydroxide solutions are carried in tanks which form part of the ship's hull, the tanks are to be subjected to hydrostatic tests in accordance with **2.1.5(1)**, **Part B**. Where the specific gravities of the liquids used for the tests are less than those of the sodium hydroxide solution, an appropriate additional head is to be considered.

2 After installation on board, exhaust gas cleaning systems are to be tested in accordance with the following:

(1) Piping systems for liquids containing sodium hydroxide solutions are to be subjected to leak tests at pressures equal to 1.5 times the design pressure or 0.4 *MPa*, whichever is greater.

(2) Operation tests of exhaust gas cleaning systems are to be carried out at maximum quantities of emitted exhaust gas.

(3) Performance tests for control, safety and alarm devices are to be carried out

(4) Operation tests for changeover devices of exhaust gas pipes and the corresponding indicators are to be carried out.

Chapter 23 EXHAUST GAS RECIRCULATION SYSTEMS AND ASSOCIATED EQUIPMENT

23.1 General

23.1.1 Application

1 The requirements in this Chapter apply to exhaust gas recirculation systems and associated equipment installed to reduce nitrogen oxides emitted from reciprocating internal combustion engines.

2 Special consideration is to be given to exhaust gas recirculation systems to which the requirements in this Chapter are not applicable in accordance with their respective designs.

3 In addition to the requirements in this Chapter, the Society may apply special requirements as instructed by the flag administration of the ship or the governments of sovereign nations whose waters ships navigate.

23.1.2 Terminology

The terms used in this Chapter, in addition to those defined in **22.1.2,** are defined as follows:

(1) "Exhaust gas recirculation systems" means systems which clean a part of exhaust gas emitted from an engine in a scrubber chamber and recirculate the cleaned exhaust gas into the engine.

23.1.3 Drawings and Data to be Submitted

Drawings and data to be submitted are generally as follows:

(1) Plans and documents for approval

The plans and documents specified in **22.1.3(1)**. In such case, "exhaust gas cleaning system" is to be read as "exhaust gas recirculation system".

(2) Plans and documents for reference

(a) The plans and documents specified in **22.1.3(2)**. In such case, "exhaust gas cleaning system" is to be read as "exhaust gas recirculation system".

(b) Specifications of blowers fitted onto exhaust gas recirculation systems

(c) Assembly of exhaust gas recirculation systems (except in cases where it is submitted in accordance with **Chapter 2**)

(d) Construction and arrangement of thermal insulation for exhaust gas pipes fitted onto exhaust gas recirculation systems (except in cases where it is submitted in accordance with **Chapter 2**)

23.2 Design

23.2.1 General Requirements

1 The requirements of **22.2.1** are to be applied. In such cases, "exhaust gas cleaning system" is to be read as "exhaust gas recirculation system".

2 Heat exchangers fitted onto exhaust gas recirculation systems are to comply with **Chapter 10**.

23.2.2 Materials

The requirements of **22.2.2** are to be applied. In such cases, "exhaust gas cleaning system" is to be read as "exhaust gas recirculation system".

23.3 Exhaust Gas Cleaning Systems

23.3.1 Construction of Exhaust Gas Cleaning Systems

1 The requirements of **22.3.1** (excluding **-3** and **-6**) are to be applied.

2 Devices to shut down the exhaust gas supply to exhaust gas pipes in which a scrubber is fitted are to be provided.

23.4 Requirements for Construction and Arrangements, etc.

23.4.1 Construction and Arrangement

In addition to **22.4.1**, the following **(1)** and **(2)** requirements are to be applied:

(1) Consideration is to be given to ensure that recirculating exhaust gas does not have any adverse effect on engine performance and safety due to corrosion and fouling, etc.

(2) Consideration is to be given to ensure taken that temperature of the intake air/scavenging air introduced into cylinders does not exceed the allowable temperatures specified by engine manufacturers.

23.4.2 Ventilation Systems

The requirements of **22.4.2** are to be applied.

23.4.3 Safety Devices and Alarm Devices

The requirements of **22.4.3** are to be applied.

23.5 Electrical Installations

23.5.1 General

The requirements of **22.5.1** are to be applied. In such cases, “exhaust gas cleaning system” is to be read as “exhaust gas recirculation system”.

23.6 Safety and Protective Equipment

23.6.1 General

The requirements of **22.6.1** are to be applied.

23.7 Tests

23.7.1 Tests at Facilities (Shop tests)

In addition to **22.7.1**, the following **(1)** and **(6)** requirements are to be applied:

(1) Starting and stopping test of exhaust gas recirculation systems

(2) Test for load response

(3) Emergency stop test

(4) Test at normal load with exhaust gas recirculation systems running

(5) Hydrostatic test (at a pressure equal to 1.5 times the maximum working pressure for the pressure receiving parts of the cooling systems for blowers fitted onto exhaust gas recirculation systems and the cooling sides of heat exchangers fitted onto exhaust gas recirculation systems)

(6) Other tests deemed necessary by the Society

23.7.2 Tests after Installation On Board

The requirements of **22.7.2** are to be applies. In such cases, “exhaust gas cleaning system” is to be read as “exhaust gas recirculation system”.

EFFECTIVE DATE AND APPLICATION (Amendment 1-21)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Rules, the current requirements apply to SCR systems, EGCS or EGR systems whose applications for approval are submitted to the Society before the effective date installed on ships for which the date of contract for construction is before the effective date.

GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

GUIDANCE

Part D Machinery Installations

2020 AMENDMENT NO.1

Notice No.26 30 June 2020

Resolved by Technical Committee on 22 January 2020

Notice No.26 30 June 2020
AMENDMENT TO THE GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS

"Guidance for the survey and construction of steel ships" has been partly amended as follows:

Part D MACHINERY INSTALLATIONS

Amendment 1-1

D1 GENERAL

D1.3 General Requirements for Machinery Installations

D1.3.1 General

Sub-paragraph -6 has been added as follows.

6 When designing and constructing machinery installations that are adequate for the service for which they are intended in accordance with **1.3.1-1, Part D of the Rules**, the properties (e.g. viscosity, cold flow property) of the fuel oils intended to be used by the machinery installations are to be taken into account, and fuel oil heaters and fuel oil coolers are to be provided when deemed necessary.

EFFECTIVE DATE AND APPLICATION (Amendment 1-1)

1. The effective date of the amendments is 30 June 2020.
2. Notwithstanding the amendments to the Guidance, the current requirements apply to ships for which the date of contract for construction is before the effective date.

Amendment 1-2

Title of D2 has been amended as follows.

D2 ~~DIESEL~~ RECIPROCATING INTERNAL CONBUSTION ENGINES

D2.4 Safety Devices

Paragraph D2.4.1 has been added as follows.

D2.4.1 Speed Governors and Overspeed Protective Devices

In applying **2.4.1-5(1)(c), Part D of the Rules**, the following throwing-on methods are considered acceptable.

(1) Four-stroke diesel engines with mean effective pressures of 1.35 *MPa* or more (Refer to **Fig. D2.4.1**)

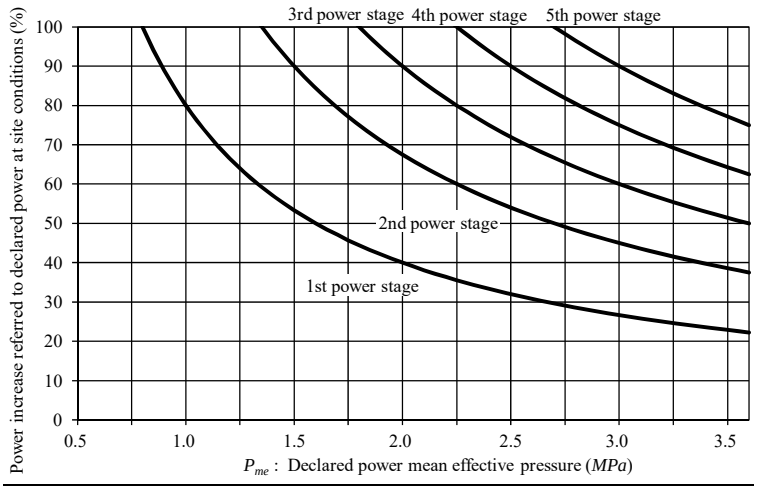
Total throw-on loads at the 1st power stage (%) = $80/P_{me}$
Total throw-on loads at the 2nd power stage (%) = $135/P_{me}$
Total throw-on loads at the 3rd power stage (%) = $180/P_{me}$
Total throw-on loads at the 4th power stage (%) = $225/P_{me}$
Total throw-on loads at the 5th power stage (%) = $270/P_{me}$
Total throw-on loads at the 6th power stage (%) = 100

(2) Gas-fuelled engines

Methods of throwing-on in steps decided by mutual agreement between manufacturer and user.

