

Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines

Object of Amendment

Rules for Approval of Manufactures and Service Suppliers
Rules for the Survey and Construction of Steel Ships Parts B, D, GF, K, N, P, PS and Q
Guidance for the Survey and Construction of Steel Ships Parts D, GF, N and I
Rules/Guidance for High Speed Craft
Rules for the Survey and Construction of Passenger Ships
Rules/Guidance for the Survey and Construction of Inland Waterway Ships
Guidance for the Approval of Materials and Equipment for Marine Use

Reason for Amendment

IACS Unified Requirements (UR) M44, M51, M53, M71 and M78 specify requirements for the design and testing of reciprocating internal combustion engines, and these UR have already been incorporated into the NK Rules.

IACS reviewed these UR in light of industry feedback and technological developments, including those related to new fuels. As a result of specifying new requirements and revising the structure and terminology of the UR, a total of seven UR (M44(Rev.11), M51(Rev.5), M53(Rev.6), M71(Rev.1), M78(Rev.3), M87(New) and M88(New)) were adopted in April 2025.

Accordingly, relevant requirements are amended in accordance with these UR.

Outline of Amendment

The main contents of this amendment are as follows:

- (1) Revises requirements related to the drawings and data for reciprocating internal combustion engines.
- (2) Revises the test conditions for trials of reciprocating internal combustion engines.
- (3) Reorganises the rule structure for reciprocating internal combustion engines and turbochargers.
- (4) Specifies requirements for allowable time to transit the barred speed range and related testing requirements for reciprocating internal combustion engines.
- (5) Expands the scope of fuels covered by the requirements for gas-fuelled engines in Parts GF and N of the Rules for the Survey and Construction of Steel Ships.
- (6) Clarifies the information to be included in the Safety Concept for gas-fuelled engines.
- (7) Clarifies the details of tests for type approval testing of reciprocating internal combustion engines.
- (8) Specifies an approval scheme incorporating the concept of sub-systems for reciprocating internal combustion engines.
- (9) Specifies requirements for the issuance of design evaluation certificate for reciprocating internal combustion engines.

Effective Date and Application

- (1) Rules for Approval of Manufacturers and Service Suppliers, Parts B, D, K, GF, N, P, PS and Q of the Rules for the Survey and Construction of Steel Ships and relevant Guidance

(except for the amendments in (2) to (6) below)

Effective date of this amendment is 1 January 2027

- (2) Parts B and D of the Rules and Guidance for the Survey and Construction of Steel Ships (amendment related to requirements for factory acceptance tests, shipboard trials, etc. in UR M78, and to UR M88)

This amendment applies to ships for which the date of contract for construction is on or after 1 January 2027

- (3) Parts D, GF and N of the Rules and Guidance for the Survey and Construction of Steel Ships and the Guidance for the Approval of Materials and Equipment for Marine Use (amendment related to UR M44, M71 and M87, and to requirements for design, type testing, etc. in UR M78)

This amendment applies to reciprocating internal combustion engines for which the application for type approval is submitted to the Society on or after 1 January 2027

- (4) Part D of the Rules and Guidance for the Survey and Construction of Steel Ships (amendment related to UR M51)

This amendment applies to reciprocating internal combustion engines that fall under the following:

(a) those for which the application for approval is submitted to the Society on or after 1 January 2027

(b) those installed on ships for which the date of contract for construction is on or after 1 January 2027

- (5) Annex 2.3.1 to Part D of the Rules for the Survey and Construction of Steel Ships (amendment related to UR M53)

This amendment applies to crankshafts for which the application for approval is submitted to the Society on or after 1 January 2027

- (6) Chapter 11, Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use (amendment related to type approval of turbochargers)

This amendment applies to turbochargers for which the application for type approval is submitted to the Society on or after 1 January 2027

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

ID:DD25-30

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
RULES FOR APPROVAL OF MANUFACTURERS AND SERVICE SUPPLIERS Part 2 REQUIREMENTS FOR APPROVAL OF MANUFACTURERS Chapter 4 ADDITIONAL REQUIREMENTS FOR MANUFACTURERS OF MASS PRODUCED PRODUCTS 4.6 Exhaust Gas Turbochargers 4.6.2 Initial Assessment Approval tests (1) The approval tests are to be carried out on the standard turbocharger randomly selected one for each type from the production line. (2) The tests carried out during approval tests are to be the dynamic balancing tests and the overspeed tests specified in <u>2.7.4-4</u> and -5, Part D of the Rules for the Survey and Construction of Steel Ships, respectively.	RULES FOR APPROVAL OF MANUFACTURERS AND SERVICE SUPPLIERS Part 2 REQUIREMENTS FOR APPROVAL OF MANUFACTURERS Chapter 4 ADDITIONAL REQUIREMENTS FOR MANUFACTURERS OF MASS PRODUCED PRODUCTS 4.6 Exhaust Gas Turbochargers 4.6.2 Initial Assessment Approval tests (1) The approval tests are to be carried out on the standard turbocharger randomly selected one for each type from the production line. (2) The tests carried out during approval tests are to be the dynamic balancing tests and the overspeed tests specified in <u>2.6.1-4</u> and -5, Part D of the Rules for the Survey and Construction of Steel Ships, respectively.	Alignment of reference numbers

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended		Original				Remarks
RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part B CLASS SURVEYS Chapter 2 CLASSIFICATION SURVEYS		RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part B CLASS SURVEYS Chapter 2 CLASSIFICATION SURVEYS				Alignment of reference numbers
Table B2.2 Plans and Documents – Machinery						
Name*1	Notes	Submission			Maintained On Board	
		Approval	Other	Finished Plans (Submission)	Finished Plans (On Board)	
(Omitted)						
2 Main and auxiliary engines (including attachments)	(1) Plans and data specified in 2.1.34-1(1), Part D of the Rules in relation to the kind of engine as well as documents showing specifications of louvers for emergency generator rooms and closing appliances of ventilators fitted to the rooms (if they are of a power-operated type.) .	○			○	
	(2) Plans and data specified in 2.1.34-1(2) and (3), Part D of the Rules.		○		○	
(Omitted)						

Amended-Original Requirements Comparison Table
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Amended		Original				Remarks
Table B2.3 Plans and Documents – Ships Carrying Liquefied Gases in Bulk						Codification of the existing practice
Name*1	Notes	Submission			Maintained On Board	
		Approval	Other	Finished Plans (Submission)	Finished Plans (On Board)	
(Omitted)						Items (2)(a) and (2)(b) have been moved from 1.3(1)(j) and (l) of Annex 16.1.1-3, Part N.
51 Piping diagram, constructions and particulars of utilisation units	(1) Where cargo is used as fuel. (2) Including the following items: <u>(a) Gas fuel make-up plants (including construction, equipment, and control systems).</u> <u>(b) Automatic control and remote control systems for gas fuel supply systems.</u> <u>(c) Installation procedures and working standards of double wall piping and ducts.</u> <u>(d) Investigation reports of the design pressures for outer pipes or ducts of fuel piping (as specified in 5.4.4, Part N of the Rules).</u>	○				
(Omitted)						
Table B2.5 Plans and Documents – Ships Using Low-flashpoint Fuels						Codification of the existing practice
Name*1	Notes	Submission		Maintained On Board		
		Approval	Other	Finished Plans (On Board)		
(Omitted)						
54 Investigation reports of the design pressures for outer pipes or ducts of high pressure fuel piping	(1) As specified in 9.8-2 , Part GF of the Rules.		○			
(Omitted)						
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)						

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
Table B2.11 Survey – Sea Trials *1		
Test Items	Details	
	(Omitted)	
2 Astern tests	((1) is omitted.) (2) Engines are to be functioning normally while the ship is running astern. Main propulsion machinery is to be capable of operating the <i>MPAP</i> referred to in 1.3.2, Part D of the Rules, and ships are to keep running astern for the periods specified in the following (a) and (b) corresponding to engine type. In addition, performance is to satisfy 1.3.2, Part D of the Rules. This test is to also be conducted in accordance with the provisions of <i>ISO 19019:2005</i>, section 5.4: Astern trial. (a) For ships with main engines other than steam turbines: Until the astern speed (rotational speed in rpm) stabilises. (b) For ships with steam turbines: A period of at least 15 <i>minutes</i>; the astern trial, however, is to be limited to 30 <i>minutes</i> or in accordance with manufacturer recommendations to avoid overheating the turbine due to the effects of “windage” and friction. (3) For gas-fuelled dual fuel engines, the confirmation specified in (2)(a) above is to be carried out for all operating modes (i.e. the applicable gas mode, diesel fuel oil mode, etc. and variable fuel oil/gas ratio mode.).	(3): Paragraph 3, 4.3 of UR M78 (related to 5.3.3 E) of UR M88).
	(Omitted)	
5 Performance tests of machinery installations	(1) The performance tests of machinery installations are to include the following (a) to (j) in order to verify that the machinery installations have sufficient normal functions and reliability and are free from detrimental vibration within the numbers of revolutions used. The details of these tests may be found in <i>JIS F 0801 “Test Code of Propelling Machinery at Sea Trials”</i> or other documents considered equivalent thereto³. (a) For reciprocating internal combustion engines, the output tests specified in Table B2.12, “Survey – Sea Trials of Reciprocating Internal Combustion Engines”, Part B of the Rules, are to be used as the standard carried out. <u>The scope of the tests may be expanded in cases where deemed necessary by the Society.</u> For reciprocating internal combustion engines driving generators or auxiliary machinery (excluding auxiliary machinery for specific uses), operation tests may be carried out at an appropriate time after installation on board. (b) For steam turbines and gas turbines used as main propulsion machinery, output tests are to be carried out at 3 or 4 levels of power output selected from normal continuous cruise power run and 4/4, 3/4, 2/4 and 1/4 of the maximum continuous output of the engine.	(a): 5.3.1 of UR M88

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
	(c) Operating tests for starting devices are to be carried out. It is to be confirmed that the engines start continuously for the number of times required by 2.5.32-2 or 4.4.3-2, Part D of the Rules during tests. For gas fueled dual fuel engines, this test is to be carried out for all operating modes (i.e. the applicable gas mode, diesel mode, etc.). (d) Function tests of the alarms and safety devices required by 2.4, 3.3 and 4.3, Part D of the Rules are to be carried out to verify effectiveness of the actual installation. <u>A part of or all of such tests may be substituted by the results of shop trials required by 2.6.1-2, Part D of the Rules.</u> (e) The suitability of residual and other special fuels for use in engines is to be confirmed. However, such tests may be dispensed with where the suitability has already been demonstrated at shop trials. (f) For reciprocating internal combustion engines driving main sources of electrical power (including reciprocating internal combustion engines driving generators for both propulsion and main power supply), <u>integration tests of generators with power management systems are to be carried out. During the integration tests, the characteristics for governors specified in 2.4.1-5(1), Part D of the Rules are to be confirmed.</u> (g) Function tests of the safety devices and alarms of boilers are to be carried out. (h) Function tests of the safety devices and alarms of exhaust gas economisers are to be carried out. (i) Gas-fuelled engines are to comply with (a) and (f), and further comply with the following i) to iiiiv, in the case of gas-fuelled dual fuel engines. i) The output tests <u>specified in (a) and the governor tests specified in (f)</u> are to be carried out for all operating modes (i.e. the applicable gas mode, diesel fuel oil mode, etc. and variable fuel oil/as ratio mode). The 110 % load test is not required for in the gas mode <u>for dual fuel engines driving generators</u>, provided that changeover to oil fuel mode is automatically performed in case of overload. ii) During the output tests specified in i), if a test load is performed in all applicable operation modes without interruption (direct changeover at same power and speed), the duration of 100 % power run required by Table B2.2 may be considered as the total duration demonstrated in all fuel modes. However, demonstration at each mode is not to be less than 1 hour. <u>iii) For engines starting in gas mode, the tests specified in (c) are to be carried out in applicable operating modes.</u> iiiiv) Automatic switching over to oil fuel mode is to be tested. Further,	(c): Moved to item (i)iii), as it is a requirement for dual fuel engines. (d): 5.2 of UR M88 (f): 5.3.5 C) of UR M88 (i)i): Paragraphs 4 and 5, 4.3 of UR M78 (i)iii): Paragraph 5, 4.3 of UR M78

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended		Original	Remarks
		manual changeover from diesel to gas mode and vice versa is to be tested. (j) For gas-fuelled engines, the effectiveness of the ventilation and gas detection arrangement, or other approved principle, of the double walled gas piping system is to be demonstrated. (k) Confirmation tests that crankshaft hot deflection values are within engine manufacturer recommended ranges (confirmation of measuring records is acceptable instead). (l) For engines fitted with sub-systems which are defined in 2.1.2(32), Part D of the Rules, integration tests are to be carried out for those sub-systems that are assembled for the first time on board. The scope of these tests is to be determined by taking into account of multiple engine operational mode, FMEA reports and the impact of the test on the engine, and agreed with the Society, and is to at least include the following i) to iii). In addition, any items of integration tests specified in 2.6.1-2(11), Part D of the Rules that have been postponed to shipboard testing are also to be conducted. For engines having multiple operating modes, extended performance and load tests may be required. i) Safety tests of sub-systems ii) Functional tests of sub-systems iii) Changeover tests	(j): Paragraph 8, 4.3 of UR M78 (l): 5.5 of UR M88
		(Omitted)	
8	Measurements of torsional vibration for the shafting systems	(1) Measurements are to be carried out in accordance with 8.1.34, Part D of the Rules. In cases where the confirmation of engine running conditions specified in 8.14.3-26, Part D of the Rules is performed at the estimated upper and lower borders by calculation, it is recommended that the fuel index around the estimated borders also be confirmed with consideration given to differences between estimated borders and actual borders confirmed through measurements. (2) Measurements in either diesel mode or in the gas mode (but not both modes) may be omitted where considered appropriate by the Society based upon relevant torsional vibration calculation sheets of diesel and gas mode.	(2) Deleted because the test conditions are specified in 8.4, Part D.
		(Omitted)	

Notes

*1: These tests may be dispensed with where such tests have been conducted while the ships are anchored or at dockside.

*2: In applying the requirements, the items specified in (1) or (2) are to be applied. Alternatively, designers or builders may use computational fluid dynamic (CFD) studies or experimental investigations to predict the rudder stock moment (torque in the rudder stock) under the full load condition and at the service speed.

(1) The rudder torque in the full load condition and at the speed of ship defined in 2.1.8, Part A of the Rules is to be predicted using the following extrapolation formula. There is, however, no need for extrapolation where A_T is greater than $0.95A_F$.

Amended-Original Requirements Comparison Table (Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
Q_F: the rudder stock moment (torque in the rudder stock) for the full load condition and the speed of ship defined in 2.1.8, Part A of the Rules Q_T: the rudder stock moment (torque in the rudder stock) for the trial condition α: the extrapolation factor in accordance with the following formula: $\alpha = 1.25 \left(\frac{A_F}{A_T} \right) \left(\frac{V_F}{V_T} \right)^2$ A_F: the total immersed projected area of the movable part of the rudder in the full load condition A_T: the total immersed projected area of the movable part of the rudder in the trial condition V_F: the contractual design speed of the vessel corresponding to the maximum continuous revolutions of the main engine in the full load condition V_T: the measured speed of the vessel (considering current) in the trial condition (2) Where rudder actuator system pressure is shown to have a linear relationship to rudder stock torque, (1) above can be taken in accordance with the following formula. Where constant volume fixed displacement pumps are utilised, 15.2.2(1) or 15.2.3(1), Part D of the Rules can be deemed satisfied if the estimated steering actuator hydraulic pressure in the full load condition is less than the specified maximum working pressure of the rudder actuator. Where a variable delivery pump is utilised, pump data are to be supplied and interpreted to estimate the delivered flow rate corresponds to the full load condition in order to calculate the steering time and allow it to be compared to the required time. $P_F = P_T \alpha$ P_F: the estimated steering actuator hydraulic pressure in the full load condition P_T: the maximum measured actuator hydraulic pressure in the trial condition *3: The following preparations are to be made before carrying out tests. (1) All relevant equipment for the safety of attending personnel such as <u>crankcase explosive condition protection</u> (e.g. oil mist detection arrangements), overspeed protective devices and any other shut down functions are to be made available and are to be operational. (2) The overspeed protective device is to be set to a value which is not higher than the allowable overspeed value. This set point is to be confirmed by surveyors. (3) The engines are to be run as prescribed by the engine manufacturer. (4) All fluids used for testing purposes (fuel oils, lubrication oils, cooling water, etc., including all fluids used temporarily or repeatedly for testing purposes only) are to be suitable for their intended purposes (i.e. they are to be clean, preheated if necessary and cause no harm to engine parts). *4: Where these tests have been carried out when the ship was anchored or at dockside, some of these tests may be dispensed with at sea trials.		

Amended-Original Requirements Comparison Table
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Amended		Original			Remarks
Table B2.12 Survey – Sea Trials of Reciprocating Internal Combustion Engines					
Test items		Use of engines			
		Main engines of ships in which reciprocating internal combustion engines are used as main propulsion machinery (excluding electric propulsion ships) ⁽¹⁾	Reciprocating internal combustion engines driving generators (including main engines of electric propulsion ships) ⁽²⁾	Reciprocating internal combustion engines driving auxiliaries (excluding auxiliary machinery for specific use, etc.)	
Load test	110 % power run	—	10 minutes at n_0 (n_0 is the rated engine speed.) ⁽³⁾	—	
	100 % power (rated power) run	4 hours at engine speed in accordance with propeller curve ^{(4) (5) (6)}	1 hour at n_0 ⁽³⁾	30 minutes at n_0	
Overspeed run		30 minutes at 1.032 n_0 or more ^{(7) (8)}	—	—	
Minimum revolution test of main engine ⁽⁹⁾		○ ⁽⁷⁾	—	—	
Intermittent overload ⁽¹⁰⁾		○		○	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
Notes (1) After testing has been completed, the fuel delivery system is to be blocked so as to limit the engines to run at not more than 100 % power, excluding propulsion engines for which intermittent overload is approved as well as propulsion engines also driving generators. (2) The tests are to be performed based on the rated electrical powers of the driven generators. (3) This may, if possible, be done during the electrical propulsion plant test, which is tested at 100 % propulsion power (i.e., total electric motor capacity for propulsion) by distributing the power on as few generators as possible. The duration of this test is to be sufficient to reach the stable operating temperatures of all rotating machines or for at least 4 <i>hours</i>. When some of the generator set(s) cannot be tested due to insufficient time during the propulsion system test mentioned above, those required tests are to be carried out separately. (4) In the case of controllable pitch propellers, the test is to be performed at rated engine speed n_0 at a propeller pitch leading to 100 % power, or to the maximum achievable power if 100 % power cannot be reached. (5) In the case of propulsion engines also driving generators, tests are to be also carried out for 2 hours at 100% propeller branch power (unless already covered in the test at 100% power) and 1 hour with 100% power take off branch power at rated engine speed n_0 in addition to the test for 4 hours at 100% power. <u>the tests specified in following (a) to (c) are to be carried out.</u> (a) <u>4 hours at 100 % power at rated engine speed n_0.</u> (b) <u>2 hours at 100 % propeller branch power at rated engine speed n_0 (unless already covered in (a)).</u> (c) <u>1 hour at 100 % power take off branch power at the designed (maximum possible) engine speed (unless already covered in (a)).</u> (6) For ships in which the tests specified in 2.2.5-2(1), Rules for Automatic and Remote Control Systems are performed for not less than 4 <i>hours</i> at 100 % power without interruption, the 100 % power test specified in this table may be omitted. For gas-fuelled engines, see also 2.3.1-1(5)(g)ii). (7) Only for engines driving fixed pitch propellers. (8) The test may be omitted if a 100 % power test is performed at $1.032n_0$ or more. In cases where engine speed cannot reach the specified speed due to the planned propeller curve, etc., an overspeed test may be performed at maximum achievable continuous revolution (i.e., maximum engine speed within the range of torque limit, etc.). (9) The test is to be carried out to identify the minimum working revolution of the main engine when the ship is steered to the maximum rudder angle. (10) Only for engines for which intermittent overload is approved. The test is to be performed for the duration agreed upon with the manufacturer.		(5): 5.3.6 of UR M88 Editorial revisions of the text was also made.
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (B)		

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
Chapter 14 SURVEY FOR FLOATING OFFSHORE FACILITIES FOR CRUDE OIL/PETROLEUM GAS PRODUCTION, STORAGE AND OFFLOADING 14.2 Classification Surveys 14.2.2 Submission of Plans and Documents 1 At the Classification Surveys during construction of Floating Offshore Facilities, the following plans and documents are to be submitted as plans and documents for approval before the work is commenced. ((1) is omitted.) (2) Machinery ((a) and (b) are omitted.) (c) Prime movers including attached auxiliaries (plans and data specified in 2.1.4, 3.1.2 and 4.1.2, Part D corresponding to the kind of prime mover) ((d) to (j) are omitted.)	Chapter 14 SURVEY FOR FLOATING OFFSHORE FACILITIES FOR CRUDE OIL/PETROLEUM GAS PRODUCTION, STORAGE AND OFFLOADING 14.2 Classification Surveys 14.2.2 Submission of Plans and Documents 1 At the Classification Surveys during construction of Floating Offshore Facilities, the following plans and documents are to be submitted as plans and documents for approval before the work is commenced. ((1) is omitted.) (2) Machinery ((a) and (b) are omitted.) (c) Prime movers including attached auxiliaries (plans and data specified in 2.1.3, 3.1.2 and 4.1.2, Part D corresponding to the kind of prime mover) ((d) to (j) are omitted.)	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)		

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part D MACHINERY INSTALLATIONS Chapter 2 RECIPROCATING INTERNAL COMBUSTION ENGINES <u>AND EXHAUST DRIVEN TURBOCHARGERS</u> 2.1 General 2.1.1 General* 2 For 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 2.5.4-1), 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. (Moved) <u>4</u> (Omitted) <u>5</u> (Omitted) <u>6</u> (Omitted) 2.1.2 Terminology* (Moved)	RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part D MACHINERY INSTALLATIONS Chapter 2 RECIPROCATING INTERNAL COMBUSTION ENGINES 2.1 General 2.1.1 General* 2 For 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. <u>4 The requirements of exhaust driven turbochargers specified in this chapter also apply, in principle, to engine driven chargers.</u> <u>5</u> (Omitted) <u>6</u> (Omitted) <u>7</u> (Omitted) 2.1.2 Terminology* <u>1 In this chapter, exhaust driven turbochargers are</u>	Alignment of reference numbers Moved to 2.7.1 Moved to 2.7.2

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
	<u>categorised into the following three groups according to the engine power at maximum continuous rating (<i>MCR</i>) supplied by a group of cylinders served by the actual turbocharger (e.g., turbocharger size is to be 50% of total engine power for a V-engine with one turbocharger serving each bank of cylinders).</u> <u>(1) Category <i>A</i> turbochargers</u> <u>The engine power at <i>MCR</i> supplied by a group of cylinders served by the turbocharger is not more than 1000 <i>kW</i>.</u> <u>(2) Category <i>B</i> turbochargers</u> <u>The engine power at <i>MCR</i> supplied by a group of cylinders served by the turbocharger is not less than 1000 <i>kW</i>, but not more than 2500 <i>kW</i>.</u> <u>(3) Category <i>C</i> turbochargers</u> <u>The engine power at <i>MCR</i> supplied by a group of cylinders served by the turbocharger is not less than 2500 <i>kW</i>.</u>	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
<u>1</u> The terminology used in the application of 2.1.3 and 2.1.4 is as specified in the following (1) to (<u>37</u>): ((1) to (31) are omitted.) (32) “Sub-system” means assembly of components belonging to engine, intended to achieve a defined function and which may affect the engine performance, e.g. electronic control systems, gas system of gas fuelled engines. (33) (Omitted) (34) (Omitted) (35) (Omitted) (36) (Omitted) (37) (Omitted) <u>2</u> (Omitted) <u>3</u> (Omitted) 2.1.<u>3</u> Approval of Reciprocating Internal Combustion Engines 1 Reciprocating internal combustion engines are to be approved in accordance with the following (1) to (<u>5</u>): (Deleted) (1) Each type of reciprocating internal combustion engine is to be provided with a certificate of type approval <u>or design evaluation</u> obtained by the licensor in accordance with 2.1.1-3 <u>prior to the commencement</u>	<u>2</u> The terminology used in the application of 2.1.3 and 2.1.4 is as specified in the following (1) to (<u>36</u>): ((1) to (31) are omitted.) (Newly added) (32) (Omitted) (33) (Omitted) (34) (Omitted) (35) (Omitted) (36) (Omitted) <u>3</u> (Omitted) <u>4</u> (Omitted) 2.1.<u>4</u> Approval of Reciprocating Internal Combustion Engines 1 Reciprocating internal combustion engines are to be approved in accordance with the following (1) to (<u>6</u>): (1) <u>Development of documents and data for engine production</u> (a) <u>Prior to the start of the reciprocating internal combustion engine approval process in accordance with the following (c) and subsequent sub-paragraphs of this paragraph, a design approval is to be obtained as specified separately by the Society.</u> (b) Each type of reciprocating internal combustion engine is to be provided with a certificate of type approval obtained by the licensor in accordance with 2.1.1-3. For the first engine of a type or for	(32): Definition of the engine “subsystems” (UR M87 Appendix 1). Former item (a): Deleted because it is already specified in 2.1.1-3 and is therefore redundant. (1): 6. And 6.1 of UR M87

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Amended	Original	Remarks
of manufacture by the engine manufacturer (hereinafter referred to as “licensee” in this Chapter). 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. (2) <u>Drawings and data for the approval of reciprocating internal combustion engines in this Chapter are to be submitted in accordance with 2.1.4.</u>	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. (Newly added) (c) <u>The licensor is to review the drawings and data of the reciprocating internal combustion engine whose type approval has been obtained for the application and develop, if necessary, application specific drawings and data for production of reciprocating internal combustion engines for the use of the licensee in developing the reciprocating internal combustion engine specific production drawings and data for the inspection and testing specified in 2.1.3-1.</u> (d) <u>If substantive modifications to the drawings and data of the reciprocating internal combustion engine whose type approval has been obtained have been made in the drawings and data of 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.</u> (2) <u>Drawings and data for the inspection and testing of reciprocating internal combustion engines</u> (a) <u>The licensee is to develop the drawings and data for the inspection and testing specified in 2.1.3-1 and a comparison list of these drawings and data</u>	(2): 6.1 of UR M87 Requirements for the submission of drawings and data are specified in 2.1.4.

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
	to the drawings and data of the reciprocating internal combustion engine whose type approval has been obtained by the licensor and submit these drawings and the comparison list to the Society. (b) <u>As for the drawings and data for the inspection and testing specified in 2.1.3-1, if there are differences in the technical content on the licensee's production drawings and data of the reciprocating internal combustion engine compared to the drawings and data of the reciprocating internal combustion engine whose type approval 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 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 reciprocating internal combustion engine.</u> (c) <u>In applying (b) above, modifications applied by the licensee are to be provided with appropriate quality requirements.</u> (d) <u>The Society returns the drawings and data specified in (a) and (b) above to the licensee with confirmation that the design has been approved.</u> (e) <u>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</u>	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(3) <u>Licensee assessment</u> The Society <u>verifies</u> conformity of production with the Society's requirements for production facilities comprising manufacturing facilities and processes, machining tools, quality assurance, testing facilities, etc. (Deleted) (4) <u>Engine assembly and testing</u> The licensee is to assemble and test the reciprocating internal combustion engine according to the Society's technical rules. <u>The testing of each reciprocating internal combustion engine is to be witnessed by the Surveyor unless the manufacturer of the 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.</u>	<u>during manufacture and testing of the reciprocating internal combustion engine and its components.</u> (3) <u>Additional drawings and data</u> <u>In addition to the drawings and data for the inspection and testing specified in 2.1.3-1, the licensee is to be able to provide to the Surveyor performing the test specified in 2.6.1 upon request the relevant detail drawings, production quality control specifications and acceptance criteria. These drawings and data are for supplemental purposes to the survey only.</u> (4) <u>Licensee approval</u> (a) <u>The Society assesses conformity of production with the Society's requirements for production facilities comprising manufacturing facilities and processes, machining tools, quality assurance, testing facilities, etc. as specified separately by the Society.</u> (b) <u>Satisfactory conformance with (a) above results in the issue of a document showing the licensee has been approved by the Society.</u> (5) <u>Engine assembly and testing</u> The licensee is to assemble and test the reciprocating internal combustion engine according to the Society's technical rules <u>each of the reciprocating internal combustion engine assembly and testing procedure is to be witnessed by the Surveyor unless the manufacturer of the 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.</u>	(3): 6.2 of UR M87 Description revised to align with actual practice (6.4 of UR M87).

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(5) Issue of certificates of reciprocating internal combustion engines and components (a) The attending Surveyors, at the licensee/subcontractors, will issue product certificates as necessary for components manufactured upon satisfactory inspections and tests. (b) An engine certificate is issued by the Surveyor upon satisfactory completion of assembly and tests specified in (4) above. (Deleted) <u>2</u> Components and sub-systems of licensor's design which are covered by the certificate of type approval of the relevant engine type are regarded as approved whether manufactured by the reciprocating internal combustion engine manufacturer or sub-supplied. For components and subsystems of subcontractor's design, necessary approvals are to be obtained by the relevant suppliers (e.g. exhaust gas turbochargers.). <u>3</u> In case where the scope of a certificate of type approval or design evaluation is extended to allow the incorporation of an additional or alternative sub-system, the requirements specified separately by the Society are to apply. <u>4</u> In case where type approval for sub-systems is required by the Society or is voluntarily sought, the requirements specified separately by the Society are to apply.	(6) Issue of certificates of reciprocating internal combustion engines and components (a) The attending Surveyors, at the licensee/subcontractors, will issue product certificates as necessary for components manufactured upon satisfactory inspections and tests. (b) An engine certificate is issued by the Surveyor upon satisfactory completion of assembly and tests specified in (5) above. <u>2</u> 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 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. <u>3</u> Components of licensor's design which are covered by the certificate of type approval of the relevant engine type are regarded as approved whether manufactured by the reciprocating internal combustion engine manufacturer or sub-supplied. <u>4</u> For components of subcontractor's design, necessary approvals are to be obtained by the relevant suppliers (e.g. exhaust gas turbochargers, charge air coolers, etc.). (Newly added) (Newly added)	((5): 6.3 and 6.5 of UR M87) The Rules do not address the form of the contractual arrangement (e.g. whether it is a licence agreement). 2: 5.10.2 of UR M87. An editorial revision of the wording is also made. 3: 5.101 and paragraph 2, 5.10.2 of UR M87

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
5 The engine approval based on type approval specified in -1(1) may be substituted by individual approval when deemed appropriate by the Society. In such cases, requirements equivalent to those for approval based on type approval are to apply. 2.1.4 Drawings and Data* 1 Drawings and data to be submitted are generally as follows: (1) Drawings and data for approval (a) <u>A list containing all drawings and data submitted (including relevant drawing numbers and revision status)</u> (b) <u>Engine particulars (The applicable items in the following i) to xvii) are to be included.)</u> i) <u>Engine type</u> ii) <u>Engine manufacturer</u> iii) <u>Maximum continuous rating (MCR)</u> iv) <u>Speed (rpm)</u> v) <u>Maximum combustion pressure</u> vi) <u>Mean effective pressure</u> vii) <u>Mean indicated pressure</u> viii) <u>Bore</u> ix) <u>Stroke</u> x) <u>Crankshaft materials</u> xi) <u>Type and number of exhaust driven turbochargers</u> xii) <u>Type of crankcase explosion relief valves</u> xiii) <u>Type of oil mist detection arrangements</u> xiv) <u>Type of electronic governors</u> xv) <u>Software name and version number of electronic control systems</u>	(Newly added) 2.1.3 Drawings and Data* 1 Drawings and data to be submitted are generally as follows: (1) Drawings and data for approval <u>Drawings and data specified in Table D2.1(a)</u>	5. paragraph 3, 1 of UR M87 Reorganization of the drawings and data required to be submitted for the approval of individual engines.

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
<u>xvi) Sub-systems</u> <u>xvii) Other items deemed necessary by the Society</u> (c) <u>In cases where the engine designer and the engine manufacturer are different, schematic layout or other equivalent drawings and data on the engine of the following i) to vii):</u> <u>i) Starting air system</u> <u>ii) Fuel system</u> <u>iii) Lubricating oil system</u> <u>iv) Cooling water system</u> <u>v) Hydraulic system</u> <u>vi) Hydraulic system (for valve lift)</u> <u>vii) Engine control and safety system</u> (d) <u>Drawings and data specified in -2, if applicable (this may be included in (a) above)</u> (2) Drawings and data for reference (a) <u>The following drawings and data for measures to prevent crankcase explosions:</u> <u>i) Documentation containing evidence of studies justifying the selected location of sample points and the sample extraction rate specified in 2.4.5-2(6) (may be omitted in cases where replaced by the test specified in 2.4.5-2(7))</u> <u>ii) Documentation of alternative methods to prevent the build-up of oil mist within the crankcase specified in 2.4.5-3 (if applicable)</u> <u>iii) Documentation of the introduction of inert gas into the crankcase specified in 2.4.6-1 (if applicable)</u> (b) <u>Other drawings and data deemed necessary by</u>	(2) Drawings and data for reference <u>Drawings and data specified in Table D2.1(b)</u>	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
<u>the Society</u> (Deleted) <u>2 The drawings and data specified in -1(1)(d) are to be submitted in accordance with the following (1) and (2).</u> (Deleted)	<u>2 The drawings and data for the inspection and testing specified in -1 (the items represented by the mark ○ in Table D2.1(a) and Table D2.1(b), hereinafter indicated the same way throughout this Chapter) are to be submitted in accordance with 2.1.4-1 by the engine manufacturer producing engines with the drawings and data whose type approval has been obtained in accordance with 2.1.1-3 (hereinafter referred to as “licensee” in this Chapter). Such drawings and data, however, may be submitted by the licensor in accordance with 2.1.4-2.</u> <u>(hereinafter referred to as 2.1.4-1(1) of the current Rules)</u> <u>(c) The licensor is to review the drawings and data of the reciprocating internal combustion engine whose type approval has been obtained for the application and develop, if necessary, application specific drawings and data for production of reciprocating internal combustion engines for the use of the licensee in developing the reciprocating internal combustion engine specific production drawings and data for the inspection and testing specified in 2.1.3-1.</u> <u>(d) If substantive modifications to the drawings and data of the reciprocating internal combustion engine whose type approval has been obtained have been made in the drawings and data of 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.</u>	-2.: 6 of UR M44 Former item (c) is deleted, with reference to Fig. D2.1.4-2, “Flow of Approval of Reciprocating Internal Combustion Engines”, in the Guidance for Part D. Former item (d) is deleted from Part D, as it contains requirements relating to the reapproval of engine types.

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(1) <u>If there are differences in the drawing numbers or content of the licensee's production drawings and data compared to the drawings and data whose type approval has been obtained by the licensor, a comparison list is to be prepared and submitted to the Society.</u> (2) If there are differences in the technical content of the licensee's production drawings and data compared to the drawings and data whose type approval 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 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 reciprocating internal combustion engine.	(hereinafter referred to as 2.1.4-1(2) of the current Rules) (a) <u>The licensee is to develop the drawings and data for the inspection and testing specified in 2.1.3-1 and a comparison list of these drawings and data to the drawings and data of the reciprocating internal combustion engine whose type approval has been obtained by the licensor and submit these drawings and the comparison list to the Society.</u> (b) <u>As for the drawings and data for the inspection and testing specified in 2.1.3-1, if there are differences in the technical content on the licensee's production drawings and data of the reciprocating internal combustion engine compared to the drawings and data of the reciprocating internal combustion engine whose type approval 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 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 reciprocating internal combustion engine.</u> (c) <u>In applying (b) above, modifications applied by the licensee are to be provided with appropriate quality requirements.</u> (d) <u>The Society returns the drawings and data specified in (a) and (b) above to the licensee with confirmation that the design has been approved.</u>	(1): 6.1.2 and 6.1.3 of UR M44 (2): 6.1.2 and 6.2.3 of UR M44 Former item (c): Deleted due to duplication with 2.1.3-1(3). Former items (d) and (e): Deleted as redundant.

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
<u>3</u> The licensee is to be able to provide to the Surveyor performing the test specified in 2.6.1 upon request <u>the drawings and data listed in Table D2.1</u>, the relevant detail drawings, production quality control specifications and acceptance criteria. These drawings and data are for supplemental purposes to the survey only.	(e) <u>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 reciprocating internal combustion engine and its components.</u> (hereinafter referred to as 2.1.4-1(3) of the current Rules) (3) <u>Additional drawings and data</u> <u>In addition to the drawings and data for the inspection and testing specified in 2.1.3-1</u>, the licensee is to be able to provide to the Surveyor performing the test specified in 2.6.1 upon request the relevant detail drawings, production quality control specifications and acceptance criteria. These drawings and data are for supplemental purposes to the survey only.	3: 6.2.2 of UR M44

Amended-Original Requirements Comparison Table
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Amended		Original	Remarks
Table D2.1(a) Drawings and Data for Approval			
	Items	For inspection and testing	
(1)	Engine particulars (in the format designated by the Society)	⊖	
(2)	Material specifications of main parts with information on non-destructive testing and pressure testing as applicable to the material	⊖	
(3)	Bedplate and crankcase of welded design, with welding details and welding instructions ^(†)	⊖	
(4)	Thrust bearing bedplate of welded design, with welding details and welding instructions ^(†)	⊖	
(5)	Frame/framebox/gearbox of welded design, with welding details and instructions ^(†)	⊖	
(6)	Crankshaft, assembly and details	⊖	
(7)	Thrust shaft or intermediate shaft (if integral with engine)	⊖	
(8)	Shaft coupling bolts	⊖	
(9)	Connecting rod bearings (four stroke design)	—	
(10)	Bolts and studs for connecting rods (four stroke design)	⊖	
(11)	Schematic layout or other equivalent drawings and data on the reciprocating internal combustion engine of the following (a) to (g) (details of the system so far as supplied by the licensee such as: main dimensions, operating media and maximum working pressures): (a) Starting air system (b) Fuel oil system (c) Lubricating oil system (d) Cooling water system (e) Hydraulic system (f) Hydraulic system (for valve lift) (g) Engine control and safety system	⊖	
(12)	High pressure oil pipes for driving exhaust valves with its shielding	—	
(13)	Shielding of high pressure fuel pipes, assembly (all engines)	⊖	
(14)	High pressure parts for fuel oil injection system The documentation to contain specifications for pressures, pipe dimensions and materials.	⊖	
(15)	Arrangement and details of the crankcase explosion relief valve (only for engines of a cylinder diameter of 200 mm or more or a crankcase volume of 0.6 m ³ or more)	⊖	
(16)	Oil mist detection and/or alternative alarm arrangements	⊖	
(17)	Connecting rod with cap (four stroke design)	⊖	
(18)	Arrangement of foundation (for main engines only)	⊖	
(19)	The drawings, data, etc. required by 2.1.4.	⊖	
(20)	The following drawings and data for exhaust driven turbochargers:	—	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(a) Category A turbochargers (upon request) i) Sectional assembly (including principal dimensions and names of components) ii) Containment test report iii) — Test procedures (b) Category B turbochargers i) Sectional assembly (including principal dimensions and materials of housing components for containment evaluation.) ii) Documentation of containment in the event of the disc fracture specified in 2.5.1-6 iii) — Documentation of following operational data and limitations • Maximum permissible operating speed (<i>rpm</i>) • Maximum permissible exhaust gas temperature at the turbine inlet • Minimum lubrication oil inlet pressure • Maximum permissible vibration levels (self and externally generated vibrations) • 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) iv) — Diagram of lubrication oil systems (diagrams included in piping arrangements fitted to engines may be accepted instead) v) Test report of type approval test (only for type approval tests) vi) — Test procedure (only for type approval tests) (c) Category C turbochargers i) Drawings listed in (b) above ii) Drawings of the housing and rotating parts (including details of blade fixing) iii) — Material specifications (including mechanical properties and chemical composition) of the parts mentioned in ii) above iv) — Welding details and welding procedures for the parts mentioned in ii) above, if made of welded construction		
(21) Other drawings and data deemed necessary by the Society	⊖	

Note:

(1) — For approval of materials and weld procedure specifications, the weld procedure specification is to include details of pre- and post-weld heat treatments, weld consumables and fit-up conditions.

Amended-Original Requirements Comparison Table
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Amended		Original	Remarks
Table D2.1(b) Drawings and Data for Reference			
	Items	For inspection and testing	
(1)	A list containing all drawings and data submitted – (including relevant drawing numbers and revision status)	⊖	
(2)	Bolts and studs for main bearings	⊖	
(3)	Connecting rod bearings (two-stroke design)	—	
(4)	Bolts and studs for cylinder heads and exhaust valve (two-stroke design)	⊖	
(5)	Bolts and studs for connecting rods (two-stroke design)	⊖	
(6)	Tie rods	⊖	
(7)	Piston pins	—	
(8)	Construction of accumulators for hydraulic oil and fuel oil	⊖	
(9)	Cylinder head fixing bolts and valve box fixing bolts	—	
(10)	Rocker valve gears	—	
(11)	Cylinder head	⊖	
(12)	Cylinder block, engine block	⊖	
(13)	Cylinder liner	⊖	
(14)	Counterweights (if not integral with crankshaft), including fastening	⊖	
(15)	Connecting rod with cap (two-stroke design)	⊖	
(16)	Crosshead	⊖	
(17)	Piston rod	⊖	
(18)	Piston, assembly, including identification (e.g. drawing number) of components	⊖	
(19)	Piston head	⊖	
(20)	Camshaft drive, assembly, including identification (e.g. drawing number) of components	⊖	
(21)	Flywheel	⊖	
(22)	Fuel oil injection pump	⊖	
(23)	Shielding and insulation of exhaust pipes and other parts of high temperature which may be impinged as a result of a fuel system failure, assembly	⊖	
(24)	Construction and arrangement of dampers	⊖	
(25)	Construction and arrangement of detuners, balancers or compensators, bracings as well as all calculation sheets related to engine balancing and engine vibration prevention	—	
(26)	For electronically controlled engines, assembly drawings or arrangements of the following (a) to (d): (a) Control valves (b) High pressure pumps (c) Drive for high pressure pumps	⊖	

Amended-Original Requirements Comparison Table
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Amended		Original		Remarks
	(d) Valve bodies, if applicable			
(27)	Operation and service manuals ⁽¹⁾		⊖	
(28)	Engine control system diagram (including the monitoring, safety and alarm systems)		=	
(29)	Test program resulting from FMEA (for engine control system) in cases of engines that rely on hydraulic, pneumatic or electronic control of fuel injection and/or valves		⊖	
(30)	Production specifications for castings and welding (sequence)		⊖	
(31)	Certification of a type approval for environmental tests, control components ⁽²⁾		⊖	
(32)	Quality requirements for engine production		⊖	
(33)	Location of measures preventing oil from spraying out from joints in flammable oil piping (if fitted)		=	
(34)	The following drawings and data for exhaust driven turbochargers (only for category C turbochargers): (a) Documentation of the safe torque transmission specified in 2.5.1-6 when the disc is connected to the shaft by an interference fit (b) Information on expected lifespan (creep, low cycle fatigue and high cycle fatigue are to be considered) (c) Operation and maintenance manuals		=	
(35)	The following drawings and data for measures to prevent crankcase explosions: (a) Documentation containing evidence of studies justifying the selected location of sample points and the sample extraction rate specified in 2.4.5-2(6) (may be omitted in cases where replaced by the test specified in 2.4.5-2(7)) (b) Documentation of alternative methods to prevent the build up of oil mist within the crankcase specified in 2.4.5-3 (if applicable) (c) Documentation of the introduction of inert gas into the crankcase specified in 2.4.6-1 (if applicable)		⊖	
(36)	Other drawings and data deemed necessary by the Society		⊖	

Notes:

(1) — Operation and service manuals are to contain maintenance requirements (servicing and repair) including details of any special tools and gauges that are to be used with their fitting/settings together with any test requirements on completion of maintenance.

(2) — Drawings and data modified for a specific application are to be submitted to the Society for reference or approval, as applicable

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
Table D2.1 Drawings and Data for the Inspection and Testing of Reciprocating Internal Combustion Engines		
	Items	
(1)	<u>Material specifications of main parts with information on non-destructive testing and pressure testing as applicable to the material</u>	
(2)	<u>Bedplate and crankcase of welded design, with welding details and welding instructions</u>	
(3)	<u>Thrust bearing bedplate of welded design, with welding details and welding instructions</u>	
(4)	<u>Frame/framebox/gearbox of welded design, with welding details and instructions</u>	
(5)	<u>Crankshaft, assembly and details</u>	
(6)	<u>Thrust shaft or intermediate shaft (if integral with engine)</u>	
(7)	<u>Shaft coupling bolts</u>	
(8)	<u>Bolts and studs for main bearings</u>	
(9)	<u>Bolts and studs for cylinder heads and exhaust valve (two-stroke design)</u>	
(10)	<u>Bolts and studs for connecting rods</u>	
(11)	<u>Tie rods</u>	
(12)	<u>Shielding of high pressure fuel pipes, assembly (all engines)</u>	
(13)	<u>Construction of accumulators for hydraulic oil and fuel oil</u>	
(14)	<u>High pressure parts for fuel oil injection system</u> <u>The documentation to contain specifications for pressures, pipe dimensions and materials.</u>	
(15)	<u>Arrangement and details of the crankcase explosion relief valve (only for engines of a cylinder diameter of 200 mm or more or a crankcase volume of 0.6 m³ or more)</u>	
(16)	<u>Oil mist detection and/or alternative alarm arrangements</u>	
(17)	<u>Cylinder head</u>	
(18)	<u>Cylinder block, engine block</u>	
(19)	<u>Cylinder liner</u>	
(20)	<u>Counterweights (if not integral with crankshaft), including fastening</u>	
(21)	<u>Connecting rod with cap</u>	
(22)	<u>Crosshead</u>	
(23)	<u>Piston rod</u>	
(24)	<u>Piston, assembly, including identification (e.g. drawing number) of components</u>	
(25)	<u>Piston head</u>	
(26)	<u>Camshaft drive, assembly, including identification (e.g. drawing number) of components</u>	
(27)	<u>Flywheel</u>	
(28)	<u>Arrangement of foundation (for main engines only)</u>	
(29)	<u>Fuel injection pump</u>	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended		Original	Remarks
(30)	<u>Shielding and insulation of exhaust pipes and other parts of high temperature which may be impinged as a result of a fuel system failure, assembly</u>		
(31)	<u>Construction and arrangement of dampers</u>		
(32)	<u>For electronically controlled engines, assembly drawings or arrangements of the following (a) to (d):</u> <u>(a) Control valves</u> <u>(b) High-pressure pumps</u> <u>(c) Drive for high pressure pumps</u> <u>(d) Valve bodies, if applicable</u>		
(33)	<u>Operation and service manuals⁽¹⁾</u>		
(34)	<u>Test program resulting from FMEA (for engine control system) in cases of engines that rely on hydraulic, pneumatic or electronic control of fuel injection and/or valves</u>		
(35)	<u>Production specifications for castings and welding (sequence)</u>		
(36)	<u>Certification of a type approval for environmental tests, control components⁽²⁾</u>		
(37)	<u>Quality requirements for engine production</u>		
(38)	<u>Other drawings and data deemed necessary by the Society</u>		
Notes: (1) Operation and service manuals are to contain maintenance requirements (servicing and repair) including details of any special tools and gauges that are to be used with their fitting/settings together with any test requirements on completion of maintenance. (2) Drawings and data modified for a specific application are to be submitted to the Society for reference or approval, as applicable			
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (C)			

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks																																																																																																															
2.2 Materials, Construction and Strength Table D2.2 Application of Materials and Non-destructive Tests as well as Surface Inspections and Dimension Inspections to Principal Components of Reciprocating Internal Combustion Engines <table><tr><th rowspan="3">Principal components</th><th colspan="11">Cylinder bore D (mm)</th></tr><tr><th colspan="3">$D \leq 300$</th><th colspan="3">$300 < D \leq 400$</th><th colspan="5">$400 < D$</th></tr><tr><th>I</th><th>II</th><th>III</th><th>I</th><th>II</th><th>III</th><th>I</th><th>II</th><th colspan="3">III</th></tr><tr><td colspan="12">(Omitted)</td></tr><tr><td rowspan="3">23</td><td colspan="5" rowspan="3">Turbine discs, blades, blower impellers and rotor shafts of exhaust driven turbochargers⁽⁺⁶⁾</td><td>Category A</td><td>⊖⁽⁹⁾</td><td></td><td></td><td>⊖⁽⁹⁾</td><td></td><td></td></tr><tr><td>Category B</td><td>⊖</td><td>⊖</td><td>⊖⁽⁺⁷⁾</td><td>⊖</td><td>⊖</td><td>⊖⁽⁺⁷⁾</td><td>⊖</td><td>⊖</td><td>⊖⁽⁺⁷⁾</td></tr><tr><td>Category C</td><td>⊖</td><td>⊖</td><td>⊖⁽⁺⁷⁾</td><td>⊖</td><td>⊖</td><td>⊖⁽⁺⁷⁾</td><td>⊖</td><td>⊖</td><td>⊖⁽⁺⁷⁾</td></tr><tr><td rowspan="3">24</td><td colspan="5" rowspan="3">Casings of exhaust driven turbochargers⁽⁺⁶⁾⁽⁺¹⁸⁾</td><td>Category A</td><td>⊖⁽⁹⁾</td><td></td><td></td><td>⊖⁽⁹⁾</td><td></td><td></td></tr><tr><td>Category B</td><td>⊖</td><td></td><td></td><td>⊖</td><td></td><td></td><td>⊖</td><td></td><td></td></tr><tr><td>Category C</td><td>⊖</td><td></td><td></td><td>⊖</td><td></td><td></td><td>⊖</td><td></td><td></td></tr></table> Notes: ((1) to (15) are omittd.) (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. (18) Chemical composition analysis may be omitted.	Principal components	Cylinder bore D (mm)											$D \leq 300$			$300 < D \leq 400$			$400 < D$					I	II	III	I	II	III	I	II	III			(Omitted)												23	Turbine discs, blades, blower impellers and rotor shafts of exhaust driven turbochargers ⁽⁺⁶⁾					Category A	⊖ ⁽⁹⁾			⊖ ⁽⁹⁾			Category B	⊖	⊖	⊖ ⁽⁺⁷⁾	⊖	⊖	⊖ ⁽⁺⁷⁾	⊖	⊖	⊖ ⁽⁺⁷⁾	Category C	⊖	⊖	⊖ ⁽⁺⁷⁾	⊖	⊖	⊖ ⁽⁺⁷⁾	⊖	⊖	⊖ ⁽⁺⁷⁾	24	Casings of exhaust driven turbochargers ⁽⁺⁶⁾⁽⁺¹⁸⁾					Category A	⊖ ⁽⁹⁾			⊖ ⁽⁹⁾			Category B	⊖			⊖			⊖			Category C	⊖			⊖			⊖			2.2 Materials, Construction and Strength Requirements relating to turbocharger tests have been moved to 2.7.4-1 and -2.
Principal components		Cylinder bore D (mm)																																																																																																															
		$D \leq 300$			$300 < D \leq 400$			$400 < D$																																																																																																									
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23	Turbine discs, blades, blower impellers and rotor shafts of exhaust driven turbochargers ⁽⁺⁶⁾					Category A	⊖ ⁽⁹⁾			⊖ ⁽⁹⁾																																																																																																							
						Category B	⊖	⊖	⊖ ⁽⁺⁷⁾	⊖	⊖	⊖ ⁽⁺⁷⁾	⊖	⊖	⊖ ⁽⁺⁷⁾																																																																																																		
						Category C	⊖	⊖	⊖ ⁽⁺⁷⁾	⊖	⊖	⊖ ⁽⁺⁷⁾	⊖	⊖	⊖ ⁽⁺⁷⁾																																																																																																		
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						Category B	⊖			⊖			⊖																																																																																																				
						Category C	⊖			⊖			⊖																																																																																																				
2.4 Safety Devices 2.4.5 Crankcase Oil Mist Detection Arrangements* 2 The crankcase oil mist detection arrangements required in -1 above are to be of an approved type and in accordance with the following requirements: ((1) to (5) are omitted.) (6) Plans showing details and arrangements of oil mist detection and alarm arrangements are to be submitted	2.4 Safety Devices 2.4.5 Crankcase Oil Mist Detection Arrangements* 2 The crankcase oil mist detection arrangements required in -1 above are to be of an approved type and in accordance with the following requirements: ((1) to (5) are mitted.) (6) Plans showing details and arrangements of oil mist detection and alarm arrangements are to be submitted																																																																																																																

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Amended	Original	Remarks
for approval in accordance with 2.1.4-1(2). Additionally, documentation containing evidence of studies justifying the selected location of sample points, supported by a confirmation from the oil mist detection system manufacturer, from the crankcase and the spaces mentioned in 2.4.3-3, is to be submitted to the Society for reference purposes only. When the systems use a suction method, information regarding the sample extraction rate is to be included. ((7) to (10) are omitted.) <u>2.4.7 Safety Measures for Exhaust Driven Turbochargers</u> <u>1</u> 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. <u>2</u> 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. <u>3</u> 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	for approval in accordance with (16) of Table D2.1(1). Additionally, documentation containing evidence of studies justifying the selected location of sample points, supported by a confirmation from the oil mist detection system manufacturer, from the crankcase and the spaces mentioned in 2.4.3-3, is to be submitted to the Society for reference purposes only. When the systems use a suction method, information regarding the sample extraction rate is to be included. ((7) to (10) are omitted.) (Newly added) (Moved) (Moved) (Moved)	Moved from 2.5.1-2 Moved from 2.5.1-3 Moved from 2.5.1-9

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Amended	Original	Remarks
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. 2.5 Associated Installations (Deleted) (Moved) (Moved) (Moved) (Moved) (Moved) (Moved)	2.5 Associated Installations <u>2.5.1 Exhaust Driven Turbochargers*</u> <u>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.</u> <u>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.</u> <u>3 Where the main propulsion engine can not 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.</u> <u>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.</u> <u>5 The air inlets of exhaust driven turbochargers are to be</u>	Moved to 2.7.3-1 Moved to 2.4.7-1 Moved to 2.4.7-2 Moved to 2.7.3-2 Moved to 2.7.3-3

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Amended	Original	Remarks
(Moved)	<u>fitted with filters.</u> <u>6 Exhaust driven turbochargers 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.</u>	Moved to 2.7.3-4
(Moved)	<u>7 In the case of category C turbochargers 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.</u>	Moved to 2.7.3-5
(Moved)	<u>8 For categories B and C turbochargers, the indications and alarms listed in the Table D2.4 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.</u>	Moved to 2.7.3-6
(Moved)	<u>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.</u>	Moved to 2.4.7-3

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Amended	Original	Remarks
(Moved)	<u>10 Certificates for categories <i>B</i> and <i>C</i> turbochargers issued by the Society will, at a minimum, cite the applicable type approval.</u>	Moved to 2.7.3-7
(Moved)	<u>11 Certification and test requirements specified in this chapter apply to the replacement of rotating parts and casings.</u>	Moved to 2.7.3-8
Table D2.4 Alarms and Indications of Turbochargers (Table is omitted.)		Moved after 2.7.3, with the table number revised to Table D2.7.
2.5.1 Exhaust Gas Arrangements (Omitted)	2.5.2 Exhaust Gas Arrangements (Omitted)	
2.5.2 Starting Arrangements* (Omitted)	2.5.3 Starting Arrangements* (Omitted)	
2.5.3 Fuel Oil Arrangements (Omitted)	2.5.4 Fuel Oil Arrangements (Omitted)	
2.5.4 Lubricating Oil Arrangements (Omitted)	2.5.5 Lubricating Oil Arrangements (Omitted)	
2.5.5 Cooling Arrangements (Omitted)	2.5.6 Cooling Arrangements (Omitted)	
2.5.6 Control Valves for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Omitted)	2.5.7 Control Valves for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Omitted)	

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Amended	Original	Remarks
2.5.7 Accumulators and Common Accumulators for Electronically-controlled Engines which are used as the Main Propulsion Machinery 1 Accumulators and common accumulators are to comply with the requirements in Chapter 10. However, notwithstanding this requirement, materials and non-destructive tests as well as surface inspections and dimension inspections are to be in accordance with Table D2.2 and hydrostatic tests are to be in accordance with Table D2.5. 2.5.8 Fuel Oil Piping Systems and Hydraulic Oil Piping Systems for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Omitted) 2.5.9 Electronic Control Systems for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Omitted) 2.5.10 Failure Mode Effect Analysis for Electronically-controlled Engines which are used as the Main Propulsion Machinery Failure Mode Effect Analysis (FMEA) is to be carried out, for electronic control systems, in order to confirm that any one equipment or circuits in such systems which lose function may not cause any malfunction or deterioration in other equipment or circuits, in accordance with the following: ((1) and (2) are omitted.) (3) FMEA results are to be created in table form as shown in Table D2.4 or be of equivalent forms thereto.	2.5.8 Accumulators and Common Accumulators for Electronically-controlled Engines which are used as the Main Propulsion Machinery 1 Accumulators and common accumulators are to comply with the requirements in Chapter 10. However, notwithstanding this requirement, materials and non-destructive tests as well as surface inspections and dimension inspections are to be in accordance with Table D2.2 and hydrostatic tests are to be in accordance with Table D2.6. 2.5.9 Fuel Oil Piping Systems and Hydraulic Oil Piping Systems for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Omitted) 2.5.10 Electronic Control Systems for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Omitted) 2.5.11 Failure Mode Effect Analysis for Electronically-controlled Engines which are used as the Main Propulsion Machinery Failure Mode Effect Analysis (FMEA) is to be carried out, for electronic control systems, in order to confirm that any one equipment or circuits in such systems which lose function may not cause any malfunction or deterioration in other equipment or circuits, in accordance with the following: ((1) and (2) are omitted.) (3) FMEA results are to be created in table form as shown in Table D2.5 or be of equivalent forms thereto.	

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Amended	Original	Remarks
((4) and (5) are omitted.) Table D2.54 Failure Mode Effect Analysis Table for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Table is omitted.)	((4) and (5) are omitted.)	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
2.6 Tests 2.6.1 Shop Tests* 1 For components or accessories specified in Table D2.5, 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 D2.5. 2 For reciprocating internal combustion engines, the purpose of the shop trials 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: <u>(1) For tests of reciprocating internal combustion engines, the documents specified below are to be submitted to the Surveyor before, during and after the tests. Where deemed appropriate by the Society after consideration has been given to the engine type and production, a part of or all of the documentations may be omitted.</u> <u>(a) Before test</u> i) <u>Valid certificate of type approval or design evaluation covering the tested engine.</u> ii) <u>Evidence of the Society's approval of the drawings and data.</u> <u>(b) During test</u> i) <u>Calibration records for the test bed instrumentation used to collect data.</u> ii) <u>Certificate or reports of components.</u>	2.6 Tests 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 For reciprocating internal combustion engines, the purpose of the shop trials 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: (Newly added)	(1): 5.2 of UR M51 Item (ii) refers to the approval of drawings and data for individual engines.