Fig D2.4.1 has been added as follows.

Fig. D2.4.1 Reference values for maximum possible sudden power increases as a function of brake mean effective pressure (P_{me}) at declared power (four-stroke diesel engines)



EFFECTIVE DATE AND APPLICATION (Amendment1-2)

1. The effective date of the amendments is 30 June 2020.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to governors for which the application for approval is submitted to the Society before the effective date.

Amendment 1-3

D11 WELDING FOR MACHINERY INSTALLATIONS

D11.2 Welding Procedure and Related Specifications

Paragraph D11.2.2 has been amended as follows.

D11.2.2 Execution of Tests

1 Approval tests for welding procedures and related specifications that fall under **11.2.2(1), Part D of the Rules** are to comply with the following requirements. For items not specified in the following requirements, **4.1.3** and **4.2** to **4.~~5~~6, Part M of the Rules** are to be applied correspondingly. In cases where it is difficult to meet the above requirements, approval tests are to be as deemed appropriate by the Society.

(1) (Omitted)

(2) Tests for butt welded joints

(a) The kinds of tests, the areas subjected to tests and the number of specimens is to be in accordance with the requirements specified in **Table D11.2.2-1**.

(b) (Omitted)

(c) (Omitted)

(3) (Omitted)

2 Approval tests for welding procedures and related specifications that fall under **11.2.2(2), Part D of the Rules** are to be comply with the following requirements. For the approval tests for welding procedures and related specifications applied to the welding work for materials used at high temperatures, the Society may require a creep test or a high temperature tensile test where deemed necessary. For items not specified in the following requirements, **4.1.3** and **4.2** to **4.~~5~~6, Part M of the Rules** are to be applied correspondingly.

((1) to (3) are omitted.)

Note of Table D11.2.2-1 has been amended as follows.

Table D11.2.2-1 Kinds of Tests, Areas Subjected to Tests and Number of Specimens
(Approval Tests for Welding Procedures and Related Specifications Applicable to Welding Work for Windlasses)

(Table is omitted.)

Notes:

(1) Internal inspections by radiographic examination or ultrasonic examination, and surface inspections by magnetic particle examination or liquid penetrant examination are to be carried out.

(2) Two specimens are to be taken from the root bend and face bend respectively. However, the root and face bends may be substituted for by four side bends for plates and pipes (or tubes) with a thickness of 12 *mm* or more~~, and pipes with a wall thickness of 20 *mm* or more~~ regardless of **Table D11.2.2-1**.

(3) Impact tests may be omitted when welding base metals which have no requirements related to testing temperature during impact tests and minimum mean absorbed energy.

(4) **Fig 4.2** and **Fig. M4.3, Part M of the Rules** are to be applied correspondingly to the position of the notch of the impact test specimen.

(5) Hardness tests may be omitted when welding austenitic stainless steels or materials for which requirements related to yield point or proof stress is less than 355 N/mm^2.

Paragraph D11.2.3 has been amended as follows.

D11.2.3 Range of Approval

1 For welding procedures and related specifications that fall under **11.2.~~3~~1-1(1)(a), Part D of the Rules**, the range of approval related to the kind of base metal is to be in accordance with the following requirements; however, **4.1.4, Part M of the Rules** is to be correspondingly applied for ranges of approval other than that for the kind of base metal. In cases where it is difficult to meet the above requirements, the ranges of approval are to be as deemed appropriate by the Society.

(1) In cases where the approval test is conducted using the materials specified in **Part K of the Rules** as base metals

(a) The welding procedures may be considered applicable to the materials specified in **Part K of the Rules** in accordance with **4.1.4, Part M of the Rules**.

(~~a~~b) In addition to **(a),** where approved by the Society, the welding procedures may be considered applicable to materials not specified in **Part K of the Rules** in accordance with the group and the subgroup of base metals during approval tests as well as the range of approval related to the kind of base metals specified in *ISO* 15614-1.
(The group and the subgroup of materials are to be in accordance with *ISO/TR* 15608. This also applies throughout the rest of requirement **-1**.)

(~~b~~c) With respect to **(~~a~~b)**, in cases where a welding heat input is greater than 50 *kJ/cm*, the welding procedures may be considered applicable only to materials in the same group and the same subgroup as the materials to which the welding procedures are considered applicable in **4.1.4, Part M of the Rules**.

(2) (Omitted)

2 For the welding procedures and related specifications that fall under **11.2.~~3~~2(2)** and **(3), Part D of the Rules**, the upper limit of the range of approval related to thickness is, in principle, to be a value same as the thickness of test assembly; however, **4.1.4, Part M of the Rules** is to be correspondingly applied for the range of approval for the thickness.

D12 PIPES, VALVES, PIPE FITTINGS AND AUXILIARIES

D12.4 Connection and Forming of Piping Systems

Paragraph D12.4.1 has been added as follows.

D12.4.1 Welding of Piping Systems

1 The welding work for a pipe referred to in **12.4.1-2, Part D of the Rules** includes butt welded joints of direct connection, slip-on sleeve welded joints and welded joints between pipes and pipe flanges, etc.

2 The "standards recognized by the Society" referred to in **12.4.1-2(1), Part D of the Rules** means national or international standards such as *JIS* and *ISO*.

3 The "deposited weld metal tests" referred to in **12.4.1-2(2), Part D of the Rules** means the deposited metal test specified in **Chapter 6, Part M of the Rules** or an equivalent test. The tests are to be carried out at the same time as the tests for approval of welding procedures and related specifications.

EFFECTIVE DATE AND APPLICATION (Amendment1-3)

1. The effective date of the amendments is 30 June 2020.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to pipes and piping systems other than those which fall under the following:
   (1) pipes and piping systems used on ships for which the date of contract for construction is on or after the effective date;
   (2) pipes and piping systems for which the application for examinations of altered parts related to welding is submitted to the Society on or after after the effective date.

Amendment 1-4

D1 GENERAL

D1.1 General

D1.1.1 Scope

Sub-paragraph -1(1) has been amended as follows.

1 In **Part D of the Rules**, "main propulsion machinery" means the following machinery which generates or converts motive power capable of propelling a ship at the speed specified in **2.1.8, Part A of the Rules**:
(1) ~~Diesel~~ Reciprocating internal combustion engines (including superchargers)
(2) Steam turbines (including main condensers)
(3) Gas turbines (including combustors)
(4) Generating plants for propulsion and motors for propulsion (excluding **Chapter 18**)

D6 SHAFTINGS

Section D6.1 has been added as follows.

D6.1 General

D6.1.2 Drawings and Data

The "Shaft alignment calculation sheets" referred to in **6.2.1(1)(l)viii), Part D of the Rules** mean those in accordance with **Annex D6.2.13**.

D6.2 Materials, Construction and Strength

D6.2.6 Detailed Evaluation for Strength

Sub-paragraph -3 has been amended as follows.

3 The diameters of propeller shafts of vessels whose main propulsion machinery falls under one of classes of high speed ~~diesel~~ engines which are reciprocating internal combustion engines may be in accordance with **(1)** to **(3)** below. However, in special cases, such as the vessels are intended to navigate in rough sea frequently, special considerations for the features affecting to the strength are to be paid.
(1) The definition of "high speed ~~diesel~~ engine"
The term "high speed ~~diesel~~ engine" in this sub-paragraph is defined as those engines simultaneously complying with the following conditions:

$$\frac{Sn^2}{1.8 \times 10^6} \geq 90$$

$$\frac{\pi d_j n}{6.0 \times 10^4} \geq 6$$

S : Length of stroke (*mm*)

n : Number of revolutions at maximum continuous output of engine (*rpm*)

d_j : Diameter of crank journal (*mm*)

((2) and (3) are omitted.)

Paragraph D6.2.11 has been deleted.

~~**D6.2.11 Additional Requirements for Propeller Shaft Kind 1*C***~~

~~The wording "the requirements specified otherwise by the Society" in **6.2.11, Part D of the Rules** means the following **(1)** through **(5)**:~~

~~(1) Four sets of drawings and data of the following **(a)** through **(h)** are to be submitted and once approved, one of sets that has been returned is to be kept on board. In this case, submission of any drawings and data included in those specified in **6.1.2(1)(g)** and **6.1.2(1)(h)**, **13.1.2(1)(b)** and **18.1.3(1)(a), Part D of the Rules may be omitted.**~~

~~(a) Specifications for the devices and equipment required in **D6.2.11**~~

~~(b) Tables of monitoring, control, and alarm items (including bearing temperatures, tank levels, seal air pressure, switchover of pumps, changeover of tanks (high or low) and changeover of spare seal rings), and their settings and indication methods.~~

~~(c) Documents for countermeasures after alarms have been activated (including necessary operations such as valve handling after alarming)~~

~~(d) Drawings of stern tube bearings~~

~~(e) Drawings of stern tube sealing devices~~

~~(f) Piping diagrams (including those related to the height of sensing positions for monitoring and controlling tank levels, systems for monitoring and controlling seal air pressure, and explanations of each symbol for sensors, switches, valves and other fittings and valve operations)~~

~~(g) Specification sheets for allowable ranges of pressure or tank levels for stern tube sealing devices~~

~~(h) Shaft alignment calculation sheets in accordance with **Annex D6.2.13 "GUIDANCE FOR CALCULATION OF SHAFT ALIGNMENT"**~~

~~(2) Stern tube bearings are to comply with the following **(a)** through **(c)**:~~

~~(a) Either of the following devices to measure stern tube metal temperature at the aft end bottom along with devices to record temperature is to be provided. In addition, audible and visible high temperature alarms (with a preset value of 55 ℃ or below) are to be provided in main control stations as specified in **18.1.2(3)** or **(4), Part D of the Rules**.~~

~~i) Two or more temperature sensors embedded in the metal; or~~

~~ii) An embedded temperature sensor, replaceable from inboard the ship, and a spare temperature sensor.~~

~~In this case, replacement of such sensors according to procedures submitted beforehand is to be demonstrated.~~

~~(b) Devices are to be installed for automatically reducing the speed of main propulsion machinery or for issuing audible and visual alarms which requires operation to reduce the running speed of the main propulsion machinery in main control stations in cases where at least one of the sensors specified in **(a)** above detects temperatures higher than preset values.~~

~~In cases where means are provided to reduce the speed of main propulsion machinery automatically, the override arrangements specified in **18.2.6-3, Part D of the Rules** are~~

~~to be provided for bridge control devices.~~

~~(c) The adhering strength of stern tube white metal lining is to be not less than 40 *MPa*.~~

~~(3) Stern tube sealing devices are to be of such a construction as to permit repairs or replacement without drawing out the propeller shaft not to impair the oil sealing properties and the durability. For this purpose, a two-piece type sealing device is to be used or a distance piece to shift the seal ring contact position is to be provided.~~

~~(4) Piping arrangements are to comply with the following **(a)** through **(d)**.~~

~~(a) Audible and visual alarms are to be provided in main control stations to show the lubricating oil pressure of the stern tube bearing and the sealing oil (or air) pressure between the seal rings (excluding the pressure of any oil between enclosed seals) are out of their allowable ranges. In cases where the upper limit of the pressure is controlled by means of over flow piping, alarms for the upper limit may be omitted.~~

~~(b) As for the lower limit of the allowable range specified in **(a)**, low level alarms in cases where oil tanks are provided, otherwise a non-flow alarms may be used.~~

~~(c) The lubricating oil for stern tube bearings is to be incessantly circulated. Two circulating pumps, arranged to be automatically switched over in the event of a pump stopping or a lower delivery pressure than the preset value, are to be provided. Audible and visual alarms, coming into action at the switchover, and a means to indicate which pump is working are to be provided in main control stations.~~

~~(d) In cases where the pressure of the lubricating oil for the stern tube bearing or the sealing oil between seal rings of the stern tube sealing device is changed to high or low according to the draught of the ship, means, such as a lamp linked to the valve change operation, to indicate which pressure is working are to be provided at main control stations.~~

~~(5) The devices and equipment specified in this **D6.2.11** are to be tested after being installed on board in order to verify the performance of the system in accordance with the items in the table specified in **(1)(b)** above.~~

D7 PROPELLERS

D7.2 Construction and Strength

Paragraph D7.2.1 has been amended as follows.

D7.2.1 Thickness of Blade

1 With respect to the wording "as deemed appropriate by the Society" specified in **Note (1) for Table D7.2 of the Rules**, the value is to be 0.6 ~~I~~in cases where the materials used for propellers~~are either~~ are grey cast iron ~~or steel castings~~, and the values ~~specified in **Table D7.2.1-1** are to be used for *K* in the formulae given in **7.2.1-1 of the Rules**.~~ are to be determined on a case by case basis by the Society in cases where the material is some other specific material.

~~**2** The thickness of highly skewed propeller blades, depending on the skew angle (the angle, on the expanded blade drawing, between the line connecting the centre of the propeller shaft with the point at the blade tip on the centre line of blade width and the tangential line drawn from the centre of the propeller shaft to the centre line of blade width (*See* **Fig. D7.2.1-1**.)) is to comply with the following requirements:~~

~~(1) In cases where the skew angle exceeds 25 degrees but is 60 degrees or less~~

~~(a) The blade thicknesses at radii $0.25R$ ($0.35R$ for controllable pitch propellers) and $0.6R$ are not to be less than the values obtained from multiplying those values calculated by the formula in **7.2.1-1, Part D of the Rules**, by the coefficient A given in the formula below;~~

~~$$A = 1 + B\frac{\theta - 25^{\circ}}{60^{\circ}}$$~~

~~where~~

~~θ : skew angle (*degree*)~~

~~B : 0.2 at $0.25R$ (or $0.35R$ for controllable pitch propeller) 0.6 at $0.6R$~~

~~(b) Blade thickness t_x at any radius between $0.6R$ and $0.9R$ is not to be less than the value determined by the following formula. Moreover, this thickness is provide sufficient strength against loads imparted during reversing manoeuvres, etc.~~

~~$$t_x = 0.003D + \frac{(1-x)(t_{0.6} - 0.003D)}{0.4} \ (mm)$$~~

~~where~~

~~D : diameter of propeller (*mm*)~~

~~x : ratio of the radius (= $2r/D$, r is the radius (*mm*))~~

~~$t_{0.6}$: blade thickness at $0.6R$ as required in **(a)** above (*mm*)~~

~~In cases where the skew angle exceeds 60 degrees~~

~~Based on the precise calculation sheet of propeller strength submitted by the manufacturer or designer, blade thickness is to be determined by the Society on a case by case basis.~~

~~3~~**2** In accordance of **7.2.1-1 of the Rules**, the following **(1)** to **(3)** are to be applied to Δw and w when using experimental data taken from model ships which are 6 *m* or more in length.

(1) Δw and w are to be calculated using a wake distribution for those model ship or be calculated using a method deemed equivalent thereto.

(2) The wake distribution is to be converted into the full scale value, using a suitable method.

(3) w is to be calculated by averaging the square measure of the wake distribution inside the propeller's circumference.

~~4~~**3** When applying **7.2.1-4, Part D of the Rules**, ~~T~~the standard method of detailed calculation of a propeller blade thickness is shown as follows for :

(1) The hydraulic forces on a propeller blade during a propeller rotation are calculated by the lifting-surface theory, and the stresses on the propeller blade are calculated by structural analysis using the hydraulic forces. The wake distribution used for the calculation of the hydraulic forces is to be experimental data taken from a sister vessel or a model ship (data is to be corrected appropriately to the actual ship's scale). In cases where such data is not known, the data shown in **Fig. D7.2.1-~~2~~1** or **Table D7.2.1-~~3~~1** may be used for high speed craft ($C_b \leq 0.6$), excluding those with unconventional stern constructions (such as multi-shafting arrangements), instead.

((2) to (6) are omitted.)

Table D7.2.1-1 has been deleted.

~~Table D7.2.1-1 Values of K~~

~~Material~~		~~K~~
~~Steel castings~~	~~*KSC*, Tensile strength is greater than or equal to 480 N/mm^2~~	~~1.0~~
	~~*KSC*, Tensile strength is less than 480 N/mm^2~~	~~0.9~~
~~Grey cast iron~~		~~0.6~~

Fig. D7.2.1-1 has been deleted.

~~Fig. D7.2.1-1 Definition of Skew Angle~~

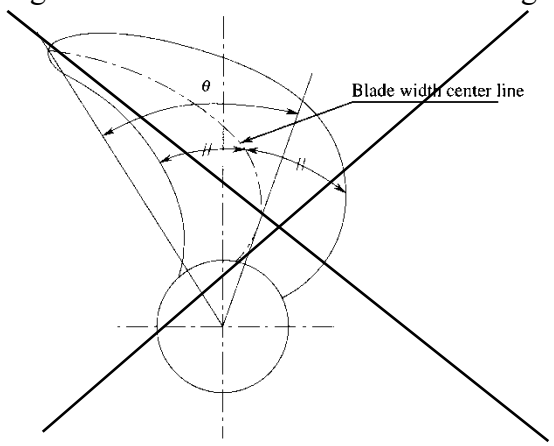


Fig. D7.2.1-2 has been renumbered to Fig. D7.2.1-1.