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Amended	Original	Remarks
<u>iii) Necessary internal test results, when requested by the Surveyor.</u> <u>(c) After test</u> The manufacturer is to submit a formal report to the Society, which includes, <u>i) Valid certificate of type approval or design evaluation covering the tested engine.</u> <u>ii) Calibration records for the instrumentation used to collect data</u> <u>iii) Documentation and test results with the signature of attending Surveyor</u> <u>iv) Surveyor's comments during shop trials, and the manufacturer's replies/explanations.</u> <u>(2) The following preparations are to be made before carrying out the engine tests:</u> <u>(a) All relevant equipment for the safety of attending personnel such as <u>safety barrier, safety railings, information and marking of escape routes, sirens, crankcase explosive conditions protection (e.g. oil mist detection arrangements), overspeed protective devices and any other shut down functions are to be made available and are to be operational, and its correct functioning is to be verified.</u> The overspeed protective device is to be set to a value which is not higher than the allowable overspeed value.</u> <u>(Deleted)</u> <u>(b) Jacketing of high-pressure fuel oil lines and screening of pipe connections in piping containing flammable liquids required in (9)(a) and (b) are to be verified.</u>	<u>(1) The following preparations are to be made before carrying out the engine tests:</u> <u>(a) All relevant equipment for the safety of attending personnel such as oil mist detection arrangements, overspeed protective devices and any other shut down functions are to be made available and are to be operational.</u> <u>(b) The overspeed protective device is to be set to a value which is not higher than the allowable overspeed value. This set point is to be verified by the surveyor.</u> <u>(c) The engines are to be run as prescribed by the engine manufacturer.</u> <u>(Newly added)</u>	(a): 5.1.1, 5.1.2 and 5.1.3 of UR M51 (b): 5.1.4 of UR M51

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Amended	Original	Remarks
(c) All fluids used for testing purposes (fuel oils, lubrication oils, cooling water, etc., including all fluids used temporarily or repeatedly for testing purposes only) are to be suitable for their intended purposes (i.e. they are to be clean, preheated if necessary and cause no harm to engine parts). (3) For all stages of testing, the following (a) to (c) ambient conditions are to be recorded and the pertaining operation values (normally the following (d) to (l) items) for each load point are to be measured and recorded by the engine manufacturer. All results are to be compiled in an acceptance protocol to be issued by the manufacturer. Calibration records for the instrumentation are to be presented to the attending Surveyor. ((a) to (k) are omitted.) <u>(l) All engine parameters required for control and monitoring for the intended use (propulsion, auxiliary or emergency), if applicable to the scope of delivery</u> (4) All measurements conducted at the various load points are to be carried out under steady operating conditions. However, provision is to be made for time needed by the surveyor to carry out visual inspections for all load points. The readings for 100 % power (rated power at rated speed) are to be taken twice at an interval of at least 30 <i>minutes</i>. (5) <u>During all load points, engine parameters are to be</u>	(d) All fluids used for testing purposes (fuel oils, lubrication oils, cooling water, etc., including all fluids used temporarily or repeatedly for testing purposes only) are to be suitable for their intended purposes (i.e., they are to be clean, preheated if necessary and cause no harm to engine parts). (2) For all stages of testing, the following (a) to (c) ambient conditions are to be recorded and the pertaining operation values (normally the following (d) to (k) items) for each load point are to be measured and recorded by the engine manufacturer. All results are to be compiled in an acceptance protocol to be issued by the manufacturer. Calibration records for the instrumentation are to be presented to the attending surveyor. <u>In addition, crankshaft deflection is to be checked and recorded in the results in cases where such a check is required by the manufacturer during the operating life of the engine.</u> ((a) to (k) are omitted.) (Newly added) (3) All measurements conducted at the various load points are to be carried out under steady operating conditions. However, provision is to be made for time needed by the surveyor to carry out visual inspections for all load points. The readings for 100 % power (rated power at rated speed) are to be taken twice at an interval of at least 30 <i>minutes</i>. (Newly added)	Deleted because the requirement relating to crankshaft deflection is not necessary as a rule requirement. (3)(l): 6.2 of UR M51 (5): 6.5 of UR M51

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Amended	Original	Remarks
within the specified and approved values. (6) In cases where a no-load operation is conducted for adjusting engine conditions, the fuel delivery system, manoeuvring system and safety devices are to be properly adjusted by the manufacturer before the operation. (7) <u>Tests of safety precautions are to be carried out in accordance with the manufacturer's specification to the extent applicable for the scope of delivery of the engine, especially for overspeed protective devices and safeguards of the low pressure of lubricating oil systems. If applicable, oil mist detection systems and other safeguards are also to be tested. The shutdown tests of safety devices are to be carried out at running condition. Testing by simulating the concerned parameter or adjusting the set-point may be accepted subject to special consideration by the Society.</u> (8) The programme shown in Table D2.6 is to be used for the shop trials of reciprocating internal combustion engines. In this case, refer to the <i>JIS</i> 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) and (b) are omitted.) (9) 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.	(4) In cases where a no-load operation is conducted for adjusting engine conditions, the fuel delivery system, manoeuvring system and safety devices are to be properly adjusted by the manufacturer before the operation. (Newly added) (5) The programme shown in Table D2.7 is to be used for the shop trials of reciprocating internal combustion engines. In this case, refer to the <i>JIS</i> 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) and (b) are omitted.) (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.	(7): 7.1 of UR M51 (8): Paragraph 1, 7.2 of UR M51

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Amended	Original	Remarks
(a) Jacketing of high-pressure fuel oil lines, including the system used for the detection of leakage (b) Screening of pipe connections in piping containing flammable liquids (c) Temperature of hot surface insulation <u>Proper insulation of hot surfaces is to be verified. Readings of surface temperatures are to be done randomly by using of infrared thermoscanning equipment while the engine is running at rated power. Equivalent measurement equipment may be used when approved by the Society.</u> If the insulation is modified subsequently to the type approval test, the Society may request temperature measurements as required by the type approval test. <u>(10)</u> Category C turbochargers installed on 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) For 4-stroke engines, the operations given in the following i) and ii) are to be performed without any indication of surging.	(a) Jacketing of high-pressure fuel oil lines, including the system used for the detection of leakage (b) Screening of pipe connections in piping containing flammable liquids (c) Temperature of hot surface insulation <u>Random temperature readings are to be compared with corresponding readings obtained during the type approval test. This is to be done while running at the rated power of engine.</u> If the insulation is modified subsequently to the type approval test, the Society may request temperature measurements as required by the type approval test. <u>In the case of 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 approval test, temperature measurements are to be performed by a procedure deemed appropriate by the Society.</u> <u>(7)</u> Category C turbochargers installed on 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) For 4-stroke engines, the operations given in the following i) and ii) are to be performed without any indication of surging.	(c): 7.5.1 of UR M51 This requirement has been deleted.

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Amended	Original	Remarks
i) While at maximum continuous rating (maximum continuous power and speed), speed is to be reduced with the constant torque (fuel index) down to 90 % power. ii) While at 50 % power and speed <u>according to propeller curve depending on application (see Note (9) of Table D2.6)</u>, speed is to be reduced <u>with</u> constant torque (fuel index) down to 45 % power. (b) For 2-stroke engines, the surge margin is to be demonstrated by at least one of the following i) to iii): i) The engine working characteristics established at shop tests of the engine is to be plotted into the compressor chart of the turbocharger (<u>which was established</u>) <u>by the turbocharger manufacturer's testing</u>. There is to be at least a 10 % surge margin in the full load range, i.e. working flow is to be 10 % above the theoretical mass flow at the surge limit where there are no pressure fluctuations. ii) A sudden fuel cut-off to at least one cylinder at the following 1) and 2) loads is not to result in continuous surging and the turbocharger is to be stabilised at the new loads within 20 <i>seconds</i>. For applications with more than one turbocharger, the fuel supply to the cylinders closest upstream to each turbocharger is to be cut off. 1) The maximum power permitted for one cylinder misfiring.	i) While at maximum continuous rating (maximum continuous power and speed), speed is to be reduced with the constant torque (fuel index) down to 90 % power. ii) While at 50 % power and <u>80 % speed</u>, speed is to be reduced <u>to 72 % while keeping</u> constant torque (fuel index). (b) For 2-stroke engines, the surge margin is to be demonstrated by at least one of the following i) to iii): i) The engine working characteristics established at shop tests of the engine is to be plotted into the compressor chart of the turbocharger (<u>established in a test rig</u>). There is to be at least a 10 % surge margin in the full load range, i.e. working flow is to be 10 % above the theoretical mass flow at the surge limit where there are no pressure fluctuations. ii) A sudden fuel cut-off to at least one cylinder at the following 1) and 2) loads is not to result in continuous surging and the turbocharger is to be stabilised at the new loads within 20 <i>seconds</i>. For applications with more than one turbocharger, the fuel supply to the cylinders closest upstream to each turbocharger is to be cut off. 1) The maximum power permitted for one cylinder misfiring.	ii): Paragraph 2, 7.3.2 A) of UR M51 i): Paragraph 2, 7.3.2 B) of UR M51

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Amended	Original	Remarks
2) The <u>maximum</u> engine load corresponding to a charge air pressure of about 0.06 MPa, but without auxiliary blowers running. iii) No continuous surging and the turbocharger is to be stabilised at the new load within 20 <i>seconds</i> when the power is abruptly reduced from 100 % to 50 % of the maximum continuous power. (11) <u>Integration tests for sub-system acceptance</u> are to be made to verify that the response of the complete mechanical, hydraulic and electronic system is as predicted. If the tests are technically unfeasible on the test bed, they may be conducted during the sea trials. The scope of these tests is to be <u>proposed by the designer taking into account of multiple engine operational mode, a risk analysis approved by the Society and the impact of the test on engine, and agreed with the Society, prior to the tests. Typical examples of extended tests include, but are not limited to, the following.</u> The tests may be carried out using other alternative methods, subject to special consideration by the Society. (a) <u>Safety test of sub-systems</u> (b) <u>Functional test of sub-systems</u> (c) <u>Operational mode switch/Changeover test: Switch between multiple operational mode or turn on/off sub-systems</u> (d) <u>Extended performance and load test for engines with multiple operational modes, if applicable</u>	2) The engine load corresponding to a charge air pressure of about 0.06 MPa, but without auxiliary blowers running. iii) No continuous surging and the turbocharger is to be stabilised at the new load within 20 <i>seconds</i> when the power is abruptly reduced from 100 % to 50 % of the maximum continuous power. (8) <u>For electronically controlled engines, integration tests</u> are to be made to verify that the response of the complete mechanical, hydraulic and electronic system is as predicted. The scope of these tests is to be <u>determined based on a risk analysis by a method deemed appropriate</u> by the Society and agreed with the Society, prior to the tests. The tests may be carried out using other alternative methods, subject to special consideration by the Society.	ii)2): Paragraph 4, 7.3.2 B) of UR M51 (11): 7.4 of UR M51
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (D)		

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Amended	Original	Remarks
3 For gas-fuelled engines (specified in 4.2.2, Annex 1.1.3-3, Part GF or 5.2.2, Annex 16.1.1-3, Part N), the following requirements are to be complied with. In addition, the scope of the tests may be expanded depending on the engine application, service experience, or other relevant reasons. (1) The requirements specified in -2(1) to (10) apply subject to following (2) to (8) requirements. (2) For dual fuel engines, the tests specified in Table D2.6 are to be carried out for <u>all operating mode (i.e. the applicable fuel oil mode, gas mode, variable fuel oil/gas ratio mode)</u>. However, for loads considered by the Society not to be designed to operate, the load test may be omitted. For load tests for the gas mode, test loads are to be determined based on the maximum continuous power available in the gas mode (see 2.5.1-1, Annex 1.1.3-3, Part GF or 2.5.1-1, Annex 16.1.1-3, Part N). The 110 % load test is not required for the gas mode provided that changeover to oil fuel mode is automatically performed in case of overload. (3) In addition to the preparations specified in -2(2), 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. (4) <u>The overspeed test specified in -2(7) need only be verified in fuel oil mode.</u> (5) In addition to -2(3) and (4), the following engine data are to be recorded. (a) The item listed in -2(3)(f) is to be measured and recorded for both gas <u>mode</u> and <u>fuel oil mode</u>, as applicable (b) Gas pressure and temperature	3 For gas-fuelled engines (specified in 4.2.2, Annex 1.1.3-3, Part GF or 5.2.2, Annex 16.1.1-3, Part N), the following requirements are to be complied with. In addition, the scope of the tests may be expanded depending on the engine application, service experience, or other relevant reasons. (1) The requirements specified in -2(1) to (7) apply subject to following (2) to (5) requirements. (2) For dual fuel engines, the tests specified in Table D2.7 are to be carried out for <u>both diesel and gas mode</u>. However, for loads considered by the Society not to be designed to operate, the load test may be omitted. For load tests for the gas mode, test loads are to be determined based on the maximum continuous power available in the gas mode (see 2.5.1-1(1), Annex 1.1.3-3, Part GF or 2.5.1-1(1), Annex 16.1.1-3, Part N). The 110 % load test is not required for the gas mode provided that changeover to oil fuel mode is automatically performed in case of overload. (3) In addition to the preparations specified in -2(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. (Newly added) (4) In addition to -2(2) and (3), the following engine data are to be recorded. (a) The item listed in -2(2)(f) is to be measured and recorded for both gas and <u>diesel</u>, as applicable (b) Gas pressure and temperature	(2): 4.2.4 of UR M78 (4): Paragraph 4, 4.2.1 of UR M78

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Amended	Original	Remarks
(c) Pilot fuel temperature and pressure (supply or common rail as appropriate) (6) <u>The hot surface test specified in -2(9)(c) is to be verified in the mode with the highest exhaust gas temperatures.</u> (7) <u>The Category C turbocharger surge margin test specified in -2(10) is also to be verified in gas mode unless documented that a greater surge margin exists for gas mode than fuel oil mode.</u> (8) 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 <u>the required safety concept and risk analysis</u> by a procedure deemed appropriate by the Society 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. (a) Failure of ignition (spark ignition or pilot injection systems) (b) Failure of a cylinder gas supply valve (c) Failure of combustion (to be detected by e.g. misfiring, knocking, exhaust temperature deviation, etc.) (d) Abnormal gas pressure (e) Abnormal gas temperature	(c) Pilot fuel temperature and pressure (supply or common rail as appropriate) (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 by a procedure deemed appropriate by the Society 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. (a) Failure of ignition (spark ignition or pilot injection systems) (b) Failure of a cylinder gas supply valve (c) Failure of combustion (to be detected by e.g. misfiring, knocking, exhaust temperature deviation, etc.) (d) Abnormal gas pressure (e) Abnormal gas temperature	(6): Paragraph 5, 4.2.1 of UR M78 (7): Paragraph 6, 4.2.1 of UR M78 (8): 4.2.5 of UR M78
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (B)		

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Amended	Original	Remarks
(Moved)	<u>4 For rotating assemblies of exhaust driven turbochargers of categories B and C, dynamic balancing tests are to be carried out.</u>	Moved to 2.7.4-4
(Moved)	<u>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. For forged impellers and inducers subject to quality control through an approved non-destructive test method, overspeed tests may be dispensed with.</u> <u>(1) 120 % of the alarm level speed at room temperature;</u> <u>or</u> <u>(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.</u>	Moved to 2.7.4-5
(Moved)	<u>6 For categories B and C turbochargers, tests are to be carried out to verify durability according to procedures deemed appropriate by the Society.</u>	Moved to 2.7.4-6

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Amended		Original			Remarks
Table D2.65 Hydrostatic Test Pressure					Turbocharger-related tests have been moved to 2.7.4-3.
Part		Cylinder bore D (mm)		Test Pressure ⁽²⁾ (MPa)	
		$D \leq 300$	$300 < D$		
(Omitted)					
Turbocharger, cooling space ⁽⁷⁾	Category A			0.4 or 1.5P, whichever is greater	
	Category B	⊖	⊖		
	Category C	⊖	⊖		
Heat exchanger, both sides			○	1.5P	
Exhaust gas valve cage ⁽⁸⁾		○	○	1.5P	
Accumulator ⁽⁹⁾		○	○	1.5P	
Piping, pumps, actuators, etc. for hydraulic drive of valves ⁽¹⁰⁾		○	○	1.5P	
Engine driven pumps (oil, water, fuel, bilge) ⁽¹⁰⁾		○	○	1.5P	
Piping system other than those listed in this Table		○	○	Apply the requirements in 12.6	
Notes: ((1) to (6) are omitted.) (7) In cases where the manufacturer has a quality system deemed appropriate by the Society, hydrostatic tests for category 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 reciprocating internal combustion engines. (9) Only when capacity exceeds 0.5 l. (10) Only when engine power exceeds 800 kW/cyl.					
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)					

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Amended		Original			Remarks	
Table D2.76 Programme for Shop Trials of Engines						
Test items		Use of engines			7.2.1 B) of UR M51	
		Reciprocating internal combustion engines used as main propulsion machinery ⁽¹⁾	Reciprocating internal combustion engines driving generators (including those used as main propulsion machinery of electric propulsion ships) ⁽²⁾	Reciprocating internal combustion engines driving auxiliaries (excluding auxiliary machinery for specific use etc.) ⁽¹⁾		
Load test	110 % power run ⁽³⁾	15 minutes or until after having reached steady conditions have been reached, which is shorter, at 1.032 n₀ – or more (where n₀ is the rated engine speed)^{(4), (5), (6)}	15 minutes after having reached steady conditions at n ₀ ⁽⁷⁾	15 minutes after having reached steady conditions at n ₀		
	100 % power run	60 minutes at n ₀	60 minutes at n ₀	30 minutes at n ₀		
	90 % power run (or normal continuous cruise power) ^{(6), (78)}	20 minutes at engine speed in accordance with the nominal propeller curve ⁽⁹⁾	-	-		
	75 % power ^{(6), (78)}		20 minutes at n ₀	20 minutes in accordance with the nominal power consumption curve ^(8,10)		
	50 % power ^{(6), (78)}					
	25 % power ^{(6), (78)}					
Idle run ⁽⁶⁸⁾		-	An adequate time at n ₀	-		
Reversing manoeuvres ⁽⁹¹¹⁾		○	-	-		
Intermittent overload ⁽⁴⁴¹²⁾		○	-	○		
Governor test		-	○ ⁽¹³⁾	-		
Performance of monitoring, alarm and safety devices		○	○	○		
Open-up inspection ⁽⁴¹¹⁴⁾		○	○	○		
Notes:						
(1) After testing has been completed, the fuel delivery system is to be blocked so as to limit the engines to run at not more than 100 % power, unless (Unless intermittent overload power is approved by the Society. In that case, the fuel delivery system is to be limited to that power). In the case of propulsion engines also driving power take-off generators, the fuel delivery system is to be adjusted so that overload of generator (110 % power) can be given in service and the electrical protection of downstream system components is activated before the engine stalls.						
(1): Note of 7.2.5 of UR M51						

(1): Note of 7.2.5 of UR M51

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Amended	Original	Remarks
(2) After testing has been completed, the fuel delivery system is to be adjusted such that overload (110 % power) can be given in service after installation on board so that the governing characteristics (including the activation of generator protective devices) can be fulfilled at all times. (3) For dual fuel engines, tests in the gas mode are not required in accordance with 2.6.1-3(2). (4) Submission of test reports for identical engines and turbocharger configurations proving their compatibility for over-loaded operation may be accepted as substitutions for the 110 % power run. <u>(5) In the case of propulsion engines driving controllable pitch propeller, tests are to be carried out at n_0 for 15 minutes after having reached a steady operating condition.</u> (5) In the case of propulsion engines also driving power take-off generators, tests are to be carried out at n_0 for 15 minutes after having reached a steady operating condition. (6) The sequence is to be selected by the engine manufacturer. <u>(7) 10% overload power may not require for e.g. variable speed engines driving electrical machines for electric propulsion, when they are connected to a DC grid where the inverter is limiting the requested power.</u> (7) A shorter time may be considered by the Society provided that the time specified in 2.6.1-2(34) is allowed. <u>(9) The engine speed is to be as follows:</u> <u>(a) In accordance with the nominal propeller curve, for an engine driving a fixed pitch propeller, waterjet. Or</u> <u>(b) In accordance with the nominal propeller curve or modified propeller curve for an engine driving controllable pitch propeller with variable speed and pitch. Or</u> <u>(c) At constant speed for an engine driving a controllable pitch propeller with constant speed.</u> (8) Only for variable speed engines. (9) The test item applies only to direct reversible engines. (10) Only for engines for which intermittent overload is approved, and tests are to be for the duration agreed upon with the manufacturer. <u>(13) Only for engines driving constant speed (synchronous) generators.</u> (11) The scope of the open-up inspection is to be as deemed appropriate by the surveyor. The omission of the open-up inspection may be considered by the Society provided that all of the following (a) through (g) are met: (a) It is not the open-up inspection to be carried out during the type approval test specified in Chapter 8, Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use. (b) No abnormality is found in the temperature measurement for each bearing of the main bearings and the crank pin bearings after the load test, and in the visual inspection of the inner surfaces of the cylinder liners from the inspection ports of the crankcase. (In the case of a 2-stroke engine, the cylinder liners, pistons, piston rings and piston rods are to be inspected from the scavenging space.) (c) No abnormality is found in the visual inspection of the lubrication oil after the load test (including the visual inspection of the filter in cases where the open-up of the strainer is reasonable). (d) Flushing of the parts through which the lubrication oil passes is carried out during the manufacturing process. (e) The manufacturer of the reciprocating internal combustion engine is approved by the Society in accordance with the Rules for Approval of Manufacturers and Service Suppliers.		(5): 7.2.1 B) of UR M51 (7): Note 2, 7.2.2 of UR M51 (9): 7.2.1 D) of UR M51 (13): 7.2.2 C) of UR M51

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Amended	Original	Remarks
(f) There is agreement between the involved parties. (manufacturer, shipyard, prospective owner, etc.) (g) Other items deemed necessary by the Society.		
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Amended	Original	Remarks
<u>2.7 Exhaust Driven Turbochargers</u> <u>2.7.1 General</u> <u>1 The requirements of exhaust driven turbochargers specified in 2.7 also apply, in principle, to engine driven chargers.</u> <u>2.7.2 Terminology</u> <u>In 2.7, exhaust driven turbochargers are categorised into the following three groups according to the engine power at maximum continuous rating (MCR) supplied by a group of cylinders served by the actual turbocharger (e.g. turbocharger size is to be 50 % of total engine power for a V-engine with one turbocharger serving each bank of cylinders).</u> <u>(1) Category A turbochargers</u> <u>The engine power at MCR supplied by a group of cylinders served by the turbocharger is not more than 1000 kW.</u> <u>(2) Category B turbochargers</u> <u>The engine power at MCR supplied by a group of cylinders served by the turbocharger is not less than 1000 kW, but not more than 2500 kW.</u> <u>(3) Category C turbochargers</u> <u>The engine power at MCR supplied by a group of cylinders served by the turbocharger is not less than 2500 kW.</u> <u>2.7.3 Requirements for Design, Safety and Alarm Arrangements, etc.</u> <u>1 Manufacturers are to adhere to a quality system</u>	(Newly added) (Newly added) (Moved) (Newly added) (Moved) (Newly added) (Moved)	The requirements for engines and turbochargers, which were previously combined, have been separated and specified individually Moved from 2.1.1-4 Moved from 2.1.2-1 Moved from 2.5.1-1

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Amended	Original	Remarks
<u>designed to ensure that designer specifications are met, and that manufacturing is in accordance with the approved drawings.</u>		
<u>2 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.</u>	(Moved)	Moved from 2.5.1-4
<u>3 The air inlets of exhaust driven turbochargers are to be fitted with filters.</u>	(Moved)	Moved from 2.5.1-5
<u>4 Exhaust driven turbochargers 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.</u>	(Moved)	Moved from 2.5.1-6
<u>5 In the case of Category C turbochargers 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.</u>	(Moved)	Moved from 2.5.1-7
<u>6 For Category B and C turbochargers, the indications and alarms listed in the Table D2.4 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.</u>	(Moved)	Moved from 2.5.1-8
<u>7 Certificates for Category B and C turbochargers issued by the Society will, at a minimum, cite the applicable type</u>	(Moved)	Moved from 2.5.1-10

Amended-Original Requirements Comparison Table

Amended	Original	Remarks
<u>approval.</u> 8 Certification and test requirements specified in 2.7 apply to the replacement of rotating parts and casings.	(Moved)	Moved from 2.5.1-11
Table D2.47 Alarms and Indications of Turbochargers (Table is omitted.)		Moved from Table D2.4
2.7.4 Tests* 1 The materials used for turbine discs, blades, blower impellers and rotor shafts of Category <i>B</i> and <i>C</i> turbochargers are to be manufactured in accordance with 1.2.1-1, Part K and are to be subjected to the following tests. Those tests are to be conducted in the presence of the Surveyor. (1) Chemical composition analysis (2) Mechanical property tests (3) Ultrasonic tests and Magnetic particle tests or liquid penetrant tests (4) Dimension inspections 2 Materials used for casings of Category <i>B</i> and <i>C</i> turbochargers are to comply with the requirements in Part K. However, chemical composition analysis may be omitted. 3 For the cooling space of Category <i>B</i> and <i>C</i> turbochargers, hydrostatic tests are to be carried out at a pressure of 0.4 MPa or 1.5 times the maximum working pressure, whichever is greater. 4 For rotating assemblies of exhaust driven turbochargers of Categories <i>B</i> and <i>C</i>, dynamic balancing tests are to be carried out. 5 For the impellers and inducers of exhaust driven turbochargers of Categories <i>B</i> and <i>C</i>, overspeed tests for a duration of 3 minutes at either of the following (1) or (2) are to be carried out. For forged impellers and inducers subject to	(Newly added) (Moved) (Moved) (Moved) (Moved) (Moved)	Moved from No.23 of Table D2.2 Moved from No.24 of Table D2.2 Moved from Table D2.6 Moved from 2.6.1-4 Moved from 2.6.1-5

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Amended	Original	Remarks
<u>quality control through an approved non-destructive test method, overspeed tests may be dispensed with.</u> <u>(1) 120 % of the alarm level speed at room temperature;</u> <u>or</u> <u>(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.</u> <u>6 For Category B and C turbochargers, tests are to be carried out to verify durability according to procedures deemed appropriate by the Society.</u>	(Moved)	Moved from 2.6.1-6
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Amended	Original	Remarks
Chapter 8 TORSIONAL VIBRATION OF SHAFTINGS 8.1 General 8.1.2 Data to be Submitted 1 Torsional vibration calculation sheets covering the following items are to be submitted for approval: (1) Natural frequency calculation tables for one node and two nodes vibration, and also for more nodes vibrations if necessary (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 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 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 giving rise to the	Chapter 8 TORSIONAL VIBRATION OF SHAFTINGS 8.1 General 8.1.2 Data to be Submitted 1 Torsional vibration calculation sheets covering the following items are to be submitted for approval: (1) Natural frequency calculation tables for one node and two nodes vibration, and also for more nodes vibrations if necessary (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 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 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 giving rise to the	

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Amended	Original	Remarks
highest torsional vibration stress. (5) <u>Calculation results of the torsional vibration stress in the fuel and operating mode resulting in the worst-case scenario during acceleration in the ship's actual operation (only where 8.4.2-1 is applicable).</u> <u>8.4 Measurements</u> <u>8.4.1 General</u> For the shafting systems where the submission of torsional vibration calculation sheets is required, measurements to confirm the correctness of the estimated value are to be carried out. However, where the submission of calculation sheets is omitted according to the requirement in 8.1.2-2; and, the Society considers that there is no critical vibration within the service speed range, the measurement of torsional vibration may be omitted. <u>8.4.2 Time for Passing Through Barred Speed Range*</u> <u>1 Where a barred speed range is required in accordance with 8.3.1, the passage through this barred speed range is to be demonstrated. The time taken to transit the barred speed range is to be recorded and when accelerating ahead is not to exceed the time determined from the following formula:</u> $T_{bsr} = 5 \cdot (\tau_{max}/\tau_2)^{-7.2}$ where: T_{bsr}: Maximum allowable time to transit the barred speed range (s) τ_{max}: Maximum stress amplitude of the steady state torsional vibration at the critical speed as per	highest torsional vibration stress. (Newly added) <u>8.1.3 Measurements</u> (Newly added) <u>1</u> For the shafting systems where the submission of torsional vibration calculation sheets is required, measurements to confirm the correctness of the estimated value are to be carried out. However, where the submission of calculation sheets is omitted according to the requirement in 8.1.2-2; and, the Society considers that there is no critical vibration within the service speed range, the measurement of torsional vibration may be omitted. (Newly added) (Newly added)	(5): Added to enable comparison with the conditions under which the barred speed range transit time is measured. 5.4.1 of UR M88

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Amended	Original	Remarks
calculation (N/mm^2) τ_2: <u>Permissible stress amplitude due to steady state torsional vibration at the critical speed as determined from 8.2.2 (N/mm^2)</u> <u>The required value for T_{bsr} is to be included within the torsional vibration calculation submission.</u> 2 <u>The designer is to ensure that sufficient torque and/or power reserve exists within the main propulsion system such that the barred speed range transit time required in -1 is not exceeded.</u> 3 <u>As an alternative to the requirements of -1 and -2 above, either of the following documents may be submitted to the Society:</u> (1) <u>When carried out in accordance with 8.2.6, alternative formulae for T_{bsr} may be presented. The submission is to demonstrate that the fatigue life is conservative with respect to the shafting material.</u> (2) <u>Documented evidence of satisfying the barred speed range transit time requirement on similar propulsion systems in terms of power, rpm and mass-elastic properties for vessels of similar type, displacement and hull form.</u> 8.4.3 Shipboard Trials 1 <u>For cases where calculations carried out in accordance with 8.3.1 indicate the necessity for a barred speed range, measurements are to be taken and recorded to confirm that the torsional vibration response characteristics satisfy the requirements of the submitted torsional vibration calculations and barred speed range transit time calculation.</u> 2 <u>Measurements are to be taken at vessel draughts which are, as far as practicable, the maximum achievable during</u>	(Newly added) (Newly added) (Newly added) (Newly added) (Newly added)	5.4.2 of UR M88

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Amended	Original	Remarks
shipboard trials. The trial draughts are to be included in the measurement report. 3 Verification of the torsional response characteristics is to be demonstrated by, at least, measurement of the following: (1) The mean torsional stress throughout the operating range of main engine revolutions (limited when strain gauges are used); and (2) The stress amplitude of the steady state torsional vibration throughout the operating range of main engine revolutions under normal firing conditions. 4 The measurement procedures adopted to verify the torsional vibration response characteristics are to identify the maximum stress amplitude of the steady state torsional vibration at any resonant condition which exists within the operating range of main engine revolutions. For resonances at which the stress amplitude of the steady state torsional vibration exceeds that permissible for continuous operation (τ_1), as defined in 8.2, the critical speeds are to be identified. Identification of any critical speed will, as defined in 8.3.1, determines the lower and upper boundaries of its associated barred speed range. 5 Verification of the barred speed range transit time is to begin at telegraph setting closest to the position below the lower border of the barred speed range. Allow the vessel to accelerate to a steady ship speed and then pass through the barred speed range as recommended for this operation. The time taken to pass through the barred speed range from lower to upper rpm limits is to be within the calculated maximum T_{bsr}. 6 The following are also to be satisfied for barred speed range transit:	(Newly added) (Newly added) (Newly added) 2 In cases where the barred speed ranges specified in 8.3.1 are marked for reciprocating internal combustion engines used as main propulsion machinery, the following (1)	

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Amended	Original	Remarks
(Deleted) (1) <u>Measurement and reporting of stable running of the main engine at the lower and upper boundaries of the barred speed range is to be carried out. Stable running is defined by an oscillation of the fuel index/metering which is less than 5% of the effective stroke or metered fuel quantity (from idle to maximum continuous power). Alternatively, in the case of engines which do not have means to confirm fuel index/metering, an oscillation range of speed less than 5% of maximum continuous revolution may be confirmed and recorded.</u> (2) <u>The vessel speed, in knots, and main engine operating speed (rpm) are to be stable prior to commencement of the transit across the barred speed range. The main engine revolutions per minute are to be in accordance with the designed engine telegraph settings.</u> (3) <u>For propulsion systems employing controllable pitch propellers, the pitch is to be recorded and included in the measurement report.</u> (4) <u>For main engines employing devices or control systems to improve the torque and/or power reserve to assist acceleration through the barred speed range, details of equipment and settings are to be included in the measurement report.</u> <u>7 Measurement accuracy tolerances are, in general, recommended to be within the following:</u>	<u>and (2) are to be confirmed and recorded.</u> (1) <u>Passing time as well as the ship draft and speed of passing through the barred speed range (accelerating and decelerating). In the case of a controllable pitch propeller, the pitch is also to be confirmed and recorded.</u> (2) <u>Running condition of engines at both the upper and lower borders of the barred speed range. In this case, the oscillation range of fuel index (fuel injection quantity (fuel rack position)) is normally to be less than 5% of the effective stroke (maximum fuel injection quantity (possible fuel rack range)). Alternatively, in the case of engines which do not have means to confirm fuel index, an oscillation range of speed less than 5% of maximum continuous revolution may be confirmed and recorded.</u> (Newly added) (Newly added) (Newly added) (Newly added)	