Fig. D7.2.1-~~2~~1 Standard Wake Distribution for High Speed Craft
(Figure is omitted.)

Table D7.2.1-3 has been renumbered to Table D7.2.1-1.

Table D7.2.1-~~3~~1 Standard Wake Distribution for High Speed Craft (V_a/V_s)
(Table and Note are omitted.)

Paragraph D7.2.2 has been amended as follows.

D7.2.2 Controllable Pitch Propellers

~~2~~1 ~~The Society may specially approve fixing bolts that satisfy the strength requirements specified in the Rules upon consideration of~~ The wording "documents deemed appropriate by the Society" specified in **7.2.2-2, Part D of the Rules** means the following documents (**(~~a~~1)** to **(~~e~~5)**).

(~~a~~1) Calculation sheet for the load sharing factor k of the bolt
where

$$k = \frac{k_b}{k_b + k_f}$$

k_b : rigidity of bolt tension
k_f : rigidity of flange compression

(~~b~~2) Static stress and dynamic stress acting on the bolt
(~~c~~3) Specifications of bolt material (including the manufacturing process)
(~~d~~4) Endurance limit curve of the bolt (both in air and in sea water)
(~~e~~5) Securing method of the bolt

~~1~~2 When fitting blade fixing bolts according to the requirements of **7.2.2-5, Part D of the Rules**, ~~B~~blades are to be fitted securely to pitch control gears by giving all of the fixing bolts an adequate initial fitting force. It is to be regarded as standard practice that the initial fitting force complies with the following condition;

$$\frac{1.3}{n}\left(\frac{AK_3}{L} + F_c\right) < T_0 < 0.55\sigma_0 d^2$$

where
T_0 : initial fitting force (N)

σ_0 : Yield strength or 0.2 % proof strength of bolt material (N/mm^2)

Other symbols are the same as in the formula shown in **7.2.2-2, Part D of the Rules**.

3 (Omitted)

D7.3 Force Fitting of Propellers

Paragraph D7.3.1 has been amended as follows.

D7.3.1 Pull-up Length

~~**1** Special consideration is required in cases where propellers are force fitted onto propeller shafts through sleeves, because the formulae of pull-up length in **7.3.1-1 of the Rules** are not able to be applied.~~

~~**2** In cases where the material of a propeller shaft is something other than forged steel or the material of a propeller boss is something other than that specified in **7.3.1-1, Part D of the Rules**, the values of K_b, K_c and K_w are to be determined by following formula:~~

$$K_b = \frac{P_b}{tan\alpha}\left\{\left(\frac{K_{a1}^2+1}{K_{a1}^2-1}+\frac{1}{m_b}\right)\frac{1}{E_b}+\left(\frac{1+K_{a2}^2}{1-K_{a2}^2}-\frac{1}{m_s}\right)\frac{1}{E_s}\right\}$$

$$K_c = \left\{(\lambda_b-\lambda_s)+\frac{(C_b-C_s)}{(C_b-C_0)}\lambda_s\right\}\left\{l_b-\frac{P_b}{tan\alpha}\right\}$$

$K_w = 0.7\sigma_{0.2}$

m_b : Poisson's number of the propeller boss material

m_s : Poisson's number of the propeller shaft material

E_b : Modulus of elasticity of the propeller boss material (N/mm^2)

E_s : Modulus of elasticity of the propeller shaft material (N/mm^2)

λ_b : Coefficient of linear thermal expansion of the propeller boss material (*mm/mm* °C)

λ_s : Coefficient of linear thermal expansion of the propeller shaft material (*mm/mm* °C)

$\sigma_{0.2}$: 0.2 % proof stress of the propeller boss material (N/mm^2)

Other symbols are to be in accordance with those shown in **7.3.1, Part D of the Rules**.

3 In the provision of coefficient "*c*" used in the calculation of tangential force F_v, specified in **7.3.1-1, Part D of the Rules**, the wording "the satisfaction of the Society" means determining "*c*" in accordance with **(2)** below using maximum torque Q_{max} as derived from **(1)** below:

(1) (Omitted)

(2) (Omitted)

D8 TORSIONAL VIBRATION OF SHAFTINGS

D8.2 Allowable Limit

D8.2.2 Intermediate Shafts, Thrust Shafts, Propeller Shafts and Stern Tube Shafts

Sub-paragraph -2 has been amended as follows.

2 For ships ~~powered by steam turbines, or gas turbines; diesel engines having slip couplings such as electro-magnetic couplings or fluid couplings between engine and propulsion shafting; and, ships with electric propulsion systems~~ that fall under any of the following, the allowable limits of torsional vibration stress on the intermediate shafts, thrust shafts, propeller shafts and stern tube shafts are to be calculated by applying the values of C_K given in the following **Table D8.2.2-2** to the formula specified in **8.2.2-1(1), Part D of the Rules**.

(1) Ships in which steam turbines, or gas turbines are used as main propulsion machinery (excluding electric propulsion ships)

(2) Ships in which reciprocating internal combustion engines are used as main propulsion machinery (excluding electric propulsion ships), having slip couplings such as electro-magnetic couplings or fluid couplings between engine and propulsion shafting; or

(3) Electric propulsion ships

D8.2.4 Power Transmission Systems

Sub-paragraph (3) has been amended as follows.

The wording “the provisions specified elsewhere” in **8.2.4-3, Part D of the Rules** means the following with respect to rubber couplings.

((1) and (2) are omitted.)

(3) In cases where rubber couplings, whose torque is transmitted in the direction of shearing rubber elements, are used in main propulsion shafting ~~powered~~ driven by ~~diesel~~ reciprocating internal combustion engines having outputs of 3,500 *kW* or more, the main propulsion shafting is to comply with the following **(a)** and **(b)**:

((a) and (b) are omitted.)

D9 BOILERS, ETC. AND INCINERATORS

D9.12 Construction of Thermal Oil Heaters

Paragraph D9.12.3 has been amended as follows.

D9.12.3 Safety Devices, etc. for Thermal Oil Heaters Directly Heated by the Exhaust Gas of Engines

The wording "Fixed fire extinguishing and cooling systems as deemed appropriate by the Society" in **9.12.3-7, Part D of the Rules** means combinations of fixed gas fire-extinguishing systems and systems for cooling heating coils, headers, casings, etc., and heater themselves such as water-spray. Fixed fire extinguishing cooling systems can be water-drenching systems able to discharge copious amounts of water. In such cases, the suitable means for collection and drainage, to prevent any water from flowing into ~~diesel~~ reciprocating internal combustion engines, are to be provided on exhaust ducting below heaters, and such drainage is to be led to suitable places.

D13 PIPING SYSTEMS

D13.9 Fuel Oil Systems

Paragraph D13.9.6 has been amended as follows.

D13.9.6 Fuel Oil Systems for ~~Diesel~~ Reciprocating Internal Combustion Engines

1 In cases where ships intended to use heavy fuel oil or marine diesel oil for operating ~~diesel~~ reciprocating internal combustion engines use low sulphur fuel oil instead, any of the following is to be complied with. For reference, "low sulphur fuel oil" in this paragraph refers to marine fuel with a sulphur content not exceeding 0.1 *% m/m* and a minimum viscosity of 2 *cSt*.
((1) to (3) are omitted.)
2 One self-cleaning filter will also be accepted as a filter capable of being cleaned without stopping the supply of filtered oil required by **13.9.6-4(2), Part D of the Rules**.

D13.9.7 Burning Systems for Boilers

Sub-paragraph -1 has been amended as follows.

1 In cases where ships intended to use heavy fuel oil or marine diesel oil for operating ~~diesel engines~~ boilers use low sulphur fuel oil instead, any of the following is to be complied with. For reference, "low sulphur fuel oil" in this paragraph refers to marine fuels with a sulphur content not exceeding 0.1 *% m/m* and a minimum viscosity of 2 *cSt*.
((1) to (3) are omitted.)

D13.12 Cooling Systems

Paragraph D13.12.1 has been amended as follows.

D13.12.1 Cooling Pumps

The capacity of stand-by circulating pumps ~~in~~ of ships ~~with main turbine propulsion machinery~~ in which steam turbines are used as main propulsion machinery specified in **13.12.1-1(1), Part D of the Rules** is to be of sufficient to assure that the ship has enough engine output to attain navigable speed.