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Amended	Original	Remarks
(1) <u>Mean torsional stress (applicable when strain gauges are used): $\pm 5\%$</u> (2) <u>Vibratory torsional stress amplitude: $\pm 5\%$</u> (3) <u>Transit time: $\pm 3\%$</u> (4) <u>Main engine revolutions per minute, including that of tachometers located at main control positions: $\pm 1\%$</u> 8 <u>For installations where the calculated maximum vibratory stress amplitude is greater than 85% of the permissible vibratory stress ($\tau_{max} > 0.85 \tau_2$), the measurement of torsional stress is to be carried out using a strain gauge-based technique. The accuracy of the strain gauge measurement is expected to be within $\pm 3\%$.</u> 9 <u>A measurement programme is to be provided by the shipyard or engine manufacturer and accepted by the Society. On completion of the shipboard trials, a report detailing the trials measurements and results is to be presented to the Society for acceptance. The report is to be received prior to vessel delivery and no later than three months after completion of the trials.</u> 10 <u>The measurement results obtained on the first ship in a series may be applied to the remaining ships in that series, provided that the main propulsion plant (including the main propulsion engine, shafting, clutches/couplings as applicable and propeller) are identical.</u> 11 <u>In cases where the measured barred speed range transit time exceeds the required allowable value (T_{bsr}), consideration may be given to the maximum stress amplitude (τ_{max}) measured by a strain gauge based technique. The shipyard is to submit a detailed report of the impact this will have on the accumulation of fatigue cycles. In such cases, the measurement result will prevail (only if determined as applicable by the manufacturer).</u>	(Newly added) (Newly added) (Newly added) (Newly added)	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
<u>12 The fuel and operating mode used in the measurement is to be selected based on the worst-case scenario and considering the fuel used during acceleration in the ship's actual operation.</u>	(Newly added)	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (B)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
Chapter 13 PIPING SYSTEMS 13.13 Pneumatic Piping Systems* 13.13.3 Number and Total Capacity of Air Compressors 3 The total capacity of air compressors is to be sufficient to supply air into the air reservoirs from atmospheric pressure to the pressure required for the consecutive starts prescribed in 2.5.2-2 or 4.4.3-2, corresponding to the type of prime mover, within one <i>hour</i>. The capacity is to be approximately equally divided between the number of starting air compressors (excluding emergency compressors installed to satisfy 1.3.1-5) fitted for main propulsion machinery. 13.13.6 Pneumatic Piping Systems for Essential Services The following (1) and (2) requirements are to be applied to the supply of compressed air required by essential services on board ships other than the supply of compressed air for engine starting. ((1) is omitted.) (2) Where compressed air is supplied from the engine starting air system, either continuously in normal operation, or periodically during maintenance or in the event of a failure of the compressed air system, the required compressed air demand is not to reduce the capacity and availability of the engine starting air required by 2.5.2-2 and 4.4.3-2.	Chapter 13 PIPING SYSTEMS 13.13 Pneumatic Piping Systems* 13.13.3 Number and Total Capacity of Air Compressors 3 The total capacity of air compressors is to be sufficient to supply air into the air reservoirs from atmospheric pressure to the pressure required for the consecutive starts prescribed in 2.5.3-2 or 4.4.3-2, corresponding to the type of prime mover, within one <i>hour</i>. The capacity is to be approximately equally divided between the number of starting air compressors (excluding emergency compressors installed to satisfy 1.3.1-5) fitted for main propulsion machinery. 13.13.6 Pneumatic Piping Systems for Essential Services The following (1) and (2) requirements are to be applied to the supply of compressed air required by essential services on board ships other than the supply of compressed air for engine starting. ((1) is omitted.) (2) Where compressed air is supplied from the engine starting air system, either continuously in normal operation, or periodically during maintenance or in the event of a failure of the compressed air system, the required compressed air demand is not to reduce the capacity and availability of the engine starting air required by 2.5.3-2 and 4.4.3-2.	

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Amended	Original	Remarks
Chapter 18 AUTOMATIC AND REMOTE CONTROL 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* 4 Remote starting of main propulsion machinery in 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) The number of times of starting main propulsion machinery is to satisfy the number specified in 2.5.2. ((2) to (4) are omitted.) 18.5 Automatic and Remote Control of Electric Generating Sets 18.5.1 General* 3 In cases where 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 2.5.2.	Chapter 18 AUTOMATIC AND REMOTE CONTROL 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* 4 Remote starting of main propulsion machinery in 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) The number of times of starting main propulsion machinery is to satisfy the number specified in 2.5.3. ((2) to (4) are omitted.) 18.5 Automatic and Remote Control of Electric Generating Sets 18.5.1 General* 3 In cases where 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.	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
Annex 2.3.1 CALCULATION METHOD OF CRANKSHAFT STRESS 1.3 Calculation of Stresses 1.3.2 Alternating Torsional Stresses 1 Nominal Alternating Torsional Stresses Calculations for nominal alternating torsional stresses are to be carried out in accordance with the following in order to specify maximum nominal alternating torsional stresses. In addition, maximum nominal alternating torsional stress is to be specified <u>for all fuels and operation modes on which an engine (and shafting system) is designed to operate</u>, and the values obtained from such calculations are to be submitted to the Society. ((1) to (3) are omitted.) For crankshaft assessments, the nominal alternating torsional stress considered in -2 below is the highest calculated value, in accordance with the above method, occurring at the most torsionally loaded mass point of the crankshaft system. Where barred speed ranges exist, the torsional stresses within such ranges are not to be considered in assessment calculations. Crankshaft approval is to instead be based on the <u>worst-case scenario, which may include an</u> installation having the largest nominal alternating torsional stress (but not exceeding the maximum figure specified by engine manufacturer). Thus, for each installation, it is to be ensured through suitable calculation that the approved nominal alternating torsional stress is not exceeded. Such calculations are to be submitted to the Society for assessment.	Annex 2.3.1 CALCULATION METHOD OF CRANKSHAFT STRESS 1.3 Calculation of Stresses 1.3.2 Alternating Torsional Stresses 1 Nominal Alternating Torsional Stresses Calculations for nominal alternating torsional stresses are to be carried out in accordance with the following in order to specify maximum nominal alternating torsional stresses. In addition, maximum nominal alternating torsional stress is to be specified, and the values obtained from such calculations are to be submitted to the Society. ((1) to (3) are omitted.) For crankshaft assessments, the nominal alternating torsional stress considered in -2 below is the highest calculated value, in accordance with the above method, occurring at the most torsionally loaded mass point of the crankshaft system. Where barred speed ranges exist, the torsional stresses within such ranges are not to be considered in assessment calculations. Crankshaft approval is to instead be based on the installation having the largest nominal alternating torsional stress (but not exceeding the maximum figure specified by engine manufacturer). Thus, for each installation, it is to be ensured through suitable calculation that the approved nominal alternating torsional stress is not exceeded. Such calculations are to be submitted to the Society for assessment.	2.2.1 of UR M53

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Amended	Original	Remarks
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (E)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part GF SHIPS USING LOW-FLASHPOINT FUELS Annex 1.1.3-3 GAS-FUELLED ENGINES Chapter 1 GENERAL 1.1 Scope 1 This annex applies to reciprocating <u>internal combustion engines</u> supplied with <u>gases or low-flashpoint fuels</u> as fuel, and gas fuel supply systems in accordance with the requirements of 1.1.3-3, Part GF of the Rules. <u>The fuels covered by this annex include the following fossil, bio-based or synthetic variants of gas-fuelled engines and gas fuel supply systems using fuels other than those listed in (1) to (4) below are to be specially considered.</u> (1) <u>Natural gas (predominantly methane)</u> (2) <u>Ethane</u> (3) <u>LPG (predominantly mixes of propane and butane)</u> (4) <u>Methyl/ethyl alcohols (methanol/ethanol)</u> (Deleted)	RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part GF SHIPS USING LOW-FLASHPOINT FUELS Annex 1.1.3-3 GAS-FUELLED ENGINES Chapter 1 GENERAL 1.1 Scope 1 This annex applies to <u>trunk piston reciprocating engines</u> supplied with <u>natural gas (including similar fuels with main component methane such as bio-methane or synthetic methane)</u> as fuel, and gas fuel supply systems in accordance with the requirements of 1.1.3-3, Part GF of the Rules. 2 <u>It is to be ensured by the gas supply system that the gas supplied to the engine is always in gaseous state. This Annex does not cover requirements for liquid or cryogenic gas.</u>	UR M78, 1.1.1

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
<u>2</u> Gases or low-flashpoint fuels are not permitted for engines used as the emergency source of power. Emergency generator engines used as a source of electrical power in port, may operate on all fuels for which they are designed when providing electrical power in port but are not permitted to operate on gases or low-flashpoint fuels when providing the emergency source of power. <u>3</u> Gas-fuelled engines and gas fuel supply systems are to be in accordance with requirements related to reciprocating internal combustion engines and gas supply systems specified in Part D and Part GF of the Rules, in addition to the requirements of this annex <u>and 10.3, Part GF of the Rules</u>. <u>4</u> The following requirements specified in Part GF of the Rules as well as other requirements specified separately by the Society apply to gas-fuelled engines regardless of ship type, ship size and ship service area. However, 1.1.1-2, Part GF of the Rules does not apply except where explicitly specified otherwise. (1) <u>2.1-4(3)</u> (2) <u>2.2.3-1</u> (Deleted) (3) <u>2.4.2-5(1)</u> (4) <u>2.4.2-5(4)</u> (5) <u>2.4.2-5(5)(a) to (d)</u> (6) <u>2.4.2-5(6)(a)</u> (7) <u>3.1-6</u> <u>5</u> Where methyl/ethyl alcohol or LPG is used as fuel, <u>MSC.1/Circ.1621 “Interim Guidelines for the Safety of Ships using Methyl/Ethyl Alcohol as Fuel” or MSC.1/Circ.1666 “Interim Guidelines for the Safety of Ships using LPG Fuels” are to apply, respectively.</u>	<u>3</u> Dual fuel engines and gas fuel only engines may not be permitted for emergency applications. <u>4</u> Gas-fuelled engines and gas fuel supply systems are to be in accordance with requirements related to reciprocating internal combustion engines and gas supply systems specified in Part D and Part GF of the Rules, in addition to the requirements of this annex. <u>5</u> The following requirements specified in Part GF of the Rules as well as other requirements specified separately by the Society apply to gas-fuelled engines regardless of ship type, ship size and ship service area. However, 1.1.1-2, Part GF of the Rules does not apply except where explicitly specified otherwise. (1) <u>2.1-4(3)</u> (2) <u>2.2.3-1</u> (3) <u>2.2.4</u> (4) <u>2.4.2-5(1)</u> (5) <u>2.4.2-5(5)</u> (6) <u>2.4.2-5(6)(a) to (c)</u> (7) <u>2.4.2-5(7)(a)</u> (8) <u>3.1-6</u> (Newly added)	UR M78, 1.1.2 para.8 UR M78, 1.1.2, para.5 and para.6 (Differences from the Annex to Part N)

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
1.3 Plans and Documents 1 The plans and documents to be submitted are as follows. (1) Plans and documents for approval (a) Drawings and data specified in 2.1.4-1(1), Part D of the Rules. <u>In addition, the list of drawings and documents to be submitted as well as the engine particulars are to comply with the following requirements.</u> i) <u>List of drawings and documents</u> <u>The list is to include, as applicable to the engine concerned, the following drawings and documents.</u> 1) <u>Schematic layout or other equivalent documents of gas system on the engine</u> 2) <u>Gas piping system, assembly and details</u> 3) <u>Parts for gas admission system</u> 4) <u>Arrangement of explosion relief valves for crankcase (if required by 2.4.3, Part D of the Rules), charge air manifold and exhaust gas manifold and exhaust gas system on the engine, as applicable</u> 5) <u>List of certified safe equipment and relevant certification</u> 6) <u>Safety Concept</u> 7) <u>Schematic layout or other equivalent documents of pilot fuel system (only for dual fuel engines)</u> 8) <u>Shielding of high pressure fuel pipes for pilot fuel system, assembly (only for dual fuel engines)</u>	1.3 <u>Submission of Plans and Documents</u> The plans and documents to be submitted are as follows. (1) Plans and documents for approval (a) Drawings and data specified in 2.1.3-1(1), Part D of the Rules	Review the required Plans for submission related to individual engines. (a) Clarify the drawings and documents to be additionally included in the “List of Drawings and Documents” for gas-fuelled engines.

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Amended	Original	Remarks
9) <u>High pressure components of pilot fuel injection devices (only for dual fuel engines)</u> 10) <u>Schematic layout or other equivalent documents of the ignition system (only for gas only engines)</u> ii) <u>Engine particulars</u> <u>Where applicable, the type of pressure relief device specified in 2.4.1-5 is also to be included.</u> (Deleted) (b) Gas piping system, assembly and details	(b) <u>Drawings and data specified in 18.1.3(1)(a), (b) and (e), Part D of the Rules</u> (c) <u>Gas admission valves and associated actuating systems</u> (d) <u>Gas fuel injection pipes and associated protective shielding</u> (e) <u>Arrangements of gas detectors</u> (f) <u>Combustion monitoring devices</u> (g) <u>Governors</u> (h) <u>Engine control system diagrams (including monitor, safety and alarm systems) for gas fuel combustion operations</u> (i) <u>Gas leak protection systems at connections between engines and gas fuel supply piping systems</u> (j) <u>Gas fuel supply piping systems (including details of valves and pipe fittings) and protective devices for gas leaks from such systems</u> (k) <u>Pilot oil fuel injection devices or ignition systems</u> (l) <u>Schematic layout or other equivalent documents of gas system on the engine</u> (m) <u>Gas piping system (including double-walled</u>	

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Amended	Original	Remarks
(including double-walled arrangement where applicable) The documentation is to contain specifications of design pressures, design temperature, pipe dimensions and materials. (Deleted)	arrangement where applicable) The documentation to contain specification of design pressures, working pressure, pipe dimensions and materials. <u>(n) Parts for gas admission system</u> <u>The documentation to contain specifications of design pressures, working pressures, pipe dimensions and materials.</u> <u>(o) Arrangement of explosion relief valves for crankcase (if required by 2.4.3, Part D of the Rules), charge air manifold and exhaust gas manifold and exhaust gas system on the engine, as applicable</u> <u>(p) List of certified safe equipment and relevant certification</u> <u>(q) Schematic layout or other equivalent documents of pilot fuel system (only for dual fuel engines)</u> <u>(r) Shielding of high pressure fuel pipes for pilot fuel system, assembly (only for dual fuel engines)</u> <u>(s) Schematic layout or other equivalent documents of the ignition system (only for gas only engines)</u> <u>(t) Other drawings and data deemed necessary by the Society according to the type of gas-fuelled engine</u>	
(2) Plans and documents for reference (a) Drawings and data specified in 2.1.4-1(2), Part D of the Rules (b) Other drawings and data deemed necessary by the Society (Deleted)	(2) Plans and documents for reference (a) Drawings and data specified in 2.1.3-1(2), Part D of the Rules (b) Other drawings and data deemed necessary by the Society (3) <u>Drawings and data for the purpose of inspecting and testing engines</u>	

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Amended	Original	Remarks
<u>2 The requirements of 2.1.4-3, Part D of the Rules are also to be complied with.</u> 1.4 Terms <u>3 Dual fuel engine means an engine that can burn gases or low-flashpoint fuels (gas mode) and also always has the capability of running on fuel oil only (fuel oil mode).</u> <u>4 Explosion relief device means a device to protect personnel and components against a determined overpressure in the event of an explosion. The device may be a valve, a rupture disc or other, as applicable.</u> <u>5 Fuel oil means residual or distillate liquid marine fuels with a closed-cup flash point as required by 4.2.1(1) and 4.2.1(2), Part R of the Rules and typically to the ISO 8217:2024 standard “Products from petroleum, synthetic and renewable sources – Fuels (class F) – Specifications of marine fuels”.</u> <u>6 Gas means gases or low-flashpoint fuels, whether in a liquid, liquefied or gaseous state, and includes natural gas (methane), ethane, LPG and methyl/ethyl alcohols. Bio or synthetic variants of these fuels are also included.</u> <u>7 Low-flashpoint fuel means gaseous or liquid fuel having a flashpoint lower than otherwise permitted under 4.2.1(1), Part R of the Rules.</u> <u>8</u> (Omitted) <u>9</u> (Omitted)	<u>Items specified in 2.1.3-1, Part D of the Rules, which are intended for inspection and testing (indicated by “○” in Table D2.1(1) and Table D2.1(2), Part D of the Rules).</u> (Newly added) 1.4 Terms <u>3 Dual fuel engine means an engine that can burn natural gas as fuel simultaneously with liquid fuel, either as pilot oil or bigger amount of liquid fuel (gas mode), and also has the capability of running on liquid diesel fuel oil only (diesel mode).</u> <u>4 Explosion relief device means a device to protect personnel and component against a determined overpressure in the event of a gas explosion. The device may be a valve, a rupture disc or other, as applicable.</u> (Newly added) <u>5 Gas means natural gas used as fuel consisting primarily of methane. Gas may also be bio-methane or synthetic methane, etc. with methane as main component.</u> (Newly added) <u>6</u> (Omitted) <u>7</u> (Omitted)	UR M78, 1.2.3 UR M78, 1.2.4 UR M78, 1.2.5 UR M78, 1.2.6 UR M78, 1.2.15

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Amended	Original	Remarks
10 <i>Gas fuel only engine</i> means an engine capable of operating on gas fuel only and not able to switch over to <u>fuel oil</u> operation. 11 (Omitted) 12 <i>High pressure gas</i> means gas with a maximum working pressure greater than 1 MPa (gauge). <u>For methyl/ethyl alcohol fuels, the applicability of requirements for high-pressure gas is to be as deemed appropriate by the Society. Refer also to the footnotes to 7.3.6 and 7.3.12.6 of MSC.1/Circ.1621.</u> 13 (Omitted) 14 (Omitted) 15 (Omitted) 16 <i>Pilot fuel</i> means the fuel that is injected into the cylinder to ignite the main gas-air mixture on <u>some</u> dual fuel engines. 17 <i>Pre-mixed engine</i> means an engine where gas is supplied in a mixture with air through a common manifold for all cylinders, e.g. mixed before or after the turbocharger. <u>Inlet manifolds, turbochargers, charge air coolers, etc. may contain gas/air mixtures during normal operation.</u> 18 <i>Safety Concept</i> is a document describing the safety philosophy with regard to gas as fuel.	8 <i>Gas fuel only engine</i> means an engine capable of operating on gas fuel only and not able to switch over to <u>oil fuel</u> operation. 9 (Omitted) 10 <i>High pressure gas</i> means gas with a maximum working pressure greater than 1 MPa (gauge). 11 (Omitted) 12 (Omitted) 13 (Omitted) 14 <i>Pilot fuel</i> means the fuel <u>oil</u> that is injected into the cylinder to ignite the main gas-air mixture on dual fuel engines. 15 <i>Pre-mixed engine</i> means an engine where gas is supplied in a mixture with air through a common manifold for all cylinders, e.g. mixed before or after the turbocharger. 16 <i>Safety Concept</i> is a document describing the safety philosophy with regard to gas as fuel. <u>It describes how risks associated with this type of fuel are controlled under reasonably foreseeable abnormal conditions as well as possible failure scenarios and their control measures. The results of the risk analysis are to be reflected in the safety concept. A detailed evaluation regarding the hazard potential of injury from a possible explosion is to be carried out and reflected in the safety concept of the engine.</u>	UR M78, 1.2.9 UR M78, 1.2.11 UR M78, 1.2.19 UR M78, 1.2.20 UR M78, 1.2.22
Chapter 2 CONSTRUCTION AND	Chapter 2 CONSTRUCTION AND	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
EQUIPMENT OF GAS-FUELLED ENGINES 2.1 General 3 The manufacturer is to declare the allowable gas composition limits for the engine and, <u>as applicable</u>, the minimum and maximum methane number. 4 Components containing or likely to contain gas are to be designed in accordance with the following (1) to (3). (1) Minimise the risk of fire and explosion so as to demonstrate an appropriate level of safety commensurate with that of an oil-fuelled engine (2) Mitigate the consequences of a possible explosion to a level providing a tolerable degree of residual risk, due to the strength of the component(s) or the fitting of suitable explosion relief devices of an approved type The strength of the components <u>and</u> arrangement of <u>the</u> explosion relief devices is to be documented (e.g. as part of <u>the safety concept / risk analysis</u>) or otherwise demonstrated to be sufficient for a worst-case explosion. (3) Refer to 10.2 and 10.3, Part GF of the Rules 5 Discharge from explosion relief devices is to prevent the passage of flame to the machinery space and be arranged such that the discharge does not endanger personnel or damage other engine components or systems. <u>For methanol engines, where discharges may pose a risk due to toxicity, such releases are to be documented by the safety concept and considered by the risk analysis.</u> (Deleted)	EQUIPMENT OF GAS-FUELLED ENGINES 2.1 General 3 The manufacturer is to declare the allowable gas composition limits for the engine and the minimum and <u>(if applicable)</u> maximum methane number. 4 Components containing or likely to contain gas are to be designed in accordance with the following (1) to (3). (1) Minimise the risk of fire and explosion so as to demonstrate an appropriate level of safety commensurate with that of an oil-fuelled engine (2) Mitigate the consequences of a possible explosion to a level providing a tolerable degree of residual risk, due to the strength of the component(s) or the fitting of suitable explosion relief devices of an approved type The strength of the component(s) <u>of</u> arrangement of explosion relief devices is to be documented (e.g. as part of risk analysis) or otherwise demonstrated to be sufficient for a worst-case explosion. (3) Refer to 10.2 and 10.3, Part GF of the Rules 5 Discharge from explosion relief devices is to prevent the passage of flame to the machinery space and be arranged such that the discharge does not endanger personnel or damage other engine components or systems. 6 <u>Explosion relief devices are to be fitted with a flame arrester</u>	UR M78, 2.1.1 UR M78, 2.1.2 UR M78, 2.1.3 This item is covered by the measures described in -5

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Amended	Original	Remarks
2.2 Construction and Strength 2.2.3 Crankcase 1 Crankcase explosion relief valves are to be installed in accordance with 2.4.3, Part D of the Rules. Refer also to 10.3.1-2, Part GF of the Rules. For engines not covered by 2.4.3, Part D of the Rules, the detailed evaluation required by 8.3, Part 6, Guidance for the Approval of Materials and Equipment for Marine Use is to determine if crankcase explosion relief valves are necessary. 2 <u>In addition to 1 above, for methanol engines where discharges may pose a risk due to toxicity, such releases are to be documented by the safety concept and considered by the risk analysis.</u> 3 <u>For maintenance purposes, on engines with a crankcase volume of 0.6 m³ and above, a connection, or other means, are to be provided for crankcase inerting and ventilating and gas concentration measuring.</u> 4 <u>Ventilation of crankcase, if arranged, is to comply with 2.2.2-6(1) to (3), Part D of the Rules. Relevant evidence is to be documented together with details on the crankcase vent piping system in the Safety Concept. The ventilation systems for crankcase, sump and other similar engine spaces are to be independent from the systems on the other engines.</u> (Deleted) (Deleted)	2.2 Construction and Strength 2.2.3 Crankcase 1 Crankcase explosion relief valves are to be installed in accordance with 2.4.3, Part D of the Rules. Refer also to 10.3.1-2, Part GF of the Rules. For engines not covered by 2.4.3, Part D of the Rules, the detailed evaluation required by 8.3, Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use is to determine if crankcase explosion relief valves are necessary. (Newly added) 2 For maintenance purposes, a connection, or other means, are to be provided for crankcase inerting and ventilating and gas concentration measuring. 3 <u>Ventilation of crankcase (either supply or extraction), if arranged, is to comply with 2.2.2-6(1) to (3), Part D of the Rules. Relevant evidence is to be documented in Safety Concept. The ventilation systems for crankcase, sump and other similar engine spaces are to be independent from the systems on the other engines.</u> 2.2.4 Gas Ignition in Cylinder <u>For gas ignition in the cylinder, the requirements of 10.3, Part GF of the Rules are to be applied.</u>	above and is therefore deleted as redundant. UR M78, 2.2.4.1, para.3 UR M78, 2.2.4.2 UR M78, 2.2.4.3 Deleted, as 1.1-3 already specifies that the engine is to comply with 10.3, Part GF, and this requirement is therefore redundant.

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Amended	Original	Remarks
2.3 Safety Systems 2.3.2 Governors 1 Governors for gas-fuelled engines are to be capable of being operated during gas fuel combustion mode. In the case of dual fuel engines, the governors are additionally to be capable of being operated either during gas and oil fuel (or pilot <u>fuel</u>) combustion mode, and/or oil fuel only combustion mode. 3 Gas-fuelled dual fuel engines are to be operated in any one of the modes specified in the following (1) to (3): (1) controllable gas fuel supply and fixed oil fuel (pilot <u>fuel</u>) supply, (2) controllable oil fuel (pilot <u>fuel</u>) supply and fixed gas fuel supply, or (3) controllable gas fuel and oil fuel supplies. 2.4 Accessory Equipment 2.4.1 Charge Air Systems and Exhaust Gas Systems (Deleted) <u>5</u> (Omitted) <u>6</u> (Omitted) <u>7</u> (Omitted)	2.3 Safety Systems 2.3.2 Governors 1 Governors for gas-fuelled engines are to be capable of being operated during gas fuel combustion mode. In the case of dual fuel engines, the governors are additionally to be capable of being operated either during gas and oil fuel (or pilot <u>oil</u>) combustion mode, and/or oil fuel only combustion mode. 3 Gas-fuelled dual fuel engines are to be operated in any one of the modes specified in the following (1) to (3): (1) controllable gas fuel supply and fixed oil fuel (pilot <u>oil</u>) supply, (2) controllable oil fuel (pilot <u>oil</u>) supply and fixed gas fuel supply, or (3) controllable gas fuel and oil fuel supplies. 2.4 Accessory Equipment 2.4.1 Charge Air Systems and Exhaust Gas Systems <u>5</u> <u>Suitable explosion relief system for air inlet manifolds, scavenge spaces and exhaust system is to be provided unless designed to accommodate the worst-case overpressure due to ignited gas leaks or justified by the safety concept of the engine. A detailed evaluation regarding the hazard potential of overpressure in air inlet manifolds, scavenge spaces and exhaust system is to be carried out and reflected in the safety concept of the engine.</u> <u>6</u> (Omitted) <u>7</u> (Omitted) <u>8</u> (Omitted)	With respect to this item, 8.4-2(1), Part 6, Guidance for Approval of Materials and Equipment for Marine Use already specifies that it is to be included in the engine Safety Concept.

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Amended	Original	Remarks
2.4.2 Gas Pipes 5 For piping attached to gas-fuelled engines, the following (1) to (7) also apply. (1) For applications using natural gas or LPG as fuel, the piping is, <u>in principle</u>, to be designed in accordance with the criteria for gas piping (design pressure, wall thickness, materials, piping fabrication and joining details, etc.) <u>as given in Part GF of the Rules and the relevant requirements. For applications using methyl/ethyl alcohol as fuel, the requirements of Chapter 7 of MSC.1/Circ.1621 are to apply in lieu of those of Part GF of the Rules.</u> (Deleted) (2) <u>Design pressure for gas pipes for applications using natural gas or LPG as fuel</u> is to be in accordance with the following rules: (a) Gas pipe (low pressure): 7.3.3-1, Part GF of the Rules (b) Gas pipe (high pressure): 7.3.3-1, Part GF of the Rules (c) Outer pipe (low pressure): 9.8.1 and 9.8.2, Part GF of the Rules (d) Outer pipe (high pressure): 9.8.1 and 9.8.2, Part GF of the Rules (e) Open ended pipes: 7.3.3-2, Part GF of the Rules (3) (Omitted)	2.4.2 Gas Pipes 5 For piping attached to gas-fuelled engines, the following (1) to (8) also apply. (1) The piping is to be designed in accordance with the criteria for gas piping (design pressure, wall thickness, materials, piping fabrication and joining details, etc.) <u>as given in Chapter 7, Part GF of the Rules.</u> (2) <u>Other connections as mentioned in 7.3.6-4(4), Part GF of the Rules may be accepted subject to type approval in accordance with the requirements of Chapter 9, Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use.</u> (3) <u>Design pressure for gas pipes</u> is to be in accordance with the following rules: (a) Gas pipe (low pressure): 7.3.3-1, Part GF of the Rules (b) Gas pipe (high pressure): 7.3.3-1, Part GF of the Rules (c) Outer pipe (low pressure): 9.8.1, Part GF of the Rules (d) Outer pipe (high pressure): 9.8.2, Part GF of the Rules (e) Open ended pipes: 7.3.3-2, Part GF of the Rules (4) (Omitted)	(1): UR M78, 2.2.1.1 (Differences from Part N) (2): UR M78, Table 1

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(4) Arrangement of the gas piping system on the engine Pipes and equipment containing gas are defined as hazardous area zone 0 (refer to 12.5.1, Part GF of the Rules). The space between the gas fuel piping and the wall of the outer pipe or duct is defined as hazardous area zone 1 (refer to 12.5.2(6), Part GF of the Rules). (5) Normal “double wall” arrangement (a) The gas piping system on the gas-fuelled engine is to be arranged according to the principles and requirements of 9.6, Part GF of the Rules. (b) The design criteria for the double pipe or duct are given in the 9.8 and 7.4.1-4, Part GF of the Rules. (c) In <u>the</u> case of a ventilated double wall, the ventilation inlet is to be located in accordance with the provisions of 13.8.3, Part GF of the Rules. (Deleted) (6) Alternative arrangement (a) Single walled gas piping is only acceptable: i) for engines supplied with low pressure gas and installed in <i>ESD</i> protected machinery spaces, as defined in 5.4.1(2), Part GF of the Rules and in compliance with other relevant parts of Part GF of the Rules (e.g. 5.6, Part GF of the Rules); ii) when complying with requirements specified separately by the Society.	(5) Arrangement of the gas piping system on the engine Pipes and equipment containing <u>fuel</u> gas are defined as hazardous area zone 0 (refer to 12.5.1, Part GF of the Rules). The space between the gas fuel piping and the wall of the outer pipe or duct is defined as hazardous area zone 1 (refer to 12.5.2(6), Part GF of the Rules). (6) Normal “double wall” arrangement (a) The gas piping system on the gas-fuelled engine is to be arranged according to the principles and requirements of 9.6, Part GF of the Rules. (b) The design criteria for the double pipe or duct are given in the 9.8 and 7.4.1-4, Part GF of the Rules. (c) In case of a ventilated double wall, the ventilation inlet is to be located in accordance with the provisions of 13.8.3, Part GF of the Rules. (d) <u>The pipe or duct is to be pressure tested in accordance with 12.6.1-2 to -4, Part D of the Rules to ensure gas tight integrity and to show that it can withstand the expected maximum pressure at gas pipe rupture.</u> (7) Alternative arrangement (a) Single walled gas piping is only acceptable: i) for engines supplied with low pressure gas and installed in <i>ESD</i> protected machinery spaces, as defined in 5.4.1(2), Part GF of the Rules and in compliance with other relevant parts of Part GF of the Rules (e.g. 5.6, Part GF of the Rules); ii) when complying with requirements specified separately by the Society.	Former item (d): Relocated to Chapter 4 as it constitutes a test requirement, with the requirement being revised accordingly (refer to 4.3-4 and 4.3-5). (6): Corresponds to UR M78, 2.2.2.2.2 (Difference from Part N)

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
<u>(b) Notwithstanding (a) above, for methyl/ethyl alcohol fuelled engines MSC.1/Circ.1621 applies and for LPG fuelled engines MSC.1/ Circ.1666 applies. For those cases single wall piping in machinery spaces is not to be applied, unless subject to special consideration by the Society.</u> (Deleted)	(Newly added) <u>(b) In case of gas leakage in an <i>ESD</i>-protected machinery space, which would result in the shutdown of the engine(s) in that space, a sufficient propulsion and manoeuvring capability including essential and safety systems is to be maintained. Therefore the safety concept of the engine is to clearly indicate application of the “double wall” or “alternative” arrangement. The minimum power to be maintained is to be assessed on a case-by-case basis in consideration of the operational characteristics of the ship.</u>	
<u>(7) Gas admission valves</u> Electrically operated gas admission valves are to be certified safe as follows: (a) The inside of the valve contains gas and therefore it is to be certified for zone 0. (b) When the valve is located within a pipe or duct in accordance with <u>(5)</u>, the outside of the valve is to be certified for zone 1. (c) When the valve is arranged without enclosure in accordance with the “<i>ESD</i>-protected machinery space” (see <u>(6)</u>) concept, no certification is required for the outside of the valve, provided that the valve is de-energised upon gas detection in the space. (d) However, if they are not rated for the zone they	<u>(8) Gas admission valves</u> Electrically operated gas admission valves are to be certified safe as follows: (a) The inside of the valve contains gas and therefore it is to be certified for zone 0. (b) When the valve is located within a pipe or duct in accordance with <u>(6)</u>, the outside of the valve is to be certified for zone 1. (c) When the valve is arranged without enclosure in accordance with the “<i>ESD</i>-protected machinery space” (see <u>(7)</u>) concept, no certification is required for the outside of the valve, provided that the valve is de-energised upon gas detection in the space. (d) However, if they are not rated for the zone they	(7): UR M78, 2.2.6

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Amended	Original	Remarks
are intended for, it is to be documented that they are suitable for that zone. Documentation and analysis <u>are</u> to be based on <i>IEC 60079-10-1:2020</i> or <i>IEC 60092-502:1999</i>. Gas admission valves operated by hydraulic oil system are to be provided with sealing arrangement to prevent gas from entering the hydraulic oil system. 2.5 Design Requirements for Each Kind of Engine 2.5.1 Dual Fuel Engine 1 Engine rating (1) The maximum continuous <u>rating</u> (<i>MCR</i>) that a dual fuel engine can develop in gas mode may be lower than the <u>fuel oil mode</u> <i>MCR</i> of the engine depending on the <u>engine combustion concept, design features and gas composition</u>. This maximum continuous <u>rating</u> in gas mode and the corresponding conditions are to be stated by the engine manufacturer. (2) <u>Where variable fuel oil / gas ratio modes of operation are offered by the engine manufacturer, details are to be included in the engine particulars and operation manuals.</u> 2 Starting, changeover and stopping (1) Dual fuel engines are to be arranged to be started using either <u>fuel oil</u> or gas fuel with pilot fuel for ignition. The engines are to be arranged for rapid changeover from gas use to fuel oil use. In the case of changeover to either fuel supply, the engines are to be capable of continuous operation using the alternative fuel supply without interruption to the power supply.	are intended for, it is to be documented that they are suitable for that zone. Documentation and analysis <u>is</u> to be based on <i>IEC 60079-10-1:2015</i> or <i>IEC 60092-502:1999</i>. Gas admission valves operated by hydraulic oil system are to be provided with sealing arrangement to prevent gas from entering the hydraulic oil system. 2.5 Design Requirements for Each Kind of Engines 2.5.1 Dual Fuel Engine 1 General The maximum continuous <u>power</u> that a dual fuel engine can develop in gas mode may be lower than the <u>approved</u> <i>MCR</i> of the engine (<i>i.e. in oil fuel mode</i>), <u>depending in particular on the gas composition and its quality or the engine design</u>. This maximum continuous <u>power available</u> in gas mode and the corresponding conditions are to be stated by the engine manufacturer. (Newly added) 2 Starting, changeover and stopping (1) Dual fuel engines are to be arranged to be started using either <u>oil fuel</u> or gas fuel with pilot <u>oil fuel</u> for ignition. The engines are to be arranged for rapid changeover from gas use to fuel oil use. In the case of changeover to either fuel supply, the engines are to be capable of continuous operation using the alternative fuel supply without interruption to the power supply.	UR M78, 3.1 UR M78, 3.1.1 UR M78, 3.1.2

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Amended	Original	Remarks
(2) (Omitted) (3) Changeover from gas fuel operation mode to <u>fuel oil</u> operation mode is to be possible at all situations and power levels. (4) (Omitted) (5) If the power level or other conditions do not allow safe and reliable gas operation, changeover to <u>fuel oil</u> mode is to be automatically performed. (6) In case of shut-off of the gas supply, the engines are to be capable of continuous operation by <u>fuel</u> oil only. 3 Pilot fuel injection (1) Gas supply to the combustion chamber is not to be possible without operation of the pilot <u>fuel</u> injection. In addition, pilot injection is to be monitored for example by fuel oil pressure and combustion parameters. (2) <u>In case of a failure of the pilot fuel injection function, the engine is to switch to fuel oil mode. However, this does not apply provided that all of the following conditions are satisfied:</u> <u>(a) The failure is limited to one cylinder</u> <u>(b) The gas supply to the affected cylinder is immediately cut off</u> <u>(c) Operation with one cylinder cut out is acceptable with respect to torsional vibrations</u> <u>(d) The safe operation of the engine is substantiated by the safety concept, risk analysis and demonstrated at the type test.</u> 2.5.2 Gas Fuel Only Engine In case of failure of the spark ignition, the engine is to be shut down except when the following (1) to (3) are	(2) (Omitted) (3) Changeover from gas fuel operation mode to <u>oil</u> fuel operation mode is to be possible at all situations and power levels. (4) (Omitted) (5) If the power level or other conditions do not allow safe and reliable gas operation, changeover to <u>oil</u> fuel mode is to be automatically performed. (6) In case of shut-off of the gas supply, the engines are to be capable of continuous operation by <u>oil</u> fuel only. 3 Gas supply to the combustion chamber is not to be possible without operation of the pilot <u>oil</u> injection. In addition, pilot injection is to be monitored for example by fuel oil pressure and combustion parameters. (Newly added) 2.5.2 Gas Fuel Only Engine In case of failure of the spark ignition, the engine is to be shut down except when the following (1) to (3) are	UR M78, 3.1.3

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Amended	Original	Remarks
satisfied: (1) the failure is limited to one cylinder; (2) the gas supply to the failed cylinder is immediately shut off; and (3) safe operation of the engine is substantiated by <u>safety concept / risk analysis and demonstrated at type tests (refer to 8.5.2-2(6)(j), Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use).</u> 2.5.3 Pre-mixed Engine (Deleted) <u>1 Failures of charge air system components likely to result in a gas leakage are to be considered in the safety concept and risk analysis.</u> <u>2 Flame arresters are to be installed before each cylinder head, unless otherwise justified in the safety concept / risk analysis, considering design parameters of the engine such as the gas concentration in the charge air system, the path length of the gas-air mixture in the charge air system, etc.</u>	satisfied: (1) the failure is limited to one cylinder; (2) the gas supply to the failed cylinder is immediately shut off; and (3) safe operation of the engine is substantiated by <u>risk analysis and tests.</u> 2.5.3 Pre-mixed Engine <u>Inlet manifolds, turbochargers, charge air coolers, etc. are to be regarded as parts of the fuel gas supply system.</u> (Newly added) (Newly added)	(3): UR M78, 3.2.1 UR M78, 3.3.1 para.1 UR M78, 3.3.1 para.2

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
Chapter 3 CONTROL, ALARM AND SAFETY SYSTEMS 3.1 General 5 Combustion is to be monitored on an individual cylinder basis. <u>In case of knocking or misfiring, either the unstable combustion is to be corrected automatically by the control system, e.g. transient adjustments, or, if a failure has occurred and can no longer be corrected by the control system, the safety system is to be activated in accordance with Table 3.1.</u> 6 In the event that poor combustion is detected on an individual cylinder, gas operation may be allowed in the conditions specified in 10.3.1-6, Part GF of the Rules. 7 <u>Where validated by the safety concept and risk analysis, the engine monitoring and safety system may be configured so that the gas supply double block-and-bleed valves and the switch to fuel oil (or shut-down for gas fuel only engines) may not be activated in case of specific failures affecting one cylinder, provided that the concerned cylinder can be individually cut off from gas operation and engine operation is acceptable with respect to torsional vibrations. Operation of the functionality is to be demonstrated at type tests (refer to 8.5.2-2(6)(j), Part 6, Guidance for the Approval of Materials and Equipment for Marine Use).</u> 8 Regardless of -5, if monitoring of combustion for each individual cylinder is not practicable due to engine size and design, common combustion monitoring may be accepted. 9 Unless risk analysis by a method deemed appropriate by the Society otherwise proves that risk is within the	Chapter 3 CONTROL, ALARM AND SAFETY SYSTEMS 3.1 General 5 Combustion is to be monitored on an individual cylinder basis. 6 In the event that poor combustion is detected on an individual cylinder, gas operation may be allowed in the conditions specified in 10.3.1-6, Part GF of the Rules. (Newly added) 7 Regardless of -5, if monitoring of combustion for each individual cylinder is not practicable due to engine size and design, common combustion monitoring may be accepted. 8 Unless risk analysis by a method deemed appropriate by the Society otherwise proves that risk is within the	UR M78, 2.2.5 para.3 UR M78, 2.2.5 para.5 UR M78, 2.2.5 para.7

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Amended	Original	Remarks																																																												
acceptable range otherwise, alarm and safety system functions for dual fuel or gas only engines are to be provided in accordance with Table 3.1. However, even if risk analysis proves that risk is within the acceptable range, the alarm and safety system functions specified in Part GF of the Rules are still to be provided. Additional alarms and safety devices may be required if deemed necessary by the Society. 3.2 Gas-fuelled Engines of Ships Subject to the Rules for Automatic Remote Control Systems	acceptable range otherwise, alarm and safety system functions for dual fuel or gas only engines are to be provided in accordance with Table 3.1 (for dual fuel engines, Table 3.1 applies only to the gas mode). However, even if risk analysis proves that risk is within the acceptable range, the alarm and safety system functions specified in Part GF of the Rules are still to be provided. Additional alarms and safety devices may be required if deemed necessary by the Society. 3.2 Gas-fuelled Engines of Ships Subject to the Rules for Automatic Remote Control Systems																																																													
Table 3.1 Alarm and Safety System Functions for Dual Fuel and Gas Only Engines <table><tr><th>Parameter</th><th>Alarm</th><th>Automatic activation of the double block and bleed valves ¹²⁾</th><th>Automatic switching over to oil-fuel oil mode¹⁾</th><th>Engine shutdown</th></tr><tr><td>1. Abnormal pressures in the gas fuel supply line</td><td>X</td><td>X</td><td>X</td><td>X ⁵⁾</td></tr><tr><td>2. Gas fuel supply systems - malfunction</td><td>X</td><td>X</td><td>X</td><td>X ⁵⁾</td></tr><tr><td>3. Leak detection in annular space of double walled pipes ¹³⁾</td><td>X</td><td>X</td><td>X</td><td>X ⁵⁾</td></tr><tr><td>34. Pilot fuel injection or spark ignition systems - malfunction</td><td>X</td><td>X ²⁾</td><td>X</td><td>X ²⁾⁵⁾</td></tr><tr><td>45. Exhaust gas temperature after each cylinder - high ¹⁴⁾</td><td>X</td><td>X ²⁾</td><td>X</td><td>X ²⁾⁵⁾</td></tr><tr><td>56. Exhaust gas temperature after each cylinder - low³⁾¹⁴⁾</td><td>X</td><td>X ²⁾</td><td>X</td><td>X ²⁾⁵⁾</td></tr><tr><td>67. Cylinder pressure or ignition - failure, including misfiring, knocking and unstable combustion ¹⁴⁾</td><td>X</td><td>X ²⁾⁴⁾</td><td>X ⁴⁾</td><td>X ²⁾⁴⁾⁵⁾</td></tr><tr><td>78. Oil mist concentration in crankcase or bearing temperature⁶⁾ - high</td><td>X</td><td>X</td><td>-</td><td>X ⁹⁾</td></tr><tr><td>89. Pressure in the crankcase - high ⁸⁾</td><td>X</td><td>X</td><td>X</td><td>-</td></tr><tr><td>910. Engine stops - any cause</td><td>X</td><td>X</td><td>-</td><td>-</td></tr><tr><td>1011. Failure of the control-actuating</td><td>X</td><td>X</td><td>X</td><td>-</td></tr></table>		Parameter	Alarm	Automatic activation of the double block and bleed valves ¹²⁾	Automatic switching over to oil-fuel oil mode ¹⁾	Engine shutdown	1. Abnormal pressures in the gas fuel supply line	X	X	X	X ⁵⁾	2. Gas fuel supply systems - malfunction	X	X	X	X ⁵⁾	3. Leak detection in annular space of double walled pipes ¹³⁾	X	X	X	X ⁵⁾	34. Pilot fuel injection or spark ignition systems - malfunction	X	X ²⁾	X	X ²⁾⁵⁾	45. Exhaust gas temperature after each cylinder - high ¹⁴⁾	X	X ²⁾	X	X ²⁾⁵⁾	56. Exhaust gas temperature after each cylinder - low ³⁾¹⁴⁾	X	X ²⁾	X	X ²⁾⁵⁾	67. Cylinder pressure or ignition - failure, including misfiring, knocking and unstable combustion ¹⁴⁾	X	X ²⁾⁴⁾	X ⁴⁾	X ²⁾⁴⁾⁵⁾	78. Oil mist concentration in crankcase or bearing temperature ⁶⁾ - high	X	X	-	X ⁹⁾	89. Pressure in the crankcase - high ⁸⁾	X	X	X	-	910. Engine stops - any cause	X	X	-	-	1011. Failure of the control-actuating	X	X	X	-	UR M78, Table 2
Parameter	Alarm	Automatic activation of the double block and bleed valves ¹²⁾	Automatic switching over to oil-fuel oil mode ¹⁾	Engine shutdown																																																										
1. Abnormal pressures in the gas fuel supply line	X	X	X	X ⁵⁾																																																										
2. Gas fuel supply systems - malfunction	X	X	X	X ⁵⁾																																																										
3. Leak detection in annular space of double walled pipes ¹³⁾	X	X	X	X ⁵⁾																																																										
34. Pilot fuel injection or spark ignition systems - malfunction	X	X ²⁾	X	X ²⁾⁵⁾																																																										
45. Exhaust gas temperature after each cylinder - high ¹⁴⁾	X	X ²⁾	X	X ²⁾⁵⁾																																																										
56. Exhaust gas temperature after each cylinder - low ³⁾¹⁴⁾	X	X ²⁾	X	X ²⁾⁵⁾																																																										
67. Cylinder pressure or ignition - failure, including misfiring, knocking and unstable combustion ¹⁴⁾	X	X ²⁾⁴⁾	X ⁴⁾	X ²⁾⁴⁾⁵⁾																																																										
78. Oil mist concentration in crankcase or bearing temperature ⁶⁾ - high	X	X	-	X ⁹⁾																																																										
89. Pressure in the crankcase - high ⁸⁾	X	X	X	-																																																										
910. Engine stops - any cause	X	X	-	-																																																										
1011. Failure of the control-actuating	X	X	X	-																																																										

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Amended			Original			Remarks
medium of the block and bleed valves						
4 12. Failure of crankcase ventilation system, if applicable	X	X ⁷⁾	X ⁷⁾	-		
4 213. Abnormal temperature in the gas fuel supply line	X	X ¹⁰⁾	X ¹⁰⁾	X ⁵⁾¹⁰⁾¹¹⁾		
4 314. Leak detection between gas piping and outer pipes or ducts as specified in 9.6.1, Part GF of the Rules ¹⁰⁾	X	X	X	X ⁵⁾		
4 415. Low pressures of hydraulic and pneumatic sources, or loss of electric power supply for gas fuel combustion control ¹⁰⁾	X	X	X	X ⁵⁾¹¹⁾		

Notes:

- 1) Dual fuel engine only, when running in gas mode
- 2) ~~For gas fuel only engines, the~~ The double block and bleed valves and the engine shutdown may not be activated in case of specific failures affecting only one cylinder, provided that the concerned cylinder can be individually shut off and the safe operation of the engine in such conditions is demonstrated by the risk analysis cut off from gas operation (see 3.1-7).
- 3) Required only if necessary for the detection of misfiring. In addition, deviation from average is to be used for the operation setting of each function.
- 4) In the case where the failure can be corrected by an automatic mitigation action, only the alarm may be activated. If the failure persists after a given time, the safety actions are to be activated (see 3.1-5).
- 5) Only for Gas fuel only engines
- 6) Where required by 2.4.5, Part D of the Rules
- 7) Automatic safety actions to be activated as specified by the engine manufacturer (see 2.2.2-6, Part D of the Rules)
- 8) Only for trunk piston engines. Method for crankcase overpressure, or fault condition, monitoring to be detailed in the safety concept.
- 9) Only for trunk piston engines. For crosshead engines slow down applies (see 2.4.5, Part D of the Rules)
- 10) Only for gas-fuelled engines installed on board ships subject to 1.1.1, Rules for Automatic and Remote Control Systems
- 11) Slowdown is acceptable instead of shutdown. In this case, “automatic activation of the double block and bleed valves” does not apply.
- 12) For methyl/ethyl alcohol fuels, activation of the remote operated shut-off valve required by 9.6.5 of MSC.1/Circ.1621.

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
<u>13) Gas detection alarms and shutdowns in accordance with Table GF15.1, Part GF of the Rules. For methyl/ethyl alcohol fuels gas and liquid detection in accordance with Table 15.1 of MSC.1/Circ.1621. For LPG fuels in accordance with MSC.1/Circ.1666.</u> <u>14) Where monitoring of exhaust temperature or combustion for each cylinder is not practicable due to the engine size and design, common combustion monitoring may be accepted. See 3.1-8 and the Rules for Automatic and Remote Control Systems.</u>		
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (C)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
Chapter 4 TESTS 4.3 Tests after Installation On Board 1 Control systems of gas-fuelled engines and related equipment are to be tested depending upon their installation characters in accordance with the requirements of 18.7.3, Part D of the Rules or the requirements of 2.2.4, Rules for Automatic and Remote Control Systems: relevant requirements are to be applied mutatis mutandis. 2 A leak test is to be carried out for the gas piping system after assembly on board in accordance with 16.7.3-3, Part GF of the Rules. 3 The efficiency of the ventilation arrangement, or other approved principle, of the double walled gas piping system is to be verified. 4 <u>For pressurised double wall piping systems installed in accordance with 9.6.1(1), Part GF of the Rules, the outer pipe or duct is to be pressure tested at 1.5 times the design pressure of the outer pipe or duct.</u> 5 <u>For ventilated double wall piping systems installed in accordance with 9.6.1(2), Part GF of the Rules, the outer pipe or duct is to be pressure tested at the design pressure calculated in accordance with 9.8.1 or 9.8.2, Part GF of the Rules to ensure gas-tight integrity.</u>	Chapter 4 TESTS 4.3 Tests after Installation On Board 1 Control systems of gas-fuelled engines and related equipment are to be tested depending upon their installation characters in accordance with the requirements of 18.7.3, Part D of the Rules or the requirements of 2.2.4 of the Rules for Automatic and Remote Control Systems: relevant requirements are to be applied mutatis mutandis. 2 A leak test is to be carried out for the gas piping system after assembly on board in accordance with 16.7.3-3, Part GF of the Rules. 3 The efficiency of the ventilation arrangement, or other approved principle, of the double walled gas piping system is to be verified. (Newly added) (Newly added)	(5)(d): UR M78, 2.2.2.1 para.5 (5)(e): UR M78, 2.2.2.1 para.4
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (B)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part K MATERIALS Chapter 5 CASTINGS 5.1 Steel Castings 5.1.9 Surface Inspection and Dimension Inspection* 4 Notwithstanding the requirements in -1 to -3 above, surface inspections or dimension inspections may be omitted for steel castings when not required according to <u>2.2.1-1 or 2.7.4, Part D</u> of the Rules. 5.1.10 Non-destructive Testing* 1 The steel castings are to be subjected to non-destructive testing in accordance with (1) and (2) of the following requirements: (1) Ultrasonic test (a) The steel castings intended for stern frame, rudder frame and other important hull structural members and required for ultrasonic test as specified in <u>2.2.1-1 or 2.7.4, Part D</u> are to be subjected to ultrasonic tests at an appropriate stage of the manufacturing process and the test reports are to be showed or submitted to the Surveyor.	RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part K MATERIALS Chapter 5 CASTINGS 5.1 Steel Castings 5.1.9 Surface Inspection and Dimension Inspection* 4 Notwithstanding the requirements in -1 to -3 above, surface inspections or dimension inspections may be omitted for steel castings when not required according to <u>2.2.1-1, Part D</u> of the Rules. 5.1.10 Non-destructive Testing* 1 The steel castings are to be subjected to non-destructive testing in accordance with (1) and (2) of the following requirements: (1) Ultrasonic test (a) The steel castings intended for stern frame, rudder frame and other important hull structural members and required for ultrasonic test as specified in <u>2.2.1-1, Part D</u> are to be subjected to ultrasonic tests at an appropriate stage of the manufacturing process and the test reports are to be showed or submitted to the Surveyor.	Alignment of reference numbers

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Amended	Original	Remarks
((b) and (c) are omitted.) (2) Magnetic particle test The important parts of the following steel castings are to be subjected to magnetic particle tests at an appropriate stage of the manufacturing process. But, machining surfaces may be subjected to liquid penetrant tests. (a) Steel castings intended for stern frame, rudder frame and other important hull structural members (b) Steel castings required for magnetic particle test or liquid penetrant test specified in <u>2.2.1-1 or 2.7.4, Part D</u> (c) Propellers (d) Turbine casings Chapter 6 STEEL FORGINGS 6.1 Steel Forgings 6.1.9 Surface Inspection and Dimension Inspection* 3 Notwithstanding the requirements in -1 and -2 above, surface inspections or dimension inspections may be omitted for steel forgings when not required according to <u>2.2.1-1 or 2.7.4, Part D of the Rules.</u> 6.1.10 Non-destructive Testing* 1 Steel forgings are to be subjected to non-destructive testing in accordance with (1) and (2) of the following requirements:	((b) and (c) are omitted.) (2) Magnetic particle test The important parts of the following steel castings are to be subjected to magnetic particle tests at an appropriate stage of the manufacturing process. But, machining surfaces may be subjected to liquid penetrant tests. (a) Steel castings intended for stern frame, rudder frame and other important hull structural members (b) Steel castings required for magnetic particle test or liquid penetrant test specified in <u>2.2.1-1, Part D</u> (c) Propellers (d) Turbine casings Chapter 6 STEEL FORGINGS 6.1 Steel Forgings 6.1.9 Surface Inspection and Dimension Inspection* 3 Notwithstanding the requirements in -1 and -2 above, surface inspections or dimension inspections may be omitted for steel forgings when not required according to <u>2.2.1-1, Part D of the Rules.</u> 6.1.10 Non-destructive Testing* 1 Steel forgings are to be subjected to non-destructive testing in accordance with (1) and (2) of the following requirements:	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(1) Ultrasonic test (a) The following steel forgings are to be subjected to ultrasonic test at an appropriate stage of the manufacturing process and the test reports are to be showed or submitted to the Surveyor. i) Rudder stocks and pintles ii) Steel forgings which are to be subjected to ultrasonic test according to the requirement specified in 2.2.1-1 or 2.7.4, Part D iii) Thrust shafts, intermediate shafts and propeller shafts iv) Reduction gears and reduction gear shafts v) Turbine rotors, turbine discs and turbine blades ((b) and (c) are omitted.) (2) Magnetic Particle or liquid penetrant testing The important parts of the following steel forgings are to be subjected to magnetic particle or liquid penetrant test at an appropriate stage of the manufacturing process: (a) Steel forgings which are to be subjected to magnetic particle test or liquid penetrant test according to the requirement specified in 2.2.1-1 or 2.7.4, Part D. (b) Propeller shafts. (c) Reduction gears. (d) Turbine rotors, turbine discs and turbine blades.	(1) Ultrasonic test (a) The following steel forgings are to be subjected to ultrasonic test at an appropriate stage of the manufacturing process and the test reports are to be showed or submitted to the Surveyor. i) Rudder stocks and pintles ii) Steel forgings which are to be subjected to ultrasonic test according to the requirement specified in 2.2.1-1, Part D iii) Thrust shafts, intermediate shafts and propeller shafts iv) Reduction gears and reduction gear shafts v) Turbine rotors, turbine discs and turbine blades ((b) and (c) are omitted.) (2) Magnetic Particle or liquid penetrant testing The important parts of the following steel forgings are to be subjected to magnetic particle or liquid penetrant test at an appropriate stage of the manufacturing process: (a) Steel forgings which are to be subjected to magnetic particle test or liquid penetrant test according to the requirement specified in 2.2.1-1, Part D. (b) Propeller shafts. (c) Reduction gears. (d) Turbine rotors, turbine discs and turbine blades.	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)		

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Amended	Original	Remarks
RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part N SHIPS CARRYING LIQUEFIED GASES IN BULK Annex 16.1.1-3 GAS-FUELLED ENGINES Chapter 1 GENERAL 1.1 Scope 1 <u>This annex applies to reciprocating internal combustion engines supplied with gases or low-flashpoint fuels as fuel, and gas fuel supply systems in accordance with the requirements of 16.1.1, Part N of the Rules. The fuels covered by this annex include the following fossil, bio-based or synthetic variants of gas-fuelled engines and gas fuel supply systems using fuels other than those listed in (1) to (3) below are to be specially considered.</u> (1) <u>Natural gas (predominantly methane)</u> (2) <u>Ethane</u> (3) <u>LPG (predominantly mixes of propane and butane)</u> (Deleted) 2 <u>Gases or low-flashpoint fuels are not permitted for</u>	RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part N SHIPS CARRYING LIQUEFIED GASES IN BULK Annex 16.1.1-3 GAS-FUELLED ENGINES Chapter 1 GENERAL 1.1 Scope 1 <u>The Guidance applies to engines supplied with natural gas (including similar fuels with main component methane such as bio-methane or synthetic methane) as fuel and gas fuel supply systems in accordance with the requirements of 16.1.1, Part N of the Rules.</u> 2 <u>It is to be ensured by the gas supply system that the gas supplied to the engine is always in gaseous state. This Annex does not cover requirements for liquid or cryogenic gas.</u> 3 <u>Dual fuel engines and gas fuel only engines may not</u>	UR M78, 1.1.1 (Differences from the Annex to Part GF) UR M78, 1.1.2 para.8

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Amended	Original	Remarks
<u>engines used as the emergency source of power. Emergency generator engines used as a source of electrical power in port, may operate on all fuels for which they are designed when providing electrical power in port but are not permitted to operate on gases or low-flashpoint fuels when providing the emergency source of power.</u> 3 Gas-fuelled engines and gas fuel supply systems are to comply with relevant requirements of Part D and Part N of the Rules, in addition to the requirements of this Guidance and 16.7, Part N of the Rules. 4 The following requirements specified in Part GF of the Rules as well as other requirements specified separately by the Society apply to gas-fuelled engines regardless of ship type, ship size and ship service area except where explicitly specified otherwise. (1) 2.1-4(3) (2) 2.2.3-1 (3) 2.4.2-4(4) (4) 2.4.2-4(5)(b) and (d) (5) 4.1-7 5 Where LPG is used as fuel, MSC.1/Circ.1666 “<i>Interim Guidelines for the Safety of Ships using LPG Fuels</i>” is to be applied. 1.3 Drawings and Data 1 The drawings and data to be submitted are as follows. (1) Drawings and data for approval (a) Drawings and data specified in 2.1.4-1(1), Part D of the Rules. <u>In addition, the list of drawings and documents to be submitted as well as the engine particulars are to comply with the following requirements.</u>	<u>be permitted for emergency applications.</u> 4 Gas-fuelled engines and gas fuel supply systems are to comply with relevant requirements of Part D and Part N of the Rules, in addition to the requirements of this Guidance and Chapter 16, Part N of the Rules. 5 The following requirements specified in Part GF of the Rules as well as other requirements specified separately by the Society apply to gas-fuelled engines regardless of ship type, ship size and ship service area except where explicitly specified otherwise. (1) 2.1-4(3) (2) 2.2.3-1 (3) 2.4.2-4(5) (4) 2.4.2-4(6)(b) (5) 4.1-7 (Newly added) 1.3 Drawings and Data The drawings and data to be submitted are as follows. (1) Drawings and data for approval (a) Drawings and data specified in 2.1.3-1(1), Part D of the Rules	UR M78, 1.1.2 para.3 Clarification UR M78, 1.1.2, para.7 (Differences from the Annex to Part GF) Review the required Plans for submission related to individual engines. (a) Clarify the drawings and documents to be additionally included in the “List of Drawings and