Title of Paragraph D13.12.3 has been amended as follows.

D13.12.3 Cooling Systems for ~~Diesel~~ Reciprocating Internal Combustion Engines

Annex D6.2.13 GUIDANCE FOR CALCULATION OF SHAFT ALIGNMENT

1.1 General

1.1.1 Application

Table 1.1.1-1 has been amended as follows.

Table 1.1.1-1 Application of 1.3 of the Guidance

Type of main propulsion machinery	Paragraphs[1)2)]		
	1.3.1	**1.3.2**	**1.3.3** [3)]
Two-stroke cycle ~~diesel~~ engines	●	●	●
Four-stroke cycle ~~diesel~~ engines	●	●	-
Steam turbines	●	●	-

Notes:
(1) to 3) are omitted.)

1.2 Models of Shafting

Paragraph 1.2.3 has been amended as follows.

1.2.3 Equivalent Diameter of Crankshafts

When evaluating the shafting of two-stroke cycle ~~diesel~~ engines used as main propulsion machinery, the equivalent diameters of crankshafts, as specified by engine manufacturers, are to be used in shaft alignment calculations in order to give due consideration to any lesser bending stiffness that exists in actual crankshafts compared with simply using those diameters of crank journals in models.

Paragraph 1.2.4 has been amended as follows.

1.2.4 Shafting with Reduction Gears

In the case of shafting with reduction gears such as those found in main steam turbines or geared ~~diesel~~ reciprocating internal combustion engines, shafting from propellers to wheel gears are to be considered in shaft alignment calculations.

1.3 Load Condition and Evaluation of Calculation Results

1.3.1 Light Draught Condition (Cold Condition)

Sub-paragraph -4 has been amended as follows.

4 In principle, bearing loads calculated at each bearing are to be positive values. However, in the case of aftmost bearings of two-stroke cycle ~~diesel~~ engines used as main propulsion machinery, bearing loads of zero may be accepted as zero (negative values are not acceptable.) subject to the agreement of the engine manufacturer. Directions of bearing loads are shown in **Fig. 1.3.1-4**.

1.3.2 Light Draught Condition (Hot Condition)

Sub-paragraph -1 has been amended as follows.

1 Shaft alignment calculations are to be performed under the assumption that ships are in light draught conditions and reciprocating internal combustion engines used as main propulsion machinery is in hot conditions. In such cases, any increases in offset specified by manufacturers for engine bearings and those bearings in reduction gears are to be considered under hot conditions.

EFFECTIVE DATE AND APPLICATION (Amendment 1-4)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to ships for which the date of contract for construction is before the effective date.

Amendment 1-5

D1 GENERAL

D1.1 General

Paragraph D1.1.3 has been amended as follows.

D1.1.3 Machinery Installations with Novel Design Features

~~**1** For the waterjet propulsion systems, **Annex D1.1.3-1 "Guidance for the Survey and Construction of Waterjet Propulsion Systems**" is to apply.~~

~~**2**~~ For installations in ships having main and essential auxiliary boilers that burn coal as fuel, the requirements specified in the **Annex D1.1.3~~-2~~** "**Guidance for the Survey and Construction of Coal Burning Installations in Ships**" are to apply; however, these requirements (excluding in **1.1.3**, **1.1.5** and **1.1.6**) may be regarded as reference for considering plans.

~~**3** For azimuth thrusters, **Annex D1.1.3-3 "GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF AZIMUTH THRUSTERS**" is to apply.~~

EFFECTIVE DATE AND APPLICATION (Amendment 1-5)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to waterjet propulsion systems or azimuth thrusters whose applications for approval are submitted to the Society before the effective date installed on ships for which the date of contract for construction is before the effective date.

Amendment 1-6

D1 GENERAL

D1.3 General Requirements for Machinery Installations

D1.3.1 General

Sub-paragraph -5 has been deleted.

~~**5** With respect to the wording "the satisfaction of the Society" specified in **1.3.1-10, Part D of the Rules**, the following **(1)** and **(2)** apply:~~

~~(1) Selective catalytic reduction (SCR) systems are to comply with **Annex D1.3.1-5(1)** "GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF SELECTIVE CATALYTIC REDUCTION SYSTEMS AND ASSOCIATED EQUIPMENT".~~

~~(2) Exhaust gas cleaning systems (EGCS) are to comply with **Annex D1.3.1-5(2)** "GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF EXHAUST GAS CLEANING SYSTEMS AND ASSOCIATED EQUIPMENT".~~

EFFECTIVE DATE AND APPLICATION (Amendment 1-6)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to SCR systems or EGCS whose applications for approval are submitted to the Society before the effective date installed on ships for which the date of contract for construction is before the effective date.

Amendment 1-7

Title of D2 has been amended as follows.

D2 ~~DIESEL~~ RECIPROCATING INTERNAL CONBUSTION ENGINES

D2.1 General

D2.1.1 General

Sub-paragraph -2 has been amended as follows.

2 The wording "the requirements specified otherwise by the Society" in **2.1.1-4, Part D of the Rules** means "**GUIDANCE FOR THE ADDITIONAL REQUIREMENTS ON ELECTRONICALLY-CONTROLLED ~~DIESEL~~ ENGINES**" in **Annex D2.1.1**.

Sub-paragraph -4 has been amended as follows.

4 The wording "the requirements specified otherwise by the Society" in **2.1.1-6, Part D of the Rules** means **Annex 3** "**GUIDANCE FOR HIGH PRESSURE DUAL FUEL ~~DIESEL~~ ENGINES**" or **Annex 4** "**GUIDANCE FOR LOW PRESSURE DUAL FUEL ~~DIESEL~~ ENGINES**" of **Part N** for gas-fuelled engines to which **Chapter 16, Part N of the Rules** apply, and **Annex 3** "**GUIDANCE FOR HIGH PRESSURE GAS-FUELLED ENGINES**" or **Annex 4** "**GUIDANCE FOR LOW PRESSURE GAS-FUELLED ENGINES**" of **Part GF** for gas-fuelled engines to which **Chapter 16, Part N of the Rules** does not apply (**Part GF of the Rules** apply instead).

D2.5 Associated Installations

D2.5.3 Starting Arrangements

Sub-paragraph -3 has been amended as follows.

3 For ~~diesel~~ reciprocating internal combustion engines starting arrangements operated by batteries, the following requirements, in addition to **2.5.3-3, Part D of the Rules**, are to be complied with:

((1) is omitted.)

(2) The starting arrangements for reciprocating internal combustion engines driving main generators ~~engines~~ are to be such that either they are provided with two sets of separate batteries; or a single battery set in cases where power for starting can also be fed through a separate circuit from those batteries used for the starting of main propulsion machinery. However, a single battery set may only be accepted in cases where only one main generator engine is provided. The capacity of this single battery set is to be such that it is sufficient for starting the engine at least three *times*.

(3) Batteries for starting are to be used only for starting and for monitoring ~~diesel~~ reciprocating internal combustion engines. Arrangements are to be made so that the energy stored in the batteries can be maintained at all times.

D2.6 Tests

D2.6.1 Shop Tests

Sub-paragraphs -1(5) to (7) have been amended as follows.

1 The purpose of the shop trials specified in **2.6.1-2, Part D of the Rules** is to verify design premises such as engine power, safety against fire, adherence to approved limits such as maximum pressure, and functionality as well as to establish reference values or base lines for later reference in the operational phase. The programme is to be in accordance with the following:
((1) to (4) are omitted.)

(5) The programme shown in **Table D2.6.1-1** is to be used for the shop trials of ~~diesel~~ reciprocating internal combustion engines. In this case, refer to the *JIS* specified below or those considered equivalent thereto for more details on each respective testing procedure. However, additional tests may be requested by the Society depending on the engine application, service experience, or other relevant reasons. In addition, alternatives to the detailed tests may be agreed between the manufacturer and the Society when the overall scope of tests is found to be equivalent.

(a) In the case of ~~diesel~~ reciprocating internal combustion engines ~~for~~ used as main propulsion machinery (including those used as main propulsion machinery for electric propulsion ships) ~~or driving generators for electrical propulsion~~;
JIS F 4304 "Shipbuilding - Internal combustion engines for propelling use-shop test code"

(b) In the case of ~~diesel~~ reciprocating internal combustion engines driving other generators or essential auxiliary machinery;
JIS F 4306 "Shipbuilding - Water cooled four-cycle generator diesel engines"

(6) The following **(a)** to **(c)** are to be inspected. However, a part of or all of these inspections may be postponed until shipboard testing when agreed to by the Society.
((a) and (b) are omitted.)