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Amended	Original	Remarks
i) <u>List of drawings and documents</u> <u>The list is to include, as applicable to the engine concerned, the following drawings and documents.</u> 1) <u>Schematic layout or other equivalent documents of gas system on the engine</u> 2) <u>Gas piping system, assembly and details</u> 3) <u>Parts for gas admission system</u> 4) <u>Arrangement of explosion relief valves for crankcase (if required by 2.4.3, Part D of the Rules), charge air manifold and exhaust gas manifold and exhaust gas system on the engine, as applicable</u> 5) <u>List of certified safe equipment and relevant certification</u> 6) <u>Safety Concept</u> 7) <u>Schematic layout or other equivalent documents of pilot fuel system (only for dual fuel engines)</u> 8) <u>Shielding of high pressure fuel pipes for pilot fuel system, assembly (only for dual fuel engines)</u> 9) <u>High pressure components of pilot fuel injection devices (only for dual fuel engines)</u> 10) <u>Schematic layout or other equivalent documents of the ignition system (only for gas only engines)</u> ii) <u>Engine particulars</u> <u>Where applicable, the type of pressure relief device specified in 2.4.1-5 is also to be included.</u>		

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Amended	Original	Remarks
(Deleted)	<u>(b) Drawings and data specified in 18.1.3(1)(a), (b) and (e), Part D of the Rules</u> <u>(c) Gas admission valves and actuating systems</u> <u>(d) Gas fuel injection pipe and shielding arrangements</u> <u>(e) Arrangement of gas detectors</u> <u>(f) Combustion monitoring device</u> <u>(g) Governor</u> <u>(h) Engine control system diagram (including monitor, safety and alarm systems) for gas fuel combustion operation</u> <u>(i) Gas leak protection system at connections between engines and gas fuel supply piping systems</u> <u>(j) Gas fuel make-up plant (including construction, equipment, and control systems)</u> <u>(k) Gas fuel supply piping system (including details of valves and pipe fittings) and protective device for gas leaks from them</u> <u>(l) Automatic control and remote control systems for gas fuel supply systems</u> <u>(m) Pilot fuel injection devices or injection arrangements</u> <u>(n) Schematic layout or other equivalent documents of gas system on the engine</u> <u>(o) Gas piping system (including double-walled arrangement where applicable)</u> The documentation to contain specification of design pressures, working pressure, pipe dimensions and materials. (p) Parts for gas admission system	
<u>(b) Gas piping system, assembly and details (including double-walled arrangement where applicable)</u> The documentation is to contain specification of design pressures, design temperature, pipe dimensions and materials. (Deleted)		

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Amended	Original	Remarks
(2) Drawings and data for reference (a) Drawings and data specified in 2.1.4-1(2), Part D of the Rules (b) Other drawings and data as deemed necessary by the Society (Deleted)	<u>The documentation to contain specifications of design pressures, working pressures, pipe dimensions and materials.</u> <u>(q) Arrangement of explosion relief valves for crankcase (if required by 2.4.3, Part D of the Rules), charge air manifold and exhaust gas manifold and exhaust gas system on the engine, as applicable</u> <u>(r) List of certified safe equipment and relevant certification</u> <u>(s) Schematic layout or other equivalent documents of pilot fuel system (only for dual fuel engines)</u> <u>(t) Assembly drawings for the shielding of high pressure fuel pipes of pilot fuel system (in the case of dual fuel engines)</u> <u>(u) Schematic layout or other equivalent documents of the ignition system (only for gas only engines)</u> <u>(v) Other drawings and data as deemed necessary by the Society according to the type of low pressure gas-fuelled engines</u> (2) Drawings and data for reference (a) Drawings and data specified in 2.1.3-1(2), Part D of the Rules (b) Other drawings and data as deemed necessary by the Society (3) <u>Drawings and data for the purpose of inspecting and testing engines</u> <u>Items specified in 2.1.3-1, Part D of the Rules, which are intended for inspection and testing (indicated by “○” in Table D2.1(1) and Table D2.1(2), Part D of the Rules).</u>	

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Amended	Original	Remarks
1.4 Terms 3 <i>Dual fuel engine</i> means an engine that can burn <u>gases</u> or <u>low-flashpoint fuels</u> (gas mode) and also <u>always</u> has the capability of running on fuel oil only (<u>fuel oil</u> mode). 4 <i>Explosion relief device</i> means a device to protect personnel and <u>components</u> against a determined overpressure in the event of <u>an</u> explosion. The device may be a valve, a rupture disc or other, as applicable. 5 <i>Fuel oil</i> means residual or distillate liquid marine fuels with a closed-cup flash point as required by 4.2.1(1) and 4.2.1(2), Part R of the Rules and typically to the <i>ISO 8217:2024</i> standard “Products from petroleum, synthetic and renewable sources – Fuels (class F) – Specifications of marine fuels”. 6 <i>Gas</i> means <u>gases or low-flashpoint fuels, whether in a liquid, liquefied or gaseous state, and includes natural gas (methane), ethane and LPG. Bio or synthetic variants of these fuels are also included.</u> 7 <i>Low-flashpoint fuel</i> means <u>gaseous or liquid fuel having a flashpoint lower than otherwise permitted under 4.2.1(1), Part R of the Rules.</u> 8 (Omitted) 9 (Omitted) 10 <i>Gas fuel only engine</i> means an engine that can be operated only with gas fuel and cannot be switched to <u>fuel</u> oil operation. 11 (Omitted) 12 <i>High pressure gas</i> means gas with a maximum	1.4 Terms 3 <i>Dual fuel engine</i> means an engine that can burn <u>natural gas as fuel simultaneously with liquid fuel, either as pilot oil or bigger amount of liquid fuel</u> (gas mode), and also has the capability of running on <u>liquid diesel</u> fuel oil only (<u>Diesel</u> mode). 4 <i>Explosion relief device</i> means a device to protect personnel and <u>component</u> against a determined overpressure in the event of <u>a gas</u> explosion. The device may be a valve, a rupture disc or other, as applicable. (Newly added) 5 <i>Gas</i> means <u>natural gas used as fuel consisting primarily of methane. Gas may also be bio-methane or synthetic methane, etc. with methane as main component.</u> (Newly added) 6 (Omitted) 7 (Omitted) 8 <i>Gas fuel only engine</i> means an engine that can be operated only with gas fuel and cannot be switched to oil-fuelled operation. 9 (Omitted) 10 <i>High pressure gas</i> means gas with a maximum	UR M78, 1.2.3 UR M78, 1.2.4 UR M78, 1.2.5 UR M78, 1.2.6 (Differences from Annex GF) UR M78, 1.2.15 UR M78, 1.2.9 UR M78, 1.2.11

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Amended	Original	Remarks
working pressure greater than 1 <i>MPa</i> (gauge). 13 (Omitted) 14 (Omitted) 15 (Omitted) 16 <i>Pilot fuel</i> means the fuel oil that is injected into the cylinder to ignite the main gas-air mixture on <u>some dual fuel</u> engines. 17 <i>Pre-mixed engine</i> means an engine where gas is supplied in a mixture with air through a common manifold for all cylinders, e.g. mixed before or after the turbocharger. <u>Inlet manifolds, turbochargers, charge air coolers, etc. may contain gas/air mixtures during normal operation.</u> 18 <i>Safety Concept</i> is a document describing the safety philosophy with regard to gas as fuel.	working pressure greater than 1 <i>MPa</i> (gauge). 11 (Omitted) 12 (Omitted) 13 (Omitted) 14 <i>Pilot fuel</i> means the fuel oil that is injected into the cylinder to ignite the main gas-air mixture on <u>Gas-fuelled</u> engines. 15 <i>Pre-mixed engine</i> means an engine where gas is supplied in a mixture with air through a common manifold for all cylinders, e.g. mixed before or after the turbocharger. 16 <i>Safety Concept</i> is a document describing the safety philosophy with regard to gas as fuel. <u>It describes how risks associated with this type of fuel are controlled under reasonably foreseeable abnormal conditions as well as possible failure scenarios and their control measures. The results of the risk analysis are to be reflected in the safety concept. A detailed evaluation regarding the hazard potential of injury from a possible explosion is to be carried out and reflected in the safety concept of the engine.</u>	(Differences from Annex GF) UR M78, 1.2.19 UR M78, 1.2.20 UR M78, 1.2.22
Chapter 2 CONSTRUCTION AND EQUIPMENT OF GAS-FUELLED ENGINES	Chapter 2 CONSTRUCTION AND EQUIPMENT OF GAS-FUELLED ENGINES	
2.1 General	2.1 General	
3 The manufacturer is to declare the allowable gas composition limits for the engine and, <u>as applicable</u>, the minimum and maximum methane number.	3 The manufacturer is to declare the allowable gas composition limits for the engine and the minimum and <u>(if applicable)</u> maximum methane number.	UR M78, 2.1.1
4 Components containing or likely to contain gas are to	4 Components containing or likely to contain gas are to	UR M78, 2.1.2

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Amended	Original	Remarks
be designed in accordance with the following (1) to (3). (1) Minimise the risk of fire and explosion so as to demonstrate an appropriate level of safety commensurate with that of an oil-fuelled engine (2) Mitigate the consequences of a possible explosion to a level providing a tolerable degree of residual risk, due to the strength of the component(s) or the fitting of suitable pressure relief devices of an approved type The strength of the component(s) of arrangement of <u>the explosion relief devices</u> is to be documented (e.g. as part of <u>the safety concept / risk analysis</u>) or otherwise demonstrated to be sufficient for a worst-case explosion. (3) Refer to 10.2 and 10.3, Part GF of the Rules 5 Discharge from explosion relief devices is to prevent the passage of flame to the machinery space and be arranged such that the discharge does not endanger personnel or damage other engine components or systems. (Deleted) 2.2 Construction and Strength 2.2.3 Crankcase 1 Crankcase explosion relief valves are to be installed in accordance with 2.4.3, Part D of the Rules. Refer also to 10.3.1-2, Part GF of the Rules. For engines not covered by 2.4.3, Part D of the Rules, the detailed evaluation required by 8.3, Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use is to determine if crankcase explosion relief valves are necessary. 2 For maintenance purposes, <u>on engines with a</u>	be designed in accordance with the following (1) to (3). (1) Minimise the risk of fire and explosion so as to demonstrate an appropriate level of safety commensurate with that of an oil-fuelled engine (2) Mitigate the consequences of a possible explosion to a level providing a tolerable degree of residual risk, due to the strength of the component(s) or the fitting of suitable pressure relief devices of an approved type The strength of the component(s) of arrangement of explosion relief devices is to be documented (e.g. as part of risk analysis) or otherwise demonstrated to be sufficient for a worst-case explosion. (3) Refer to 10.2 and 10.3, Part GF of the Rules 5 Discharge from explosion relief devices is to prevent the passage of flame to the machinery space and be arranged such that the discharge does not endanger personnel or damage other engine components or systems. 6 <u>Explosion relief devices are to be fitted with a flame arrester.</u> 2.2 Construction and Strength 2.2.3 Crankcase 1 Crankcase explosion relief valves are to be installed in accordance with 2.4.3, Part D of the Rules. Refer also to 10.3.1-2, Part GF of the Rules. For engines not covered by 2.4.3, Part D of the Rules, the detailed evaluation required by 8.3, Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use is to determine if crankcase explosion relief valves are necessary. 2 For maintenance purposes, a connection, or other	UR M78, 2.1.3 (Differences from Annex GF) This item is covered by the measures described in -5 above and is therefore deleted as redundant. UR M78, 2.2.4.2

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Amended	Original	Remarks
crankcase volume of 0.6 m^3 and above, a connection, or other means, are to be provided for crankcase inerting and ventilating and gas concentration measuring. 3 Ventilation of crankcase, if arranged, is to comply with 2.2.2-6(1) to (3), Part D of the Rules. Relevant evidence is to be documented <u>together with details on the crankcase vent piping system in the</u> Safety Concept. The ventilation systems for crankcase, sump and other similar engine spaces are to be independent from the systems on the other engines. (Deleted) (Deleted) 2.3 Safety Systems 2.3.2 Governors 1 In addition to operations using gas fuel, governors of gas-fuelled engines are to be functional in either the simultaneous combustion mode of gas and oil fuel (or pilot <u>fuel</u>) or the combustion mode of oil fuel. 3 Gas-fuelled dual fuel engines are to be operated in any one of the modes specified in the following (1) to (3): (1) controllable gas fuel supply and fixed oil fuel (pilot <u>fuel</u>) supply, (2) controllable oil fuel (pilot <u>fuel</u>) supply and fixed gas fuel supply, or (3) controllable gas fuel and oil fuel supplies.	means, are to be provided for crankcase inerting and ventilating and gas concentration measuring. 3 Ventilation of crankcase <u>(either supply or extraction)</u>, if arranged, is to comply with 2.2.2-6(1) to (3), Part D of the Rules. Relevant evidence is to be documented <u>in</u> Safety Concept. The ventilation systems for crankcase, sump and other similar engine spaces are to be independent from the systems on the other engines. <u>2.2.4 Gas Ignition in Cylinder</u> <u>For gas ignition in the cylinder, the requirements of 16.7, Part N of the Rules are to be applied.</u> 2.3 Safety Systems 2.3.2 Governors 1 In addition to operations using gas fuel, governors of gas-fuelled engines are to be functional in either the simultaneous combustion mode of gas and oil fuel (or pilot <u>oil</u>) or the combustion mode of oil fuel. 3 Gas-fuelled dual fuel engines are to be operated in any one of the modes specified in the following (1) to (3): (1) controllable gas fuel supply and fixed oil fuel (pilot <u>oil</u>) supply, (2) controllable oil fuel (pilot <u>oil</u>) supply and fixed gas fuel supply, or (3) controllable gas fuel and oil fuel supplies.	UR M78, 2.2.4.3 Deleted, as 1.1-3 already specifies that the engine is to comply with 16.7, Part N, and this requirement is therefore redundant

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Amended	Original	Remarks
2.4 Accessory Equipment 2.4.1 Charge Air Systems and Exhaust Gas Systems (Deleted) <u>5</u> (Omitted) <u>6</u> (Omitted) <u>7</u> (Omitted) 2.4.2 Gas Pipes 4 For piping attached to gas-fuelled engines, the following (1) to (7) also apply. (1) <u>For applications using natural gas or LPG as fuel, as given in 5.1 to 5.9 and Chapter 16, Part N of the Rules are applied.</u> (Deleted) (2) <u>Design pressure for gas pipes for applications using natural gas or LPG as fuel is to be in accordance with the following rules:</u> (a) Gas pipe (low pressure): 5.4.1, Part N of the Rules (b) Gas pipe (high pressure): 5.4.1, Part N of the Rules	2.4 Accessory Equipment 2.4.1 Charge Air Systems and Exhaust Gas Systems 5 <u>Suitable explosion relief system for air inlet manifolds, scavenge spaces and exhaust system is to be provided unless designed to accommodate the worst-case overpressure due to ignited gas leaks or justified by the safety concept of the engine. A detailed evaluation regarding the hazard potential of overpressure in air inlet manifolds, scavenge spaces and exhaust system is to be carried out and reflected in the safety concept of the engine.</u> <u>6</u> (Omitted) <u>7</u> (Omitted) <u>8</u> (Omitted) 2.4.2 Gas Pipes 4 For piping attached to gas-fuelled engines, the following (1) to (8) also apply. (1) <u>Requirements of 5.1 to 5.9 and Chapter 16, Part GF of the Rules are applied.</u> (2) <u>Other connections as mentioned in 7.3.6-4(4), Part GF of the Rules may be accepted subject to type approval in accordance with the requirements of Chapter 9, Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use.</u> (3) <u>Design pressure for gas pipes are to be in accordance with the following rules:</u> (a) Gas pipe (low pressure): 5.4.1, Part N of the Rules (b) Gas pipe (high pressure): 5.4.1, Part N of the Rules	With respect to this item, 8.4-2(1), Part 6, Guidance for Approval of Materials and Equipment for Marine Use already specifies that it is to be included in the engine Safety Concept. (1): UR M78, 2.2.1.1 (Differences from Annex GF)

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Amended	Original	Remarks
(c) Outer pipe (low pressure): 5.4.4, Part N of the Rules (d) Outer pipe (high pressure): 5.4.4, Part N of the Rules (e) Open ended pipes: 5.4.1, Part N of the Rules (3) (Omitted) (4) Arrangement of the gas piping system on the engine Pipes and equipment containing gas are defined as hazardous area zone 0 (refer to 12.5.1, Part GF of the Rules). The space between the gas fuel piping and the wall of the outer pipe or duct is defined as hazardous area zone 1 (refer to 12.5.2(6), Part GF of the Rules). (5) Normal “double wall” arrangement (a) The gas piping system on the gas-fuelled engine are applied the requirements of 16.4.3, Part N of the Rules. (b) The design criteria for the double pipe or duct are given in the 9.8 and 7.4.1-4, Part GF of the Rules. (c) In case of a ventilated double wall, the ventilation inlet is applied the provisions of 16.4.3(2), Part N of the Rules. (Deleted) (6) Alternative arrangement Single walled gas piping is only acceptable in cases	(c) Outer pipe (low pressure): 5.4.4, Part N of the Rules (d) Outer pipe (high pressure): 5.4.4, Part N of the Rules (e) Open ended pipes: 5.4.1, Part N of the Rules (4) (Omitted) (5) Arrangement of the gas piping system on the engine Pipes and equipment containing <u>fuel</u> gas are defined as hazardous area zone 0 (refer to 12.5.1, Part GF of the Rules). The space between the gas fuel piping and the wall of the outer pipe or duct is defined as hazardous area zone 1 (refer to 12.5.2(6), Part GF of the Rules). (6) Normal “double wall” arrangement (a) The gas piping system on the gas-fuelled engine are applied the requirements of 16.4.3, Part N of the Rules. (b) The design criteria for the double pipe or duct are given in the 9.8 and 7.4.1-4, Part GF of the Rules. (c) In case of a ventilated double wall, the ventilation inlet is applied the provisions of 16.4.3(2), Part N of the Rules. (d) <u>The pipe or duct is to be pressure tested in accordance with 12.6.1-2 to -4, Part D of the Rules to ensure gas tight integrity and to show that it can withstand the expected maximum pressure at gas pipe rupture.</u> (7) Alternative arrangement Single walled gas piping is only acceptable in cases	5)(c): UR M78, 2.2.2.1 para.3 Former item (d): Relocated to Chapter 5 as it constitutes a test requirement, with the requirement being revised accordingly (refer to 5.3-4 and 5.3-5). (Differences from Annex GF)

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Amended	Original	Remarks
where the requirements of Part N of the Rules permit (e.g. 16.4.4-1, Part N of the Rules). (7) Gas admission valves Electrically operated Gas admission valves are to be certified safe as follows: (a) The inside of the valve contains gas and therefore it is to be certified for zone 0. (b) When the valve is located within a pipe or duct in accordance with (5), the outside of the valve is to be certified for zone 1. (c) However, if they are not rated for the zone they are intended for, it is to be documented that they are suitable for that zone. Documentation and analysis is to be based on <i>IEC 60079-10-1:2020</i> or <i>IEC 60092-502:1999</i>. Gas admission valves operated by hydraulic oil system are to be provided with sealing arrangement to prevent gas from entering the hydraulic oil system.	where the requirements of Part N of the Rules permit (e.g. 16.4.4-1, Part N of the Rules). (8) Gas admission valves Electrically operated Gas admission valves are to be certified safe as follows: (a) The inside of the valve contains gas and therefore it is to be certified for zone 0. (b) When the valve is located within a pipe or duct in accordance with (6), the outside of the valve is to be certified for zone 1. (c) However, if they are not rated for the zone they are intended for, it is to be documented that they are suitable for that zone. Documentation and analysis is to be based on <i>IEC 60079-10-1:2015</i> or <i>IEC 60092-502:1999</i>. Gas admission valves operated by hydraulic oil system are to be provided with sealing arrangement to prevent gas from entering the hydraulic oil system.	(7)(c): UR M78, 2.2.6
2.5 Design Requirements for Each Kind of Engines 2.5.1 Dual Fuel Engine 1 Engine rating (1) The maximum continuous <u>rating (MCR)</u> that a dual fuel engine can develop in gas mode may be lower than the <u>fuel oil mode MCR</u> of the engine depending on the <u>engine combustion concept, design features and gas composition</u>. This maximum <u>continuous rating</u> in gas mode and the corresponding conditions are to be stated by the engine manufacturer. (2) Where variable fuel oil / gas ratio modes of operation	2.5 Design Requirements for Each Kind of Engines 2.5.1 Dual Fuel Engine 1 General The maximum continuous <u>power</u> that a dual fuel engine can develop in gas mode may be lower than the <u>approved MCR</u> of the engine (i.e. in <u>oil fuel mode</u>), <u>depending in particular on the gas composition and its quality or the engine design</u>. This maximum <u>power available</u> in gas mode and the corresponding conditions are to be stated by the engine manufacturer. (Newly added)	UR M78, 3.1.1

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Amended	Original	Remarks
<u>are offered by the engine manufacturer, details are to be included in the engine particulars and operation manuals.</u> 2 Starting, changeover and stopping (1) Dual fuel engines are to be arranged to be started using either fuel <u>oil</u> or gas fuel with pilot fuel for ignition. The engines are to be arranged for rapid changeover from gas use to fuel oil use. In the case of changeover to either fuel supply, the engines are to be capable of continuous operation using the alternative fuel supply without interruption to the power supply. (2) Changeover to gas fuel operation is to be only possible at a power level and under conditions where it can be done with acceptable reliability and safety as demonstrated through testing. (3) Changeover from gas fuel operation mode to fuel <u>oil</u> operation mode is to be possible at all situations and power levels. (4) The changeover process itself from and to gas operation is to be automatic but manual interruption is to be possible in all cases. (5) If the power level or other conditions do not allow safe and reliable gas operation, changeover to fuel <u>oil</u> mode is to be automatically performed. (6) In case of shut-off of the gas supply, the engines are to be capable of continuous operation by fuel <u>oil</u> only. 3 <u>Pilot fuel injection</u> (1) Gas supply to the combustion chamber is not to be possible without operation of the pilot <u>fuel</u> injection. In addition, pilot injection is to be monitored for example by fuel oil pressure and combustion parameters.	2 Starting, changeover and stopping (1) Dual fuel engines are to be arranged to be started using either <u>oil</u> fuel or gas fuel with pilot <u>oil</u> fuel for ignition. The engines are to be arranged for rapid changeover from gas use to fuel oil use. In the case of changeover to either fuel supply, the engines are to be capable of continuous operation using the alternative fuel supply without interruption to the power supply. (2) Changeover to gas fuel operation is to be only possible at a power level and under conditions where it can be done with acceptable reliability and safety as demonstrated through testing. (3) Changeover from gas fuel operation mode to <u>oil</u> fuel operation mode is to be possible at all situations and power levels. (4) The changeover process itself from and to gas operation is to be automatic but manual interruption is to be possible in all cases. (5) If the power level or other conditions do not allow safe and reliable gas operation, changeover to <u>oil</u> fuel mode is to be automatically performed. (6) In case of shut-off of the gas supply, the engines are to be capable of continuous operation by <u>oil</u> fuel only. 3 Gas supply to the combustion chamber is not to be possible without operation of the pilot <u>oil</u> injection. In addition, pilot injection is to be monitored for example by fuel oil pressure and combustion parameters.	UR M78, 3.1.2 UR M78, 3.1.3

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Amended	Original	Remarks
(2) <u>In case of a failure of the pilot fuel injection function, the engine is to switch to fuel oil mode. However, this does not apply provided that all of the following conditions are satisfied:</u> (a) <u>The failure is limited to one cylinder</u> (b) <u>The gas supply to the affected cylinder is immediately cut off</u> (c) <u>Operation with one cylinder cut out is acceptable with respect to torsional vibrations</u> (d) <u>The safe operation of the engine is substantiated by the safety concept, risk analysis and demonstrated at the type test.</u> 2.5.2 Gas only engine In case of failure of the spark ignition, the engine is to be shut down except when the following (1) to (3) are satisfied: (1) the failure is limited to one cylinder; (2) the gas supply to the failed cylinder is immediately shut off; and (3) safe operation of the engine is substantiated by <u>safety concept / risk analysis and demonstrated at type tests (refer to 8.5.2-2(6)(j), Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use).</u> 2.5.3 Pre-mixed Engine (Deleted) <u>1 Failures of charge air system components likely to result in a gas leakage are to be considered in the safety concept and risk analysis.</u> <u>2 Flame arresters are to be installed before each cylinder</u>	(Newly added) 2.5.2 Gas only engine In case of failure of the spark ignition, the engine is to be shut down except when the following (1) to (3) are satisfied: (1) the failure is limited to one cylinder; (2) the gas supply to the failed cylinder is immediately shut off; and (3) safe operation of the engine is substantiated by <u>risk analysis and tests.</u> 2.5.3 Pre-mixed Engine <u>Inlet manifolds, turbochargers, charge air coolers, etc. are to be regarded as parts of fuel gas supply systems.</u> (Newly added)	(3): UR M78, 3.2.1 UR M78, 3.3.1 para.1 UR M78, 3.3.1 para.2

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Amended	Original	Remarks
<u>head, unless otherwise justified in the safety concept / risk analysis, considering design parameters of the engine such as the gas concentration in the charge air system, the path length of the gas-air mixture in the charge air system, etc.</u> Chapter 4 CONTROL, ALARM AND SAFETY SYSTEMS 4.1 General 6 Combustion is to be monitored on an individual cylinder basis. <u>In case of knocking or misfiring, either the unstable combustion is to be corrected automatically by the control system, e.g. transient adjustments, or, if a failure has occurred and can no longer be corrected by the control system, the safety system is to be activated in accordance with Table 4.1.</u> 7 In the event that poor combustion is detected on an individual cylinder, gas operation may be allowed in the conditions specified in 10.3.1-6, Part GF of the Rules. 8 <u>Where validated by the safety concept and risk analysis, the engine monitoring and safety system may be configured so that the gas supply double block-and-bleed valves and the switch to fuel oil (or shut-down for gas fuel only engines) may not be activated in case of specific failures affecting one cylinder, provided that the concerned cylinder can be individually cut off from gas operation and engine operation is acceptable with respect to torsional vibrations. Operation of the functionality is to be demonstrated at type tests (refer to 8.5.2-2(6)(j), Part 6, Guidance for the Approval of Materials and Equipment for Marine Use).</u> 9 Regardless of -6, if monitoring of combustion for each	Chapter 4 CONTROL, ALARM AND SAFETY SYSTEMS 4.1 General 6 Combustion is to be monitored on an individual cylinder basis. 7 In the event that poor combustion is detected on an individual cylinder, gas operation may be allowed in the conditions specified in 10.3.1-6, Part GF of the Rules. (Newly added) 8 Regardless of -6, if monitoring of combustion for each	UR M78, 2.2.5 para.3 UR M78, 2.2.5 para.5

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks																																													
individual cylinder is not practicable due to engine size and design, common combustion monitoring may be accepted. 10 Unless risk analysis by a method deemed appropriate by the Society proves that risk is within the acceptable range, alarm and safety system functions of dual fuel or gas only engines are to be provided in accordance with Table 4.1. However, even if risk analysis proves that risk is within the acceptable range, the alarm and safety system functions specified in Part N of the Rules are still to be provided. Additional alarms and safety devices may be required if deemed necessary by the Society.	individual cylinder is not practicable due to engine size and design, common combustion monitoring may be accepted. 9 Unless risk analysis by a method deemed appropriate by the Society proves that risk is within the acceptable range, alarm and safety system functions of dual fuel or gas only engines are to be provided in accordance with Table 4.1. <u>(for dual fuel engines, Table 4.1 applies only to gas mode)</u> However, even if risk analysis proves that risk is within the acceptable range, the alarm and safety system functions specified in Part N of the Rules are still to be provided. Additional alarms and safety devices may be required if deemed necessary by the Society.	UR M78, 2.2.5 para.7																																													
Table 4.1 Alarm and Safety System Functions for Dual Fuel Engines																																															
<table><tr><th>Parameter</th><th>Alarm</th><th>Automatic activation of the double block and bleed valves</th><th>Automatic switching over to oil fuel mode ^{§1)}</th><th>Engine shutdown</th></tr><tr><td>1. Abnormal pressures in the gas fuel supply line</td><td>X</td><td>X</td><td>X</td><td>X ⁵⁾</td></tr><tr><td>2. Gas fuel supply systems - malfunction</td><td>X</td><td>X</td><td>X</td><td>X ⁵⁾</td></tr><tr><td><u>3. Leak detection in annular space of double walled pipes ¹²⁾</u></td><td><u>X</u></td><td><u>X</u></td><td><u>X</u></td><td><u>X ⁵⁾</u></td></tr><tr><td>34. Pilot fuel injection or spark ignition systems - malfunction</td><td>X</td><td>X ²⁾</td><td>X</td><td>X ²⁾⁵⁾</td></tr><tr><td>45. Exhaust gas temperature after each cylinder - high ¹³⁾</td><td>X</td><td>X ²⁾</td><td>X</td><td>X ²⁾⁵⁾</td></tr><tr><td>56. Exhaust gas temperature after each cylinder - low³⁾ ¹³⁾</td><td>X</td><td>X ²⁾</td><td>X</td><td>X ²⁾⁵⁾</td></tr><tr><td>67. Cylinder pressure or ignition - failure, including misfiring, knocking and unstable combustion ¹³⁾</td><td>X</td><td>X ²⁾⁴⁾</td><td>X⁴⁾</td><td>X ²⁾⁴⁾⁵⁾</td></tr><tr><td>78. Oil mist concentration in crankcase</td><td>X</td><td>X</td><td>-</td><td>X ⁹⁾</td></tr></table>			Parameter	Alarm	Automatic activation of the double block and bleed valves	Automatic switching over to oil fuel mode ^{§1)}	Engine shutdown	1. Abnormal pressures in the gas fuel supply line	X	X	X	X ⁵⁾	2. Gas fuel supply systems - malfunction	X	X	X	X ⁵⁾	<u>3. Leak detection in annular space of double walled pipes ¹²⁾</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X ⁵⁾</u>	3 4. Pilot fuel injection or spark ignition systems - malfunction	X	X ²⁾	X	X ²⁾⁵⁾	4 5. Exhaust gas temperature after each cylinder - high ¹³⁾	X	X ²⁾	X	X ²⁾⁵⁾	5 6. Exhaust gas temperature after each cylinder - low ³⁾ ¹³⁾	X	X ²⁾	X	X ²⁾⁵⁾	6 7. Cylinder pressure or ignition - failure, including misfiring, knocking and unstable combustion ¹³⁾	X	X ²⁾⁴⁾	X ⁴⁾	X ²⁾⁴⁾⁵⁾	7 8. Oil mist concentration in crankcase	X	X	-	X ⁹⁾
Parameter	Alarm	Automatic activation of the double block and bleed valves	Automatic switching over to oil fuel mode ^{§1)}	Engine shutdown																																											
1. Abnormal pressures in the gas fuel supply line	X	X	X	X ⁵⁾																																											
2. Gas fuel supply systems - malfunction	X	X	X	X ⁵⁾																																											
<u>3. Leak detection in annular space of double walled pipes ¹²⁾</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X ⁵⁾</u>																																											
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7 8. Oil mist concentration in crankcase	X	X	-	X ⁹⁾																																											
UR M78, Table 2																																															