(c) Temperature of hot surface insulation
Random temperature readings are to be compared with corresponding readings obtained during the type test. This is to be done while running at the rated power of engine. If the insulation is modified subsequently to the type test, the Society may request temperature measurements as required by the type test.
In the case of an reciprocating internal combustion engine with an application for approval of use dated before 1 July 2016 which is an engine type that does not have the results of temperature measurements required by the type test, temperature measurements are to be performed in accordance with **8.4.2-2(10), Part 8 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.

(7) Category *C* turbochargers ~~used~~ installed on ~~propulsion~~ reciprocating internal combustion engines used as main propulsion machinery are to be checked for surge margins in accordance with the following. However, if successfully tested earlier on an identical configuration of the engine and turbocharger (including the same nozzle rings), submission of this test report may be accepted instead.
((a) and (b) are omitted.)

Sub-paragraph -2 has been amended as follows.

2 For low pressure gas-fuelled engines (specified in **4.2.2 of Annex 4, Part GF** or **5.2.2 of Annex 4, Part N**), the following requirements are to be complied with.

(1) The requirements specified in **-1(1)** to **(7)** apply subject to following **(2)** to **(5)** requirements ~~mutatis mutandis (in this case the term "diesel engines" is to be read as "gas-fuelled engines")~~.

~~(2) The engines are to comply with the following **(a) to (d).**~~

(~~a~~2) For dual fuel engines, the tests specified in **Table D2.6.1-1** are to be carried out for both diesel and gas mode. Tests for the gas mode are to be carried out based on the maximum power available in the gas mode (see **2.5.1-1(1) of Annex 4, Part GF** or **2.5.1-1(1) of Annex 4, Part N**). The 110 % load test is not required for the gas mode.

(~~b~~3) In addition to the preparations specified in **-1(1)**, measures to verify that gas fuel piping for the engine is gas tight are to be carried out prior to the start-up of the engine.

(~~c~~4) In addition to **-1(2)** and **(3)**, the following engine data are to be recorded.

~~i~~(a) The item listed in **-1(2)(f)** is to be measured and recorded for both gas and diesel, as applicable

~~ii~~(b) Gas pressure and temperature

(~~d~~5) The engines are to undergo integration tests to verify that the responses of the complete mechanical, hydraulic and electronic systems are as predicted for all intended operational modes. The scope of these tests is to be agreed to with the Society for selected cases based upon risk analysis (see **8.3, Chapter 8, Part 6 of Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**) and is to at least include the following incidents. The tests may be carried out using simulation or other alternative methods, subject to special consideration by the Society.

~~i~~(a) Failure of ignition (spark ignition or pilot injection systems)

~~ii~~(b) Failure of a cylinder gas supply valve

~~iii~~(c) Failure of combustion (to be detected by e.g. misfiring, knocking, exhaust temperature deviation, etc.)

~~iv~~(d) Abnormal gas pressure

~~v~~(e) Abnormal gas temperature

Table D2.6.1-1 has been amended as follows.

Table D2.6.1-1 Programme for Shop Trials of ~~Diesel~~ Engines

Test items	Use of engines		
	Reciprocating internal combustion engines used as ~~M~~main propulsion machinery ~~diesel engines~~ (1)	Reciprocating internal combustion ~~E~~engines driving generators (including those used as main ~~engines~~ propulsion machinery of electric propulsion ships) (2)	Reciprocating internal combustion ~~E~~engines driving auxiliaries (excluding auxiliary machinery for specific use etc.) (1)
(Omitted)			

(Notes are omitted.)

EFFECTIVE DATE AND APPLICATION (Amendment 1-7)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to reciprocating internal combustion engines for which the application for approval is submitted to the Society before the effective date.

Amendment 1-8

Title of D2 has been amended as follows.

D2 ~~DIESEL~~ RECIPROCATING INTERNAL CONBUSTION ENGINES

D2.1 General

D2.1.1 General

Sub-paragraph -3 has been deleted.

~~**3 The wording "requirements specified otherwise by the Society" referred to in 2.1.1-5, Part D of the Rules** means **Annex D2.1.1-5 "Guidance for the Survey and Construction of Exhaust Gas Recirculation Systems and Associated Equipment".**~~
~~**4**~~**3** (Omitted)

EFFECTIVE DATE AND APPLICATION (Amendment 1-8)

1. The effective date of the amendments is 1 July 2020.
2. Notwithstanding the amendments to the Guidance, the current requirements apply to EGR systems whose applications for approval are submitted to the Society before the effective date installed on ships for which the date of contract for construction is before the effective date.

Amendment 1-9

Title of D2 has been amended as follows.

D2 DIESEL RECIPROCATING INTERNAL CONBUSTION ENGINES

D2.1 General

D2.1.1 General

Sub-paragraphs -3 and -4 have been amended as follows.

3 The wording "requirements specified otherwise by the Society" referred to in **2.1.1-~~5~~6, Part D of the Rules** means **Annex D2.1.1-5** "Guidance for the Survey and Construction of Exhaust Gas Recirculation Systems and Associated Equipment".
4 The wording "the requirements specified otherwise by the Society" in **2.1.1-~~6~~7, Part D of the Rules** means **Annex 3** "**GUIDANCE FOR HIGH PRESSURE DUAL FUEL DIESEL ENGINES**" or **Annex 4** "**GUIDANCE FOR LOW PRESSURE DUAL FUEL DIESEL ENGINES**" of **Part N** for gas-fuelled engines to which **Chapter 16, Part N of the Rules** apply, and **Annex 3** "**GUIDANCE FOR HIGH PRESSURE GAS-FUELLED ENGINES**" or **Annex 4** "**GUIDANCE FOR LOW PRESSURE GAS-FUELLED ENGINES**" of **Part GF** for gas-fuelled engines to which **Chapter 16, Part N of the Rules** does not apply (**Part GF of the Rules** apply instead).

Paragraph D2.1.3 has been amended as follows.

D2.1.3 Drawings and Data

For ~~engines equipped with exhaust driven turbochargers,~~ the following ~~drawings and~~ data ~~specified in **2.1.3, Part D of the Rules** are to~~ ,those represented by two sizes in generic range of turbochargers (i.e. the same components, materials, etc., with the only difference being the size) are acceptable. ~~include the following items according to the category of turbocharger specified in **2.1.2, Part D of the Rules**. However, this applies only to turbochargers with novel design features or no service records.~~

~~(1) Category *A* turbochargers~~

~~(a) The sectional assembly listed in **2.1.3-1(1)(g)i), Part D of the Rules** is to include principal dimensions and names of components. The submission of the drawings may be omitted where deemed appropriate by the Society.~~

~~(2) Category *B* turbochargers~~

~~(a) The sectional assembly listed in **2.1.3-1(1)(g)i), Part D of the Rules** is to include principal dimensions and materials of housing components for containment evaluation.~~

~~(b) The turbocharger particulars listed in **2.1.3-1(1)(g)ii), Part D of the Rules** are to include the following items:~~

~~i) Maximum permissible operating speed (rpm);~~

~~ii) Maximum permissible exhaust gas temperature at the turbine inlet;~~

~~iii) Minimum lubrication oil inlet pressure;~~

~~iv) Maximum lubrication oil outlet temperature; and~~

~~v) Maximum permissible vibration levels (self- and externally generated vibration).~~

~~(c) The engine control system diagram listed in **2.1.3-1(2)(f), Part D of the Rules** is to include the following items:~~

~~i) Alarm level for overspeed;~~

~~ii) Alarm level for exhaust gas temperature at the turbine inlet;~~

~~iii) Lubrication oil inlet pressure low alarm set point; and~~

~~iv) Lubrication oil outlet temperature high alarm set point.~~

~~(3) Category *C* turbochargers~~

~~(a) The items as listed in **(2)** above are to be included.~~

(~~b~~1) The documentation for safe torque transmission specified in **2.1.3-1(2)(i)i), Part D of the Rules** ~~may be for any two sizes within a series of turbocharger which is of the same design, but scaled to each other.~~

~~(c) The information on expected lifespan listed in **2.1.3-1(2)(i)ii), Part D of the Rules** is to consider creep, low cycle fatigue and high cycle fatigue.~~

(~~d~~2) The operation and ~~service~~ maintenance manuals listed in **2.1.3-1(2)(i)iii), Part D of the Rules** ~~are to include guidance for the operation and maintenance of exhaust driven turbochargers. This guidance may be for any two sizes within a series of turbocharger which is of the same design, but scaled to each other.~~

Section D2.2 has been deleted.