Amended-Original Requirements Comparison Table
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Amended			Original		Remarks
or bearing temperature ⁶⁾ - high					
8 <u>9</u> . Pressure in the crankcase - high ⁸⁾	X	X	X	-	
9 <u>10</u> . Engine stops - any cause	X	X	-	-	
10 <u>11</u> . Failure of the control-actuating medium of the block and bleed valves	X	X	X	-	
11 <u>12</u> . Failure of crankcase ventilation system, if applicable	X	X ⁷⁾	X ⁷⁾	-	
12 <u>13</u> . Abnormal temperature in the gas fuel supply line	X	X ¹⁰⁾	X ¹⁰⁾	X ⁵⁾¹⁰⁾¹¹⁾	
13 <u>14</u> . Leak detection between gas piping and outer pipes or ducts as specified in 16.4.3, Part N of the Rules ¹⁰⁾	X	X	X	X ⁵⁾	
14 <u>15</u> . Low pressures of hydraulic and pneumatic sources, or loss of electric power supply for gas fuel combustion control ¹⁰⁾	X	X	X	X ⁵⁾¹¹⁾	

Notes:

- 1) Dual fuel engine only, when running in gas mode
- 2) ~~For gas fuel only engines, the~~ The double block and bleed valves and the engine shutdown may not be activated in case of specific failures affecting only one cylinder, provided that the concerned cylinder can be individually shutoff and the safe operation of the engine in such conditions is demonstrated by the risk analysis off from gas operation (see 4.1-8).
- 3) Required only if necessary for the detection of misfiring. In addition, deviation from average is to be used for the operation setting of each function.
- 4) In cases where the failure can be corrected by an automatic mitigation action, only the alarm may be activated. If the failure persists after a given time, the safety actions are to be activated. (see 4.1-6).
- 5) Only for Gas fuel only ~~engineengines~~
- 6) Where required by 2.4.5, Part D of the Rules.
- 7) Automatic safety actions to be activated as specified by the engine manufacturer (see 2.2.2-6, Part D of the Rules)
- 8) Only for trunk piston engines. Method for crankcase overpressure, or fault condition, monitoring to be detailed in the safety concept.
- 9) Only for trunk piston engines. For crosshead engines slow down applies (see 2.4.5, Part D of the Rules)
- 10) Only for gas-fuelled engines installed onboard ships subject to the application of 1.1.1, Rules for Automatic and Remote Control Systems

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Amended	Original	Remarks
11) Slowdown is acceptable instead of shutdown. In this case, “automatic activation of the double block and bleed valves” does not apply. 12) <u>Gas detection alarms and shutdowns in accordance with Table GF15.1, Part GF of the Rules. For LPG fuels in accordance with MSC.1/Circ.1666.</u> 13) <u>Where monitoring of exhaust temperature or combustion for each cylinder is not practicable due to the engine size and design, common combustion monitoring may be accepted. See 4.1-9 and the Rules for Automatic and Remote Control Systems.</u>		
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (C)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
Chapter 5 TESTS 5.3 Tests after Installation On Board 1 The control systems of gas-fuelled engines and related equipment are to be subjected to tests in accordance with 18.7.3, Part D of the Rules or 2.2.4, Rules for Automatic and Remote Control Systems according to the kind of Installations Character. 2 A leak test is to be carried out for the gas piping system after assembly on board in accordance with 16.7.3-3, Part GF of the Rules. 3 The efficiency of the ventilation arrangement, or other approved principle, of the double walled gas piping system is to be verified. 4 <u>For pressurised double wall piping systems installed in accordance with 16.4.3(1), Part N of the Rules, the outer pipe or duct is to be pressure tested at 1.5 <i>times</i> the design pressure of the outer pipe or duct.</u> 5 <u>For ventilated double wall piping systems installed in accordance with 16.4.3(2), Part N of the Rules, the outer pipe or duct is to be pressure tested at the design pressure calculated in accordance with 9.8.1 or 9.8.2, Part GF of the Rules to ensure gas-tight integrity.</u>	Chapter 5 TESTS 5.3 Tests after Installation On Board 1 The control systems of gas-fuelled engines and related equipment are to be subjected to tests in accordance with 18.7.3, Part D of the Rules or 2.2.4, Rules for Automatic and Remote Control Systems according to the kind of Installations Character. 2 A leak test is to be carried out for the gas piping system after assembly on board in accordance with 16.7.3-3, Part GF of the Rules. 3 The efficiency of the ventilation arrangement, or other approved principle, of the double walled gas piping system is to be verified. (Newly added) (Newly added)	(5)(d): UR M78, 2.2.2.1 para.5 (5)(e): UR M78, 2.2.2.1 para.4
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (B)		

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Amended	Original	Remarks
RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part P MOBILE OFFSHORE DRILLING UNITS AND SPECIAL PURPOSE BARGES Chapter 11 MACHINERY INSTALLATIONS 11.1 General 11.1.2 General 1 For machinery installations other than those used for solely for the operation which is the purpose of the unit, relevant requirements in Part D listed in the following (1) to (40) as well as the requirements in this Chapter are to be applied. ((1) to (8) are omitted.) (9) Chapter 2, Part D Reciprocating Internal Combustion Engines and Exhaust Driven Turbochargers ((10) to (40) are omitted.) 2 For machinery installations used solely for the operation which is the purpose of the unit, relevant requirements in Part D listed in the following (1) to (25) as well as the requirements in 11.1.3 and 11.1.4 are to be applied. ((1) to (8) are omitted.) (9) 2.2.2-4, Part D Reciprocating Internal Combustion Engines and Exhaust Driven Turbochargers -	RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part P MOBILE OFFSHORE DRILLING UNITS AND SPECIAL PURPOSE BARGES Chapter 11 MACHINERY INSTALLATIONS 11.1 General 11.1.2 General 1 For machinery installations other than those used for solely for the operation which is the purpose of the unit, relevant requirements in Part D listed in the following (1) to (40) as well as the requirements in this Chapter are to be applied. ((1) to (8) are omitted.) (9) Chapter 2, Part D Reciprocating Internal Combustion Engines ((10) to (40) are omitted.) 2 For machinery installations used solely for the operation which is the purpose of the unit, relevant requirements in Part D listed in the following (1) to (25) as well as the requirements in 11.1.3 and 11.1.4 are to be applied. ((1) to (8) are omitted.) (9) 2.2.2-4, Part D Reciprocating Internal Combustion Engines - Materials, Construction and Strength -	Amended to reflect the revision of the title of Chapter 2, Part D. Amended to reflect the

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Amended	Original	Remarks
Materials, Construction and Strength - Construction, Installation and General (10) 2.2.2-5, Part D Reciprocating Internal Combustion Engines <u>and Exhaust Driven Turbochargers</u> - Materials, Construction and Strength - Construction, Installation and General (11) 2.2.2-6, Part D Reciprocating Internal Combustion Engines <u>and Exhaust Driven Turbochargers</u> - Materials, Construction and Strength - Construction, Installation and General (12) 2.4, Part D Reciprocating Internal Combustion Engines <u>and Exhaust Driven Turbochargers</u> - Safety Devices (13) 2.5.4, Part D Reciprocating Internal Combustion Engines <u>and Exhaust Driven Turbochargers</u> - Associated Installations - Fuel Oil Arrangements ((14) to (25) are omitted.)	Construction, Installation and General (10) 2.2.2-5, Part D Reciprocating Internal Combustion Engines - Materials, Construction and Strength - Construction, Installation and General (11) 2.2.2-6, Part D Reciprocating Internal Combustion Engines - Materials, Construction and Strength - Construction, Installation and General (12) 2.4, Part D Reciprocating Internal Combustion Engines - Safety Devices (13) 2.5.4, Part D Reciprocating Internal Combustion Engines - Associated Installations - Fuel Oil Arrangements ((14) to (25) are omitted.)	revision of the title of Chapter 2, Part D.

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Amended	Original	Remarks
RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part PS FLOATING OFFSHORE FACILITIES FOR CRUDE OIL/PETROLEUM GAS PRODUCTION, STORAGE AND OFFLOADING Chapter 7 MACHINERY INSTALLATIONS 7.1 General 7.1.2 General 1 With respect to machinery installations other than those used solely for the specific operation which is the purpose of the Floating Offshore Facility (the processing of crude oil, etc. extracted from seabeds.), relevant requirements given in Part D listed in the following (1) to (46) as well as the requirements given in this Chapter are to be applied. (The terms “cargo” and “cargo oil” are to be construed as “crude oil”, “carry” and “transport” are to be construed as “process/store”, “ship” and “tanker” are to be construed as “Floating Offshore Facility”). ((1) to (8) are omitted.) (9) Chapter 2, Part D Reciprocating Internal Combustion Engines <u>and Exhaust Driven Turbochargers</u>	RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part PS FLOATING OFFSHORE FACILITIES FOR CRUDE OIL/PETROLEUM GAS PRODUCTION, STORAGE AND OFFLOADING Chapter 7 MACHINERY INSTALLATIONS 7.1 General 7.1.2 General 1 With respect to machinery installations other than those used solely for the specific operation which is the purpose of the Floating Offshore Facility (the processing of crude oil, etc. extracted from seabeds.), relevant requirements given in Part D listed in the following (1) to (46) as well as the requirements given in this Chapter are to be applied. (The terms “cargo” and “cargo oil” are to be construed as “crude oil”, “carry” and “transport” are to be construed as “process/store”, “ship” and “tanker” are to be construed as “Floating Offshore Facility”). ((1) to (8) are omitted.) (9) Chapter 2, Part D Reciprocating Internal Combustion Engines	Amended to reflect the revision of the title of Chapter 2, Part D.

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Amended	Original	Remarks
((10) to (46) are omitted.) 2 With respect to machinery installations used solely for a specific operation which is the purpose of the Floating Offshore Facility (the processing of crude oil, etc. extracted from seabeds.), relevant requirements given in Part D listed in the following (1) to (25) as well as the requirements given in 7.1.3 and 7.1.4 are to be applied. (The terms “cargo” and “cargo oil” are to be construed as “crude oil”, “carry” and “transport” are to be construed as “process/store”, “ship” and “tanker” are to be construed as “Floating Offshore Facility”.) ((1) to (8) are omitted.) (9) 2.2.2-4, Part D Reciprocating Internal Combustion Engines <u>and Exhaust Driven Turbochargers</u> - Materials, Construction and Strength - Construction, Installation and General (10) 2.2.2-5, Part D Reciprocating Internal Combustion Engines <u>and Exhaust Driven Turbochargers</u> - Materials, Construction and Strength - Construction, Installation and General (11) 2.2.2-6, Part D Reciprocating Internal Combustion Engines <u>and Exhaust Driven Turbochargers</u> - Materials, Construction and Strength - Construction, Installation and General (12) 2.4, Part D Reciprocating Internal Combustion Engines <u>and Exhaust Driven Turbochargers</u> - Safety Devices (13) 2.5.4, Part D Reciprocating Internal Combustion Engines <u>and Exhaust Driven Turbochargers</u> - Associated Installations - Fuel Oil Arrangements ((14) to (25) are omitted.)	((10) to (46) are omitted.) 2 With respect to machinery installations used solely for a specific operation which is the purpose of the Floating Offshore Facility (the processing of crude oil, etc. extracted from seabeds.), relevant requirements given in Part D listed in the following (1) to (25) as well as the requirements given in 7.1.3 and 7.1.4 are to be applied. (The terms “cargo” and “cargo oil” are to be construed as “crude oil”, “carry” and “transport” are to be construed as “process/store”, “ship” and “tanker” are to be construed as “Floating Offshore Facility”.) ((1) to (8) are omitted.) (9) 2.2.2-4, Part D Reciprocating Internal Combustion Engines - Materials, Construction and Strength - Construction, Installation and General (10) 2.2.2-5, Part D Reciprocating Internal Combustion Engines - Materials, Construction and Strength - Construction, Installation and General (11) 2.2.2-6, Part D Reciprocating Internal Combustion Engines - Materials, Construction and Strength - Construction, Installation and General (12) 2.4, Part D Reciprocating Internal Combustion Engines - Safety Devices (13) 2.5.4, Part D Reciprocating Internal Combustion Engines - Associated Installations - Fuel Oil Arrangements ((14) to (25) are omitted.)	Amended to reflect the revision of the title of Chapter 2, Part D.

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Amended	Original	Remarks
RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part Q STEEL BARGES Chapter 20 MACHINERY 20.2 Internal Combustion Engines 20.2.1 General Construction 4 The fuel oil arrangements for internal combustion engines having a carburetor are to comply with the requirements in 20.4.5 and additionally, the requirements in 2.5.3, Part D.	RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part Q STEEL BARGES Chapter 20 MACHINERY 20.2 Internal Combustion Engines 20.2.1 General Construction 4 The fuel oil arrangements for internal combustion engines having a carburetor are to comply with the requirements in 20.4.5 and additionally, the requirements in 2.5.4, Part D.	Alignment of reference numbers

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Amended	Original	Remarks
RULES FOR HIGH SPEED CRAFT Part 2 CLASS SURVEYS Chapter 2 CLASSIFICATION SURVEYS 2.1 Classification Survey during Construction 2.1.2 Submission of Plans and Documents* 1 When it is intended to build a craft to the classification with the Society, the plans and documents specified in (1) to (3) below are to be submitted for the approval by the Society before the work is commenced. Plans and documents may be subjected to examination by the Society prior to the submission of the application for the classification of the craft in accordance with the provision specified otherwise by the Society: ((1) is omitted.) (2) Machinery (a) Machinery arrangement of machinery space, diagram for internal communication systems (including diagram for engineers' alarm systems) (b) Main and auxiliary engines (including their accessories): i) Reciprocating internal combustion engines Plans and data specified in 2.1.4-1(1), Part 9 of the Rules as well as documents	RULES FOR HIGH SPEED CRAFT Part 2 CLASS SURVEYS Chapter 2 CLASSIFICATION SURVEYS 2.1 Classification Survey during Construction 2.1.2 Submission of Plans and Documents* 1 When it is intended to build a craft to the classification with the Society, the plans and documents specified in (1) to (3) below are to be submitted for the approval by the Society before the work is commenced. Plans and documents may be subjected to examination by the Society prior to the submission of the application for the classification of the craft in accordance with the provision specified otherwise by the Society: ((1) is omitted.) (2) Machinery (a) Machinery arrangement of machinery space, diagram for internal communication systems (including diagram for engineers' alarm systems) (b) Main and auxiliary engines (including their accessories): i) Reciprocating internal combustion engines Plans and data specified in 2.1.3-1(1), Part 9 of the Rules as well as documents	Amended in line with the corresponding amendments to Part D of the Rules for the Survey and Construction of Steel Ships.

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Amended	Original	Remarks
showing specifications of louvers for emergency generator rooms and closing appliances of ventilators fitted to the rooms (if they are of power-operated type.) ii) Gas turbines Plans and data specified in 3.1.3(1), Part 9 of the Rules ((c) to (n) are omitted.) ((3) and (4) are omitted.) 2.1.3 Submission of Other Plans and Documents 1 When it is intended to build a craft to the classification with the Society, the following plans and documents are to be submitted in addition to those required in 2.1.2: ((1) and (6) are omitted.) (7) The following plans and documents related to machinery: (a) Main and auxiliary engines (including their accessories): i) Reciprocating internal combustion engines Plans and data specified in 2.1.4-1, Part 9 of the Rules ii) Gas turbines Plans and data specified in 3.1.3(2), Part 9 of the Rules ((b) to (j) are omitted.) ((8) to (11) are omitted.)	showing specifications of louvers for emergency generator rooms and closing appliances of ventilators fitted to the rooms (if they are of power-operated type.) ii) Gas turbines Plans and data specified in 3.1.3(1), Part 9 of the Rules ((c) to (n) are omitted.) ((3) and (4) are omitted.) 2.1.3 Submission of Other Plans and Documents 1 When it is intended to build a craft to the classification with the Society, the following plans and documents are to be submitted in addition to those required in 2.1.2: ((1) and (6) are omitted.) (7) The following plans and documents related to machinery: (a) Main and auxiliary engines (including their accessories): i) Reciprocating internal combustion engines Plans and data specified in 2.1.3-1, Part 9 of the Rules ii) Gas turbines Plans and data specified in 3.1.3(2), Part 9 of the Rules ((b) to (j) are omitted.) ((8) to (11) are omitted.)	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
Part 9 MACHINERY INSTALLATIONS Chapter 2 RECIPROCATING INTERNAL COMBUSTION ENGINES <u>AND EXHAUST DRIVEN TURBOCHARGERS</u> 2.1 General 2.1.1 General* (Deleted) <u>3</u> (Omitted) <u>4</u> (Omitted) 2.1.2 Terminology (Deleted)	Part 9 MACHINERY INSTALLATIONS Chapter 2 RECIPROCATING INTERNAL COMBUSTION ENGINES 2.1 General 2.1.1 General* <u>3</u> The requirements of exhaust driven turbochargers specified in this chapter also apply, in principle, to engine driven chargers. <u>4</u> (Omitted) <u>5</u> (Omitted) 2.1.2 Terminology <u>1</u> In this chapter, exhaust driven turbochargers are categorised into the following three groups according to the engine power at maximum continuous rating (<i>MCR</i>) supplied by a group of cylinders served by the actual turbocharger (e.g., turbocharger size is to be 50% of total engine power for a <i>V</i>-engine with one turbocharger serving each bank of cylinders). <u>(1)</u> Category <i>A</i> turbochargers The engine power at <i>MCR</i> supplied by a group of cylinders served by the turbocharger is not more than 1000 <i>kW</i>. <u>(2)</u> Category <i>B</i> turbochargers The engine power at <i>MCR</i> supplied by a group of	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
	<u>cylinders served by the turbocharger is not less than 1000 kW, but not more than 2500 kW.</u> (3) <u>Category C turbochargers</u> <u>The engine power at MCR supplied by a group of cylinders served by the turbocharger is not less than 2500 kW.</u>	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
<u>1</u> The terminology used in the application of 2.1.3 and 2.1.4 is as specified in the following (1) to (37): ((1) to (31) are omitted.) (32) “Sub-system” means assembly of components belonging to engine, intended to achieve a defined function and which may affect the engine performance, e.g. electronic control systems and gas system of gas fuelled engines. (33) (Omitted) (34) (Omitted) (35) (Omitted) (36) (Omitted) (37) (Omitted) 2 (Omitted) 2.1.3 Approval of Reciprocating Internal Combustion Engines* 1 Reciprocating internal combustion engines are to be approved in accordance with the following (1) to (5): (Deleted) (1) Each type of reciprocating internal combustion engine is to be provided with a certificate of type approval <u>or design evaluation</u> obtained by the licensor in accordance with 2.1.1-2 prior to the commencement of manufacture by the engine manufacturer	<u>2</u> The terminology used in the application of 2.1.3 and 2.1.4 is as specified in the following (1) to (36): ((1) to (31) are omitted.) (Newly added) (32) (Omitted) (33) (Omitted) (34) (Omitted) (35) (Omitted) (36) (Omitted) 3 (Omitted) 2.1.4 Approval of Reciprocating Internal Combustion Engines* 1 Reciprocating internal combustion engines are to be approved in accordance with the following (1) to (6): (1) <u>Development of documents and data for engine production</u> (a) <u>Prior to the start of the reciprocating internal combustion engine approval process in accordance with the following (c) and subsequent sub-paragraphs of this paragraph, a design approval is to be obtained as specified separately by the Society.</u> (b) Each type of reciprocating internal combustion engine is to be provided with a certificate of type approval obtained by the licensor in accordance with 2.1.1-2. For the first engine of a type or for those with no service records, the process of an	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
<u>(hereinafter referred to as “licensee” in this Chapter).</u> 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. (2) <u>Drawings and data for the approval of reciprocating internal combustion engines in this Chapter are to be submitted in accordance with 2.1.4.</u>	approval of use and the approval process for production by the licensee may be performed simultaneously. (Newly added) (c) <u>The licensor is to review the drawings and data of the reciprocating internal combustion engine whose type approval has been obtained for the application and develop, if necessary, application specific drawings and data for production of reciprocating internal combustion engines for the use of the licensee in developing the reciprocating internal combustion engine specific production drawings and data for the purpose of inspection and testing specified in 2.1.3-1.</u> (d) <u>If substantive modifications to the drawings and data of the reciprocating internal combustion engine whose type approval has been obtained have been made in the drawings and data of 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.</u> (2) <u>Drawings and data for the inspection and testing of reciprocating internal combustion engines</u> (a) <u>The licensee is to develop the drawings and data for the inspection and testing specified in 2.1.3-1 and a comparison list of these drawings and data</u>	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
	to the drawings and data of the reciprocating internal combustion engine whose type approval has been obtained by the licensor and submit these drawings and the comparison list to the Society. (b) <u>As for the drawings and data for the inspection and testing specified in 2.1.3-1, if there are differences in the technical content on the licensee's production drawings and data of the reciprocating internal combustion engine compared to the drawings and data of the reciprocating internal combustion engine whose type approval 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 reciprocating internal combustion engine manufactured by the licensee is to be regarded as a different engine type and is 2.1.1-2 is to apply to the reciprocating internal combustion engine.</u> (c) <u>In applying (b) above, modifications applied by the licensee are to be provided with appropriate quality requirements.</u> (d) <u>The Society returns the drawings and data specified in (a) and (b) above to the licensee with confirmation that the design has been approved.</u> (e) <u>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</u>	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(3) <u>Licensee assessment</u> The Society <u>verifies</u> conformity of production with the Society's requirements for production facilities comprising manufacturing facilities and processes, machining tools, quality assurance, testing facilities, etc. (Deleted) (4) <u>Engine assembly and testing</u> The licensee is to assemble and test the reciprocating internal combustion engine according to the Society's technical rules. <u>The testing of each reciprocating internal combustion engine is to be witnessed by the Surveyor unless the manufacturer of the reciprocating internal combustion engine is one approved in accordance with the Rules for Approval of Manufacturers and Service Suppliers and use of a</u>	<u>during manufacture and testing of the reciprocating internal combustion engine and its components.</u> (3) <u>Additional drawings and data</u> <u>In addition to the drawings and data for inspection and testing specified in 2.1.3-1, the licensee is to be able to provide to the Surveyor performing the test specified in 2.6.1, Part D of the Rules for the Survey and Construction of Steel Ships upon request the relevant detail drawings, production quality control specifications and acceptance criteria. These drawings and data are for supplemental purposes to the survey only.</u> (4) <u>Licensee approval</u> (a) <u>The Society assesses conformity of production with the Society's requirements for production facilities comprising manufacturing facilities and processes, machining tools, quality assurance, testing facilities, etc. as specified separately by the Society.</u> (b) <u>Satisfactory conformance with (a) above results in the issue of a document showing the licensee has been approved by the Society.</u> (5) <u>Engine assembly and testing</u> The licensee is to assemble and test the reciprocating internal combustion engine according to the Society's technical rules <u>each of the reciprocating internal combustion engine assembly and testing procedure is to be witnessed by the Surveyor unless the manufacturer of the reciprocating internal combustion engine is one approved in accordance with the Rules for Approval of Manufacturers and Service</u>	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
mass production system is agreed between the manufacturer and the Society. (5) Issue of certificates of reciprocating internal combustion engines and components (a) The attending Surveyors, at the licensee/subcontractors, will issue product certificates as necessary for components manufactured upon satisfactory inspections and tests. (b) An engine certificate is issued by the Surveyor upon satisfactory completion of assembly and tests specified in (4) above. (Deleted) <u>2</u> Components <u>and sub-systems</u> of licensor's design which are covered by the certificate of <u>type</u> approval of the relevant engine type are regarded as approved whether manufactured by the reciprocating internal combustion engine manufacturer or sub-supplied. For components <u>and subsystems</u> of subcontractor's design, necessary approvals are to be obtained by the relevant suppliers (e.g. exhaust gas turbochargers). <u>3</u> In case where the <u>scope of a certificate of type approval or design evaluation is extended to allow the incorporation of an additional or alternative sub-system, the requirements specified separately by the Society are to apply.</u> <u>4</u> In case where <u>type approval for sub-systems is</u>	Suppliers and use of a mass production system is agreed between the manufacturer and the Society. (6) Issue of certificates of reciprocating internal combustion engines and components (a) The attending Surveyors, at the licensee/subcontractors, will issue product certificates as necessary for components manufactured upon satisfactory inspections and tests. (b) An engine certificate is issued by the Surveyor upon satisfactory completion of assembly and tests specified in (5) above. <u>2</u> 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 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. <u>3</u> Components of licensor's design which are covered by the certificate of approval <u>of use</u> of the relevant engine type are regarded as approved whether manufactured by the reciprocating internal combustion engine manufacturer or sub-supplied. <u>4</u> For components of subcontractor's design, necessary approvals are to be obtained by the relevant suppliers (e.g. exhaust gas turbochargers, <u>charge air coolers, etc.</u>). (Newly added) (Newly added)	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
<u>required by the Society or is voluntarily sought, the requirements specified separately by the Society are to apply.</u> 5 <u>The engine approval based on type approval specified in -1(1) may be substituted by individual approval when deemed appropriate by the Society. In such cases, requirements equivalent to those for approval based on type approval are to apply.</u> 2.1.4 Drawings and Data* 1 Drawings and data to be submitted are generally as follows: (1) Drawings and data for approval (a) <u>A list containing all drawings and data submitted (including relevant drawing numbers and revision status)</u> (b) <u>Engine particulars (The applicable items in the following i) to xvii) are to be included.)</u> i) <u>Engine type</u> ii) <u>Engine manufacturer</u> iii) <u>Maximum continuous rating (MCR)</u> iv) <u>Speed (rpm)</u> v) <u>Maximum combustion pressure</u> vi) <u>Mean effective pressure</u> vii) <u>Mean indicated pressure</u> viii) <u>Bore</u> ix) <u>Stroke</u> x) <u>Crankshaft materials</u> xi) <u>Type and number of exhaust driven turbochargers</u> xii) <u>Type of crankcase explosion relief valves</u> xiii) <u>Type of oil mist detection arrangements</u> xiv) <u>Type of electronic governors</u>	(Newly added) 2.1.3 Drawings and Data* 1 Drawings and data to be submitted are generally as follows: (1) Drawings and data for approval <u>Drawings and data specified in Table 9.2.1(a)</u>	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
<u>xv) Software name and version number of electronic control systems</u> <u>xvi) Sub-systems</u> <u>xvii) Other items deemed necessary by the Society</u> <u>(c) In cases where the engine designer and the engine manufacturer are different, schematic layout or other equivalent drawings and data on the engine of the following i) to vii):</u> <u>i) Starting air system</u> <u>ii) Fuel system</u> <u>iii) Lubricating oil system</u> <u>iv) Cooling water system</u> <u>v) Hydraulic system</u> <u>vi) Hydraulic system (for valve lift)</u> <u>vii) Engine control and safety system</u> <u>(d) Drawings and data specified in -2, if applicable (this may be included in (a) above)</u> (2) Drawings and data for reference <u>(a) Documentation of the introduction of inert gas into the crankcase specified in 2.4.6-1, Part D of the Rules for the Survey and Construction of Steel Ships (if applicable)</u> <u>(b) Other drawings and data deemed necessary by the Society</u> (Deleted)	(2) Drawings and data for reference <u>Drawings and data specified in Table 9.2.1(b)</u> 2 <u>The drawings and data for the purpose of inspection and testing specified in -1 (the items represented by the mark ○ in Table 9.2.1(a) and Table 9.2.1(b), hereinafter indicated in the same way throughout this Chapter) are to be submitted in accordance with 2.1.4-1 by the engine manufacturer producing engines with the drawings and data whose type approval has been obtained in accordance with 2.1.1-2</u>	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
<u>2 The drawings and data specified in -1(1)(d) are to be submitted in accordance with the following (1) and (2).</u> (Deleted)	<u>(hereinafter referred to as “licensee” in this Chapter). Such drawings and data, however, may be submitted by the licensor in accordance with 2.1.4-2.</u> <u>(hereinafter referred to as 2.1.4-1(1) of the current Rules)</u> <u>(c) The licensor is to review the drawings and data of the reciprocating internal combustion engine whose type approval has been obtained for the application and develop, if necessary, application specific drawings and data for production of reciprocating internal combustion engines for the use of the licensee in developing the reciprocating internal combustion engine specific production drawings and data for the purpose of inspection and testing specified in 2.1.3-1.</u> <u>(d) If substantive modifications to the drawings and data of the reciprocating internal combustion engine whose type approval has been obtained have been made in the drawings and data of 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.</u> <u>(hereinafter referred to as 2.1.4-1(2) of the current Rules)</u> <u>(a) The licensee is to develop the drawings and data for the inspection and testing specified in 2.1.3-1 and a comparison list of these drawings and data to the drawings and data of the reciprocating internal combustion engine whose type approval</u>	
<u>(1) If there are differences in the drawing numbers or content of the licensee’s production drawings and data compared to the drawings and data whose type approval has been obtained by the licensor, a comparison list is to be prepared and submitted to the</u>		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
Society. (2) If there are differences in the technical content of the licensee's production drawings and data compared to the drawings and data whose type approval 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 reciprocating internal combustion engine manufactured by the licensee is to be regarded as a different engine type and is 2.1.1-2 is to apply to the reciprocating internal combustion engine.	has been obtained by the licensor <u>and submit these drawings and the comparison list to the Society.</u> (b) <u>As for the drawings and data for the inspection and testing specified in 2.1.3-1, if there are differences in the technical content on the licensee's production drawings and data of the reciprocating internal combustion engine compared to the drawings and data of the reciprocating internal combustion engine whose type approval 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 reciprocating internal combustion engine manufactured by the licensee is to be regarded as a different engine type and is 2.1.1-2 is to apply to the reciprocating internal combustion engine.</u> (c) <u>In applying (b) above, modifications applied by the licensee are to be provided with appropriate quality requirements.</u> (d) <u>The Society returns the drawings and data specified in (a) and (b) above to the licensee with confirmation that the design has been approved.</u> (e) <u>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 reciprocating internal combustion engine and its</u>	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
3 The licensee is to be able to provide to the Surveyor performing the test specified in 2.6.1, Part D of the Rules for the Survey and Construction of Steel Ships upon request <u>the drawings and data listed in Table 9.2.1</u>, the relevant detail drawings, production quality control specifications and acceptance criteria. These drawings and data are for supplemental purposes to the survey only.	<u>components.</u> (hereinafter referred to as 2.1.4-1(3) of the current Rules) (3) Additional drawings and data <u>In addition to the drawings and data for inspection and testing specified in 2.1.3-1</u>, the licensee is to be able to provide to the Surveyor performing the test specified in 2.6.1, Part D of the Rules for the Survey and Construction of Steel Ships upon request the relevant detail drawings, production quality control specifications and acceptance criteria. These drawings and data are for supplemental purposes to the survey only.	