~~**D2.2 Materials, Construction and Strength**~~

~~**D2.2.2 Construction, Installation and General**~~

~~With respect to the ambient reference conditions specified in **2.2.2-7, Part D of the Rules**, the expected component lifespan of a turbocharger with novel design features or no service records is to be based upon an air inlet temperature of 45°C.~~

D2.5 Associated Installations

Paragraph D2.5.1 has been deleted.

~~**D2.5.1 Exhaust Driven Turbochargers**~~

~~The safe torque transmission specified in **2.5.1-5, Part D of the Rules** is to be substantiated by calculations.~~

EFFECTIVE DATE AND APPLICATION (Amendment1-9)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to turbochargers with novel design features or no service records for which the application for approval is submitted to the Society before the effective date.

Amendment 1-10

Title of D2 has been amended as follows.

D2 ~~DIESEL~~ RECIPROCATING INTERNAL CONBUSTION ENGINES

D2.1 General

Title of Paragraph D2.1.4 has been amended as follows.

D2.1.4 Approval of ~~Diesel~~ Reciprocating Internal Combustion Engines

Sub-paragraph -3 has been amended as follows.

3 The wording "the drawings and data of the ~~diesel~~ reciprocating internal combustion engine whose approval of use has been obtained" specified in **(1)(c)**, **(1)(d)**, **(2)(a)** and **(2)(b)** of **2.1.4-1, Part D of the Rules** means those listed in **8.2.2, Part 6 of Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.

Title of Fig. D2.1.4-1 has been amended as follows.

Fig. D2.1.4-1 Flow of Approval of ~~Diesel~~ Reciprocating Internal Combustion Engines

EFFECTIVE DATE AND APPLICATION (Amendment 1-10)

1. The effective date of the amendments is 1 July 2020.
2. Notwithstanding the amendments to the Guidance, the current requirements apply to reciprocating internal combustion engines whose type is the same type of those for which the application for approval is submitted to the Society before the effective date.

Amendment 1-11

Title of D2 has been amended as follows.

D2 ~~DEISEL~~ RECIPROCATING INTERNAL CONBUSTION ENGENES

D2.6 Tests

D2.6.1 Shop Tests

Sub-paragraphs -5 and -6 have been amended as follows.

5 In cases where the manufacturer has a quality system deemed appropriate by the Society, dynamic balancing tests specified in **2.6.1-4, Part D of the Rules** for categor~~ies~~y ~~*A* and~~ *B* turbochargers may be substituted by manufacturer tests. In such cases, the submission or presentation of test records may be required by the Society.

6 ~~The programme for the overspeed tests required by **2.6.1-5, Part D of the Rules** is to be in accordance with the following:~~

~~(1) Overspeed test for a duration of 3 minutes at either of the following speeds:~~

~~(a) 120% of the alarm level speed at room temperature; or~~

~~(b) 110% of the alarm level speed at an inlet temperature of 45°C when tested in the actual housing with the corresponding pressure ratio.~~

~~(2) For forged impellers and inducers subject to quality control through an approved non-destructive test method, overspeed tests may be dispensed with.~~

~~(3)~~ In cases where the manufacturer has a quality system deemed appropriate by the Society, the overspeed tests specified in **2.6.1-5, Part D of the Rules** for category ~~*A* and~~ *B* turbochargers may be substituted for by manufacturer tests. In such cases, the submission or presentation of test records may be required by the Society.

EFFECTIVE DATE AND APPLICATION (Amendment 1-11)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to turbochargers for which the application for approval is submitted to the Society before the effective date.

Amendment 1-12

D11 WELDING FOR MACHINERY INSTALLATIONS

D11.3 Post Weld Heat Treatment

Paragraph D11.3.1 has been amended as follows.

D11.3.1 Procedure of Post Weld Heat Treatment

~~Procedures of post weld heat treatments for alloy steels other than those~~The wording "specially considered by the Society" specified in **11.3.1-~~1~~2, Part D of the Rules** ~~are to be~~ means as follows:

(1) The temperature to be maintained in the post weld heat treatment is to be as given in **Table D11.3.1-1**.

(2) The requirements in **11.3.1-1, Part D of the Rules** apply to procedures of heat treatments other than post weld heat treatments for alloy steel referred to above.

D11.6 Welding of Piping

Paragraph D11.6.2 has been deleted.

~~**D11.6.2 Alignment of Joints**~~

~~The following values are to be taken as standard values for the allowable limits of the offset of joints referred to in paragraph **11.6.2, Part D of the Rules** in cases where a pipe and pipe fitting as well as pipe and pipe are butt welded:~~

~~(1) In cases where a backing strip is used; 0.5 *mm*~~

~~(2) In cases where no backing strip is used~~

~~(a) In cases where the nominal diameter is less than 150 *A*, and the thickness is 6 *mm* or less; 1 *mm* or 25 % of the thickness, whichever is smaller.~~

~~(b) In cases where the nominal diameter is less than 300 *A*, and the thickness is 9.5 *mm* or less; 1.5 *mm* or 25 % of the thickness, whichever is smaller (excluding those cases that correspond to **(a)** above).~~

~~(c) In cases where the nominal diameter is not less than 300 *A* or the thickness exceeds 9.5 *mm*; 2 *mm* or 25 % of the thickness, whichever is smaller.~~

Paragraph D11.6.3 has been deleted.

~~**D11.6.3 Preheating of Welds**~~

~~Preheating for pipes referred to in paragraph **11.6.3, Part D of the Rules** is to be carried out at the minimum preheating temperature specified in **Table D11.6.3-1** according to the grade of the materials and their thickness.~~

Table D11.6.3-1 has been deleted.

Table D11.6.3-1 Minimum Preheating Temperature

Grade [1]		Thickness of weld (t) (mm)	Minimum preheating temperature(°C)
Grade 1 Grade 2 Grade 3	$C + \frac{Mn}{6} \leq 0.4$	$t \geq 20$ [2]	50
	$C + \frac{Mn}{6} > 0.4$	$t \geq 20$ [2]	100
Grade 4	No.12	$t \geq 13$ [2]	100
	No.22 No.23	$t < 13$ [3]	100
		$t \geq 13$	150
	No.24	$t < 13$ [3]	150
		$t \geq 13$	200

Notes:

(1) Grades are as specified in Section **4.2, Part K of the Rules**. Materials not specified in this table are to be as deemed appropriate by the Society.

(2) In cases where welding is carried out at an ambient temperature less than 0 °C, it is necessary to preheat the welding object to at least the minimum preheating temperature irrespective of the thickness, excluding those cases where sufficient consideration has been given to any possible moisture.

(3) Preheating may be omitted for thickness of 6 *mm* or less depending on the results of hardness tests in cases where sufficient consideration has been given to any possible moisture.

D12 PIPES, VALVES, PIPE FITTINGS AND AUXILIARIES

D12.4 Connection and Forming of Piping Systems

Paragraph D12.4.4 has been deleted.

~~**D12.4.4 Forming of Pipes and Heat Treatment after Forming**~~

~~The wording "a suitable heat treatment" specified in **12.4.4-2, Part D of the Rules** means, as a rule, the following:~~

~~(1) For steel pipes of Grade 2, No. 4, Grade 3, No. 4 and Grade 4 that are specified in **Table D11.6, Part D of the Rules**, stress-relieving heat treatments are to be carried out in accordance with the requirements relative to the holding temperature and holding period specified in **11.3.1, Part D of the Rules**.~~

~~(2) In cases where steel pipes of Grade 2, No. 4, Grade 3, No. 4 and Grade 4 that are specified in **Table D11.6, Part D of the Rules** are subjected to bending processes in such a manner that the bending radius of the pipe centre line is 4 times or less the outside diameter of the pipe, they are to be subjected to annealing or annealing and tempering according to the type of pipe materials. The type and temperature of this heat treatment are to be as shown in **Table D 12.4.4-1**.~~

Table D12.4.4-1 has been deleted.

~~Table D12.4.4-1 Type and Temperature of Heat Treatment~~

~~Grade (Note 1)~~		~~Type and temperature of heat treatment (°C)~~
~~Grade 2, No.4 and Grade 3, No.4~~		~~Normalizing: from 880 to 940~~
~~Grade 4~~	~~No.12~~	~~Normalizing: from 900 to 940~~
	~~No.22 No.23~~	~~Normalizing: from 900 to 960 Tempering: from 640 to 720~~
	~~No.24~~	~~Normalizing: from 900 to 960 Tempering: from 640 to 780~~

~~Note~~

~~1. Grades are as specified in **4.2, Part K of the Rules**.~~

EFFECTIVE DATE AND APPLICATION (Amendment1-12)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to the pipes used in ships for which the date of contract for construction is before the effective date.

Amendment 1-13

D13 PIPING SYSTEMS

D13.16 Exhaust Gas Piping Arrangements

Paragraph D13.16.1 has been deleted.

~~**D13.16.1 Exhaust Gas Pipes from Diesel Engines**~~

~~**1** The wording "common exhaust gas cleaning systems deemed appropriate by the Society" specified in **13.16.1-1(2)** and **13.16.1-3(2), Part D of the Rules** means systems complying with **1.4.1-6** of **Annex D1.3.1-5(2) "GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF EXHAUST GAS CLEANING SYSTEMS AND ASSOCIATED EQUIPMENT".~~

EFFECTIVE DATE AND APPLICATION (Amendment 1-13)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to EGCS whose applications for approval are submitted to the Society before the effective date installed on ships for which the date of contract for construction is before the effective date.

Amendment 1-14

D16 WINDLASSES AND MOORING WINCHES

D16.2 Windlasses

Paragraph D16.2.3 has been amended as follows.

D16.2.3 Materials and Fabrication

1 "Standards recognized by the Society" referred to in **16.2.3-1(1)** ~~and~~, **-2(2)** and **-2(4)(b), Part D of the Rules** means national or international standard such as *JIS* or *ISO*.

2 The "deposited weld metal tests" referred to in **16.2.3-2(4)(b), Part D of the Rules** means the deposited metal test specified in **Chapter 6, Part M of the Rules** or an equivalent test. The tests are to be carried out at the same time as the tests for approval of welding procedures and related specifications.

EFFECTIVE DATE AND APPLICATION (Amendment 1-14)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to windlass other than those which fall under the following:
(1) windlasses for which the application for approval is submitted to the Society on or after the effective date;
(2) windlasses used on ships for which the date of contract for construction* is on or after the effective date.
* "contract for construction" is defined in the latest version of IACS Procedural Requirement (PR) No.29.

IACS PR No.29 (Rev.0, July 2009)

1. The date of "contract for construction" of a vessel is the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. This date and the construction numbers (i.e. hull numbers) of all the vessels included in the contract are to be declared to the classification society by the party applying for the assignment of class to a newbuilding.

2. The date of "contract for construction" of a series of vessels, including specified optional vessels for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the prospective owner and the shipbuilder.
For the purpose of this Procedural Requirement, vessels built under a single contract for construction are considered a "series of vessels" if they are built to the same approved plans for classification purposes. However, vessels within a series may have design alterations from the original design provided:
(1) such alterations do not affect matters related to classification, or
(2) If the alterations are subject to classification requirements, these alterations are to comply with the classification requirements in effect on the date on which the alterations are contracted between the prospective owner and the shipbuilder or, in the absence of the alteration contract, comply with the classification requirements in effect on the date on which the alterations are submitted to the Society for approval.
The optional vessels will be considered part of the same series of vessels if the option is exercised not later than 1 year after the contract to build the series was signed.

3. If a contract for construction is later amended to include additional vessels or additional options, the date of "contract for construction" for such vessels is the date on which the amendment to the contract, is signed between the prospective owner and the shipbuilder. The amendment to the contract is to be considered as a "new contract" to which **1.** and **2.** above apply.

4. If a contract for construction is amended to change the ship type, the date of "contract for construction" of this modified vessel, or vessels, is the date on which revised contract or new contract is signed between the Owner, or Owners, and the shipbuilder.

Note:
This Procedural Requirement applies from 1 July 2009.

Amendment 1-15

Annex D1.1.3-1 has been deleted.

Annex D1.1.3-2 has been renumbered to Annex D1.1.3

Annex D1.1.3~~-2~~ GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF COAL BURNING INSTALLATIONS IN SHIPS

Annex D1.1.3-3 has been deleted.

EFFECTIVE DATE AND APPLICATION (Amendment 1-15)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to waterjet propulsion systems or azimuth thrusters whose applications for approval are submitted to the Society before the effective date installed on ships for which the date of contract for construction is before the effective date except when periodical surveys are carried out.

Amendment 1-16

Annex D1.3.1-5(1) has been deleted.

Annex D1.3.1-5(2) has been deleted.

EFFECTIVE DATE AND APPLICATION (Amendment 1-16)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to SCR systems or EGCS whose applications for approval are submitted to the Society before the effective date installed on ships for which the date of contract for construction is before the effective date except when periodical surveys are carried out.

Amendment 1-17

Title of Annex D2.1.1 has been amended as follows.

Annex D2.1.1 GUIDANCE FOR THE ADDITIONAL REQUIREMENTS ON ELECTRONICALLY-CONTROLLED ~~DIESEL~~ ENGINES

1.1 General

Paragraph 1.1.1 has been amended as follows.

1.1.1 Scope

The requirements in this Guidance apply to electronically-controlled ~~diesel~~ engines in addition to those requirements prescribed in **Chapter2** and **18, Part D of the Rules**.

Paragraph 1.1.3 has been amended as follows.

1.1.3 Plans and Documents

In cases where systems and equipment of electronically-controlled ~~diesel~~ engines are of a unique or special construction, the Society may require the submission of other plans and documents in addition to those required by **2.1.3, Part D of the Rules for the Survey and Construction of Steel Ships**.

4.1 Others

Paragraph 4.1.2 has been amended as follows.

4.1.2 Spare Parts

Spare parts for electronically-controlled ~~diesel~~ engines are to be in accordance with **Table 4.1.2**.

Table 4.1.2 Spare Parts

Items	Number required	Note
Control valves	One of each type	
Accumulator diaphragms	Two of each type	
Sensors provided for each cylinder	One of each type	Spare parts may be omitted in cases where normal operation of main propulsion machinery is available without these sensors.

EFFECTIVE DATE AND APPLICATION (Amendment 1-17)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to electronically controlled engines for which the application for approval is submitted to the Society before the effective date.

Amendment 1-18

Annex D2.1.1-5 has been deleted.

EFFECTIVE DATE AND APPLICATION (Amendment 1-18)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to EGR systems for which the application for approval is submitted to the Society before the effective date installed on ships for which the date of contract for construction is before the effective date except when periodical surveys are carried out.

Amendment 1-19

Annex D2.3.1-2(1) GUIDANCE FOR CALCULATION OF CRANKSHAFT STRESS I

Section 1.1 has been amended as follows.

1.1 Scope

This Guidance is to apply to the direct calculation method of local stress at crank-pin fillets or crank-journal fillets of solid-forged and semi-built crankshafts of reciprocating internal combustion engines made of forged or cast steel.

Annex D2.3.1-2(2) GUIDANCE FOR CALCULATION OF CRANKSHAFT STRESS II

Section 1.1 has been amended as follows.

1.1 Scope

This Guidance applies to solid-forged and semi-built crankshafts of reciprocating internal combustion engines made of forged or cast steel, with one crankthrow between main bearings.

EFFECTIVE DATE AND APPLICATION (Amendment 1-19)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to crankshafts for which the application for approval is submitted to the Society before the effective date.

Amendment 1-20

Annex D5.3.5 GUIDANCE FOR CALCULATION OF STRENGTH OF GEARS

1.5 Loading Factors

1.5.1 Application Factor, K_A

Sub-paragraphs -2(1) and (2) have been amended as follows.

2 In cases where drive systems are operating at level near their critical speed, a careful analysis of conditions is to be made. The application factor K_A is to be determined either by direct measurements or by a system analysis that is acceptable to the Society. In cases where values determined in such ways cannot be provided, the following values may be used:

(1) Main propulsion

K_A = 1.00 (~~diesel~~ reciprocating internal combustion engines with hydraulic or electromagnetic slip couplings)

= 1.30 (~~diesel~~ reciprocating internal combustion engines with high elasticity couplings)

= 1.50 (~~diesel~~ reciprocating internal combustion engines with other couplings)

However, in cases where vessels, on which reduction gear is being used, are receiving Ice Class Notation, as required in **8.6, Part I of the Rules**.

(2) Auxiliary gears

K_A = 1.00 (electric motors, ~~diesel~~ reciprocating internal combustion engines with hydraulic or electromagnetic slip couplings)

= 1.20 (~~diesel~~ reciprocating internal combustion engines with high elasticity couplings)

= 1.40 (~~diesel~~ reciprocating internal combustion engines with other couplings)

EFFECTIVE DATE AND APPLICATION (Amendment 1-20)

1. The effective date of the amendments is 1 July 2020.

2. Notwithstanding the amendments to the Guidance, the current requirements apply to all gears previously approved by the Society prior to the effective date for which no failure has occurred, and no changes related to strength, such as the scantlings of the gear meshes, materials, etc. have been made.