Table 9.2.1(a) Drawings and Data for Approval

	Items	For inspection- and testing
(1)	Engine particulars (in the format designated by the Society)	⊖
(2)	Material specifications of main parts with information on non-destructive testing and pressure testing as applicable to the material	⊖
(3)	Bedplate and crankcase of welded design, with welding details and welding instructions ⁽⁺⁾	⊖
(4)	Thrust bearing bedplate of welded design, with welding details and welding instructions ⁽⁺⁾	⊖
(5)	Frame/framebox/gearbox of welded design, with welding details and instructions ⁽⁺⁾	⊖
(6)	Crankshaft, assembly and details	⊖
(7)	Thrust shaft or intermediate shaft (if integral with engine)	⊖
(8)	Shaft coupling bolts	⊖
(9)	Connecting rod bearings (four stroke design)	—
(10)	Bolts and studs for connecting rods (four stroke design)	⊖
(11)	Schematic layout or other equivalent drawings and data on the reciprocating internal combustion engine of the following (a) to (g) (details of the system so far as supplied by the licensee such as: main dimensions, operating media and maximum working pressures): (a) Starting air system (b) Fuel oil system (c) Lubricating oil system	⊖

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Amended		Original		Remarks
	(d) Cooling water system (e) Hydraulic system (f) Hydraulic system (for valve lift) (g) Engine control and safety system			
(12)	High pressure oil pipes for driving exhaust valves with its shielding	=		
(13)	Shielding of high pressure fuel pipes, assembly (all engines)	⊖		
(14)	High pressure parts for fuel oil injection system The documentation to contain specifications for pressures, pipe dimensions and materials.	⊖		
(15)	Arrangement and details of the crankcase explosion relief valve (only for engines of a cylinder diameter of 200 mm or more or a crankcase volume of 0.6 m ³ or more)	⊖		
(16)	Oil mist detection and/or alternative alarm arrangements	⊖		
(17)	Connecting rod with cap (four stroke design)	⊖		
(18)	Arrangement of foundation (for main engines only)	⊖		
(19)	The drawings, data, etc. required by 2.1.4.	⊖		
(20)	The following drawings and data for exhaust driven turbochargers: (a) Category A turbochargers (upon request) i) Sectional assembly (including principal dimensions and names of components) ii) Containment test report iii) Test procedures	=		

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Amended		Original	Remarks
	(b) Category B turbochargers i) Sectional assembly (including principal dimensions and materials of housing components for containment evaluation.) ii) Documentation of containment in the event of the disc fracture iii) Documentation of following operational data and limitations • Maximum permissible operating speed (<i>rpm</i>) • Maximum permissible exhaust gas temperature at the turbine inlet • Minimum lubrication oil inlet pressure • Maximum permissible vibration levels (self and externally generated vibrations) • 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) iv) Diagram of lubrication oil systems (diagrams included in piping arrangements fitted to engines may be accepted instead) v) Test report of type approval test (only for type approval tests) vi) Test procedure (only for type approval tests) (e) Category C turbochargers i) Drawings listed in (b) above ii) Drawings of the housing and rotating parts (including details of blade fixing) iii) Material specifications (including mechanical properties and chemical composition) of the parts mentioned in ii) above iv) Welding details and welding procedures for the parts mentioned in ii) above, if made of welded construction		
(21)	Other drawings and data deemed necessary by the Society	⊕	

Note:

(1) For approval of materials and weld procedure specification, the weld procedure specification is to include details of pre and post weld heat treatments, weld consumables and fit up conditions.

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended		Original	Remarks
Table 9.2.1(b) Drawings and Data for Reference			
	Items	For inspection and testing	
(1)	A list containing all drawings and data submitted – (including relevant drawing numbers and revision status)	⊖	
(2)	Bolts and studs for main bearings	⊖	
(3)	Connecting rod bearings (two-stroke design)	—	
(4)	Bolts and studs for cylinder heads and exhaust valve (two-stroke design)	⊖	
(5)	Bolts and studs for connecting rods (two-stroke design)	⊖	
(6)	Tie rods	⊖	
(7)	Piston pins	—	
(8)	Construction of accumulators for hydraulic oil and fuel oil	⊖	
(9)	Cylinder head fixing bolts and valve box fixing bolts	—	
(10)	Rocker valve gears	—	
(11)	Cylinder head	⊖	
(12)	Cylinder block, engine block	⊖	
(13)	Cylinder liner	⊖	
(14)	Counterweights (if not integral with crankshaft), including fastening	⊖	
(15)	Connecting rod with cap (two-stroke design)	⊖	
(16)	Crosshead	⊖	
(17)	Piston rod	⊖	
(18)	Piston, assembly, including identification (e.g. drawing number) of components	⊖	
(19)	Piston head	⊖	
(20)	Camshaft drive, assembly, including identification (e.g. drawing number) of components	⊖	
(21)	Flywheel	⊖	
(22)	Fuel oil injection pump	⊖	
(23)	Shielding and insulation of exhaust pipes and other parts of high temperature which may be impinged as a result of a fuel system failure, assembly	⊖	
(24)	Construction and arrangement of dampers	⊖	
(25)	Construction and arrangement of detuners, balancers or compensators, bracings as well as all calculation sheets related to engine balancing and engine vibration prevention	—	
(26)	For electronically controlled engines, assembly drawings or arrangements of the following (a) to (d): (a) Control valves (b) High pressure pumps (c) Drive for high pressure pumps	⊖	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended		Original		Remarks
	(d) Valve bodies, if applicable			
(27)	Operation and service manuals ⁽¹⁾		⊖	
(28)	Engine control system diagram (including the monitoring, safety and alarm systems)		—	
(29)	Test program resulting from FMEA (for engine control system) in cases of engines that rely on hydraulic, pneumatic or electronic control of fuel injection and/or valves		⊖	
(30)	Production specifications for castings and welding (sequence)		⊖	
(31)	Certification of a type approval for environmental tests, control components ⁽²⁾		⊖	
(32)	Quality requirements for engine production		⊖	
(33)	Location of measures preventing oil from spraying out from joints in flammable oil piping (if fitted)		—	
(34)	The following drawings and data for exhaust driven turbochargers (only for category C turbochargers): (a) Documentation of the safe torque transmission when the disc is connected to the shaft by an interference fit (b) Information on expected lifespan (creep, low cycle fatigue and high cycle fatigue are to be considered) (c) Operation and maintenance manuals		—	
(35)	Documentation of the introduction of inert gas into the crankcase (if applicable)		⊖	
(36)	Other drawings and data deemed necessary by the Society		⊖	
Notes: (1) — Operation and service manuals are to contain maintenance requirements (servicing and repair) including details of any special tools and gauges that are to be used with their fitting/settings together with any test requirements on completion of maintenance. (2) — Drawings and data modified for a specific application are to be submitted to the Society for information or approval, as applicable				

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks																																																												
Table 9.2.1 Drawings and Data for the Inspection and Testing of Reciprocating Internal Combustion Engines																																																														
	<table><tr><th></th><th>Items</th></tr><tr><td>(1)</td><td><u>Material specifications of main parts with information on non-destructive testing and pressure testing as applicable to the material</u></td></tr><tr><td>(2)</td><td><u>Bedplate and crankcase of welded design, with welding details and welding instructions</u></td></tr><tr><td>(3)</td><td><u>Thrust bearing bedplate of welded design, with welding details and welding instructions</u></td></tr><tr><td>(4)</td><td><u>Frame/framebox/gearbox of welded design, with welding details and instructions</u></td></tr><tr><td>(5)</td><td><u>Crankshaft, assembly and details</u></td></tr><tr><td>(6)</td><td><u>Thrust shaft or intermediate shaft (if integral with engine)</u></td></tr><tr><td>(7)</td><td><u>Shaft coupling bolts</u></td></tr><tr><td>(8)</td><td><u>Bolts and studs for main bearings</u></td></tr><tr><td>(9)</td><td><u>Bolts and studs for cylinder heads and exhaust valve (two-stroke design)</u></td></tr><tr><td>(10)</td><td><u>Bolts and studs for connecting rods</u></td></tr><tr><td>(11)</td><td><u>Tie rods</u></td></tr><tr><td>(12)</td><td><u>Shielding of high pressure fuel pipes, assembly (all engines)</u></td></tr><tr><td>(13)</td><td><u>Construction of accumulators for hydraulic oil and fuel oil</u></td></tr><tr><td>(14)</td><td><u>High pressure parts for fuel oil injection system</u> <u>The documentation to contain specifications for pressures, pipe dimensions and materials.</u></td></tr><tr><td>(15)</td><td><u>Arrangement and details of the crankcase explosion relief valve (only for engines of a cylinder diameter of 200 mm or more or a crankcase volume of 0.6 m³ or more)</u></td></tr><tr><td>(16)</td><td><u>Oil mist detection and/or alternative alarm arrangements</u></td></tr><tr><td>(17)</td><td><u>Cylinder head</u></td></tr><tr><td>(18)</td><td><u>Cylinder block, engine block</u></td></tr><tr><td>(19)</td><td><u>Cylinder liner</u></td></tr><tr><td>(20)</td><td><u>Counterweights (if not integral with crankshaft), including fastening</u></td></tr><tr><td>(21)</td><td><u>Connecting rod with cap</u></td></tr><tr><td>(22)</td><td><u>Crosshead</u></td></tr><tr><td>(23)</td><td><u>Piston rod</u></td></tr><tr><td>(24)</td><td><u>Piston, assembly, including identification (e.g. drawing number) of components</u></td></tr><tr><td>(25)</td><td><u>Piston head</u></td></tr><tr><td>(26)</td><td><u>Camshaft drive, assembly, including identification (e.g. drawing number) of components</u></td></tr><tr><td>(27)</td><td><u>Flywheel</u></td></tr><tr><td>(28)</td><td><u>Arrangement of foundation (for main engines only)</u></td></tr><tr><td>(29)</td><td><u>Fuel injection pump</u></td></tr></table>		Items	(1)	<u>Material specifications of main parts with information on non-destructive testing and pressure testing as applicable to the material</u>	(2)	<u>Bedplate and crankcase of welded design, with welding details and welding instructions</u>	(3)	<u>Thrust bearing bedplate of welded design, with welding details and welding instructions</u>	(4)	<u>Frame/framebox/gearbox of welded design, with welding details and instructions</u>	(5)	<u>Crankshaft, assembly and details</u>	(6)	<u>Thrust shaft or intermediate shaft (if integral with engine)</u>	(7)	<u>Shaft coupling bolts</u>	(8)	<u>Bolts and studs for main bearings</u>	(9)	<u>Bolts and studs for cylinder heads and exhaust valve (two-stroke design)</u>	(10)	<u>Bolts and studs for connecting rods</u>	(11)	<u>Tie rods</u>	(12)	<u>Shielding of high pressure fuel pipes, assembly (all engines)</u>	(13)	<u>Construction of accumulators for hydraulic oil and fuel oil</u>	(14)	<u>High pressure parts for fuel oil injection system</u> <u>The documentation to contain specifications for pressures, pipe dimensions and materials.</u>	(15)	<u>Arrangement and details of the crankcase explosion relief valve (only for engines of a cylinder diameter of 200 mm or more or a crankcase volume of 0.6 m³ or more)</u>	(16)	<u>Oil mist detection and/or alternative alarm arrangements</u>	(17)	<u>Cylinder head</u>	(18)	<u>Cylinder block, engine block</u>	(19)	<u>Cylinder liner</u>	(20)	<u>Counterweights (if not integral with crankshaft), including fastening</u>	(21)	<u>Connecting rod with cap</u>	(22)	<u>Crosshead</u>	(23)	<u>Piston rod</u>	(24)	<u>Piston, assembly, including identification (e.g. drawing number) of components</u>	(25)	<u>Piston head</u>	(26)	<u>Camshaft drive, assembly, including identification (e.g. drawing number) of components</u>	(27)	<u>Flywheel</u>	(28)	<u>Arrangement of foundation (for main engines only)</u>	(29)	<u>Fuel injection pump</u>	
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Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended		Original	Remarks
(30)	<u>Shielding and insulation of exhaust pipes and other parts of high temperature which may be impinged as a result of a fuel system failure, assembly</u>		
(31)	<u>Construction and arrangement of dampers</u>		
(32)	<u>For electronically controlled engines, assembly drawings or arrangements of the following (a) to (d):</u> <u>(a) Control valves</u> <u>(b) High-pressure pumps</u> <u>(c) Drive for high pressure pumps</u> <u>(d) Valve bodies, if applicable</u>		
(33)	<u>Operation and service manuals⁽¹⁾</u>		
(34)	<u>Test program resulting from FMEA (for engine control system) in cases of engines that rely on hydraulic, pneumatic or electronic control of fuel injection and/or valves</u>		
(35)	<u>Production specifications for castings and welding (sequence)</u>		
(36)	<u>Certification of a type approval for environmental tests, control components⁽²⁾</u>		
(37)	<u>Quality requirements for engine production</u>		
(38)	<u>Other drawings and data deemed necessary by the Society</u>		
Notes: (1) Operation and service manuals are to contain maintenance requirements (servicing and repair) including details of any special tools and gauges that are to be used with their fitting/settings together with any test requirements on completion of maintenance. (2) Drawings and data modified for a specific application are to be submitted to the Society for reference or approval, as applicable			
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (C)			

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
2.2 Safety Devices <u>2.2.5 Safety Measures for Exhaust Driven Turbochargers</u> <u>Safety measures of exhaust driven turbochargers are to comply with the requirements given in 2.4.7, Part D of the Rules for the Survey and Construction of Steel Ships.</u> 2.3 Associated Installations (Deleted) (Deleted) <u>2.3.1 Starting Arrangements</u> 1 The starting air mains are to be in accordance with 2.5.2-1, Part D of the Rules for the Survey and Construction of Steel Ships. <u>2.3.2 Fuel Oil Arrangements</u> (Omitted) <u>2.3.3 Lubricating Oil Arrangements</u> (Omitted) <u>2.3.4 Cooling Arrangements</u> (Omitted)	2.2 Safety Devices (Newly added) (Newly added) 2.3 Associated Installations <u>2.3.1 Exhaust Driven Turbochargers</u> <u>Exhaust driven turbochargers are to comply with the requirements given in 2.5.1, Part D of the Rules for the Survey and Construction of Steel Ships.</u> <u>2.3.2 Starting Arrangements</u> 1 The starting air mains are to be in accordance with 2.5.3-1, Part D of the Rules for the Survey and Construction of Steel Ships. <u>2.3.3 Fuel Oil Arrangements</u> (Omitted) <u>2.3.4 Lubricating Oil Arrangements</u> (Omitted) <u>2.3.5 Cooling Arrangements</u> (Omitted)	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
2.3.5 Control Valves for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Omitted) 2.3.6 Accumulators and Common Accumulators for Electronically-controlled Engines which are used as the Main Propulsion Machinery 1 Accumulators and common accumulators are to comply with the requirements in Chapter 10, Part D of the Rules for the Survey and Construction of Steel Ships. However, notwithstanding this requirement, material and non-destructive tests as well as surface inspections and dimension inspections are to be in accordance with Table D2.2, Part D of the Rules for the Survey and Construction of Steel Ships and hydrostatic tests are to be in accordance with Table D2.5, Part D of the Rules for the Survey and Construction of Steel Ships. 2.3.7 Fuel Oil Piping Systems and Hydraulic Oil Piping Systems for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Omitted) 2.3.8 Electronic Control Systems for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Omitted)	2.3.6 Control Valves for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Omitted) 2.3.7 Accumulators and Common Accumulators for Electronically-controlled Engines which are used as the Main Propulsion Machinery 1 Accumulators and common accumulators are to comply with the requirements in Chapter 10, Part D of the Rules for the Survey and Construction of Steel Ships. However, notwithstanding this requirement, material and non-destructive tests as well as surface inspections and dimension inspections are to be in accordance with Table D2.2, Part D of the Rules for the Survey and Construction of Steel Ships and hydrostatic tests are to be in accordance with Table D2.6, Part D of the Rules for the Survey and Construction of Steel Ships. 2.3.8 Fuel Oil Piping Systems and Hydraulic Oil Piping Systems for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Omitted) 2.3.9 Electronic Control Systems for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Omitted)	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
2.3.9 Failure Mode Effect Analysis for Electronically-controlled Engines which are used as the Main Propulsion Machinery Failure Mode Effect Analysis (FMEA) is to be carried out, for electronic control systems, in order to confirm that any one equipment or circuits in such systems which lose function may not cause any malfunction or deterioration in other equipment or circuits, in accordance with the following: ((1) and (2) are omitted.) (3) FMEA results are to be created in table form as shown in Table 9.2.2 or be of equivalent forms thereto. ((4) and (5) are omitted.) Table 9.2.42 Failure Mode Effect Analysis Table for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Table is omitted.) <u>2.4 Exhaust Driven Turbochargers</u> <u>Exhaust driven turbochargers are to comply with the requirements given in 2.7, Part D of the Rules for the Survey and Construction of Steel Ships.</u>	2.3.10 Failure Mode Effect Analysis for Electronically-controlled Engines which are used as the Main Propulsion Machinery Failure Mode Effect Analysis (FMEA) is to be carried out, for electronic control systems, in order to confirm that any one equipment or circuits in such systems which lose function may not cause any malfunction or deterioration in other equipment or circuits, in accordance with the following: ((1) and (2) are omitted.) (3) FMEA results are to be created in table form as shown in Table 9.2.1 or be of equivalent forms thereto. ((4) and (5) are omitted.) (Newly added) (Newly added)	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)		

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
Chapter 5 SHAFTINGS, PROPELLERS, WATERJET PROPULSION SYSTEMS AND TORSIONAL VIBRATION OF SHAFTINGS 5.4 Torsional Vibration of Shaftings 5.4.2 General 4 In the case where the torsional vibration stresses or torques exceed the allowable limit τ_1 specified in 8.2, Part D of the Rules for the Survey and Construction of Steel Ships, the barred speed ranges are to be imposed in accordance with 8.3, Part D of the Rules for the Survey and Construction of Steel Ships. 5 <u>In cases where the barred speed ranges are imposed in accordance with -4 above, 8.4.2 and 8.4.3, Part D of the Rules for the Survey and Construction of Steel Ships are to apply.</u>	Chapter 5 SHAFTINGS, PROPELLERS, WATERJET PROPULSION SYSTEMS AND TORSIONAL VIBRATION OF SHAFTINGS 5.4 Torsional Vibration of Shaftings 5.4.2 General 4 In the case where the torsional vibration stresses or torques exceed the allowable limit τ_1 specified in 8.2, Part D of the Rules for the Survey and Construction of Steel Ships, the barred speed ranges are to be imposed in accordance with 8.3, Part D of the Rules for the Survey and Construction of Steel Ships. (Newly added)	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (B)		

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
RULES FOR THE SURVEY AND CONSTRUCTION OF PASSENGER SHIPS Part 5 MACHINERY INSTALLATIONS Chapter 1 GENERAL 1.1 General 1.1.1 Scope* 3 For machinery installations, the requirements in Part D of the Rules for the Survey and Construction of Steel Ships listed in the following (1) to (23) as well as the requirements of this Part are to be applied. ((1) is omitted.) (2) Chapter 2 RECIPROCATING INTERNAL COMBUSTION ENGINES AND EXHAUST DRIVEN TURBOCHARGERS ((3) to (23) are omitted.)	RULES FOR THE SURVEY AND CONSTRUCTION OF PASSENGER SHIPS Part 5 MACHINERY INSTALLATIONS Chapter 1 GENERAL 1.1 General 1.1.1 Scope* 3 For machinery installations, the requirements in Part D of the Rules for the Survey and Construction of Steel Ships listed in the following (1) to (23) as well as the requirements of this Part are to be applied. ((1) is omitted.) (2) Chapter 2 RECIPROCATING INTERNAL COMBUSTION ENGINES ((3) to (23) are omitted.)	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
Chapter 4 SPECIAL REQUIREMENTS FOR MACHINERY INSTALLED IN SHIPS WITH RESTRICTED AREA OF SERVICE 4.2 Modified Requirements 4.2.1 Ships with Class Notation “Coasting Service” or Equivalent 4 For ships with the Class Notation “Coasting Service” or equivalent, which are not engaged in international voyages, the following requirements may apply in addition to the requirements in -1 to -3 above. ((1) and (2) are omitted.) (3) The requirements specified in 2.5.3-2, Part D and 4.2.2(5)(b), Part R of the Rules for the Survey and Construction of Steel Ships may not apply to reciprocating internal combustion engines having an maximum continuous output of less than 375 <i>kW</i> installed in the space other than machinery spaces of category <i>A</i>, provided that a suitable enclosure for the fuel injection piping system is fitted. ((4) to (17) are omitted.)	Chapter 4 SPECIAL REQUIREMENTS FOR MACHINERY INSTALLED IN SHIPS WITH RESTRICTED AREA OF SERVICE 4.2 Modified Requirements 4.2.1 Ships with Class Notation “Coasting Service” or Equivalent 4 For ships with the Class Notation “Coasting Service” or equivalent, which are not engaged in international voyages, the following requirements may apply in addition to the requirements in -1 to -3 above. ((1) and (2) are omitted.) (3) The requirements specified in 2.5.4-2, Part D and 4.2.2(5)(b), Part R of the Rules for the Survey and Construction of Steel Ships may not apply to reciprocating internal combustion engines having an maximum continuous output of less than 375 <i>kW</i> installed in the space other than machinery spaces of category <i>A</i>, provided that a suitable enclosure for the fuel injection piping system is fitted. ((4) to (17) are omitted.)	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)		

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
RULES FOR THE SURVEY AND CONSTRUCTION OF INLAND WATERWAY SHIPS Part 2 CLASS SURVEYS Chapter 2 CLASSIFICATION SURVEYS 2.1 Classification Survey during Construction 2.1.2 Submission of Plans and Documents for Approval* 1 When it is intended to build a ship for classification by the Society, the following plans and documents are to be submitted for the approval by the Society before the work is commenced. The plans and documents may be submitted for examination by the Society prior to making an application for the classification of the ship as stipulated otherwise by the Society. ((1) is omitted.) (2) Machinery ((a) is omitted.) (b) Main and auxiliary engines (including their attachments): Plans and data specified in 2.1.4-1(1), Part 7 ((c) to (m) are omitted.) ((3) and (5) are omitted.)	RULES FOR THE SURVEY AND CONSTRUCTION OF INLAND WATERWAY SHIPS Part 2 CLASS SURVEYS Chapter 2 CLASSIFICATION SURVEYS 2.1 Classification Survey during Construction 2.1.2 Submission of Plans and Documents for Approval* 1 When it is intended to build a ship for classification by the Society, the following plans and documents are to be submitted for the approval by the Society before the work is commenced. The plans and documents may be submitted for examination by the Society prior to making an application for the classification of the ship as stipulated otherwise by the Society. ((1) is omitted.) (2) Machinery ((a) is omitted.) (b) Main and auxiliary engines (including their attachments): Plans and data specified in 2.1.3-1(1), Part 7 ((c) to (m) are omitted.) ((3) and (5) are omitted.)	Amended in line with the corresponding amendments to Part D of the Rules for the Survey and Construction of Steel Ships.

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
2.1.3 Submission of Other Plans and Documents 1 When it is intended to build a ship to the classification with the Society the following plans and documents are to be submitted, in addition to those required in 2.1.2: ((1) to (6) are omitted.) (7) The following plans and documents related to machinery: (a) Main and auxiliary engines (including their attachments): Plans and data specified in 2.1.4-1(2), Part 7 ((b) to (f) are omitted.) ((8) and (9) are omitted.) Part 7 MACHINERY INSTALLATIONS Chapter 1 GENERAL 1.3 General Requirements for Machinery Installations of Tugs and Pushers 1.3.1 General* 9 The exhaust gas treatment systems specified in the following (1) and (2) fitted onto machinery installations are to comply with the requirements of Chapter 21 and Chapter 22, Part D of the Rules for the Survey and Construction of Steel Ships, respectively. (1) Selective catalytic reduction (SCR) systems (2) Exhaust gas cleaning systems (EGCS) (excluding	2.1.3 Submission of Other Plans and Documents 1 When it is intended to build a ship to the classification with the Society the following plans and documents are to be submitted, in addition to those required in 2.1.2: ((1) to (6) are omitted.) (7) The following plans and documents related to machinery: (a) Main and auxiliary engines (including their attachments): Plans and data specified in 2.1.3-1(2), Part 7 ((b) to (f) are omitted.) ((8) and (9) are omitted.) Part 7 MACHINERY INSTALLATIONS Chapter 1 GENERAL 1.3 General Requirements for Machinery Installations of Tugs and Pushers 1.3.1 General* 9 The exhaust gas treatment systems specified in the following (1) and (2) fitted onto machinery installations are to comply with the requirements of Chapter 21 and Chapter 22, Part D of the Rules for the Survey and Construction of Steel Ships, respectively. (1) Selective catalytic reduction (SCR) systems (2) Exhaust gas cleaning systems (EGCS) (excluding	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
those specified in 2.1.1- <u>3</u>)	those specified in 2.1.1- <u>4</u>)	
Chapter 2 RECIPROCATING INTERNAL COMBUSTION ENGINES <u>AND EXHAUST DRIVEN TURBOCHARGERS</u>	Chapter 2 RECIPROCATING INTERNAL COMBUSTION ENGINES	
2.1 General	2.1 General	
2.1.1 General* (Moved)	2.1.1 General* <u>3 The requirements of exhaust driven turbochargers specified in this chapter also apply, in principle, to engine driven chargers.</u>	Moved to 2.7.1
<u>3</u> (Omitted)	<u>4</u> (Omitted)	
<u>4</u> (Omitted)	<u>5</u> (Omitted)	
2.1.2 Terminology (Moved)	2.1.2 Terminology <u>1 In this chapter, exhaust driven turbochargers are categorised into the following three groups according to the engine power at maximum continuous rating (MCR) supplied by a group of cylinders served by the actual turbocharger (e.g., turbocharger size is to be 50% of total engine power for a V-engine with one turbocharger serving each bank of cylinders).</u> <u>(1) Category A turbochargers</u> <u>The engine power at MCR supplied by a group of cylinders served by the turbocharger is not more than 1,000 kW.</u> <u>(2) Category B turbochargers</u> <u>The engine power at MCR supplied by a group of cylinders served by the turbocharger is not less than</u>	Moved to 2.7.2

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Amended	Original	Remarks
	<u>1,000 kW, but not more than 2,500 kW.</u> (3) <u>Category C turbochargers</u> <u>The engine power at MCR supplied by a group of cylinders served by the turbocharger is not less than 2,500 kW.</u>	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)		

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Amended	Original	Remarks
<u>1</u> The terminology used in the application of 2.1.3 and 2.1.4 is as specified in the following (1) to (37): ((1) to (31) are omitted.) (32) “Sub-system” means assembly of components belonging to engine, intended to achieve a defined function and which may affect the engine performance, e.g. electronic control systems and gas system of gas fuelled engines. (33) (Omitted) (34) (Omitted) (35) (Omitted) (36) (Omitted) (37) (Omitted) 2 (Omitted) 2.1.3 Approval of Reciprocating Internal Combustion Engines* 1 Reciprocating internal combustion engines are to be approved in accordance with the following (1) to (5): (Deleted) (1) Each type of reciprocating internal combustion engine is to be provided with a certificate of type approval <u>or design evaluation</u> obtained by the licensor in accordance with 2.1.1-2 prior to the commencement of manufacture by the engine manufacturer	<u>2</u> The terminology used in the application of 2.1.3 and 2.1.4 is as specified in the following (1) to (36): ((1) to (31) are omitted.) (Newly added) (32) (Omitted) (33) (Omitted) (34) (Omitted) (35) (Omitted) (36) (Omitted) 3 (Omitted) 2.1.4 Approval of Reciprocating Internal Combustion Engines* 1 Reciprocating internal combustion engines are to be approved in accordance with the following (1) to (6): (1) <u>Development of documents and data for engine production</u> (a) <u>Prior to the start of the reciprocating internal combustion engine approval process in accordance with the following (c) and subsequent sub-paragraphs of this paragraph, a design approval is to be obtained as specified separately by the Society.</u> (b) Each type of reciprocating internal combustion engine is to be provided with a certificate of type approval obtained by the licensor in accordance with 2.1.1-2. For the first engine of a type or for those with no service records, the process of an	

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Amended	Original	Remarks
<u>(hereinafter referred to as “licensee” in this Chapter).</u> 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. (2) <u>Drawings and data for the approval of reciprocating internal combustion engines in this Chapter are to be submitted in accordance with 2.1.4.</u>	approval of use and the approval process for production by the licensee may be performed simultaneously. (Newly added) (c) <u>The licensor is to review the drawings and data of the reciprocating internal combustion engine whose type approval has been obtained for the application and develop, if necessary, application specific drawings and data for production of reciprocating internal combustion engines for the use of the licensee in developing the reciprocating internal combustion engine specific production drawings and data for the inspection and testing specified in 2.1.3-1.</u> (d) <u>If substantive modifications to the drawings and data of the reciprocating internal combustion engine whose type approval has been obtained have been made in the drawings and data of 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.</u> (2) <u>Drawings and data for the inspection and testing of reciprocating internal combustion engines</u> (a) <u>The licensee is to develop the drawings and data for the inspection and testing specified in 2.1.3-1 and a comparison list of these drawings and data to the drawings and data of the reciprocating</u>	

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Amended	Original	Remarks
	<u>internal combustion engine whose type approval has been obtained by the licensor and submit these drawings and the comparison list to the Society.</u> <u>(b) As for the drawings and data for the inspection and testing specified in 2.1.3-1, if there are differences in the technical content on the licensee's production drawings and data of the reciprocating internal combustion engine compared to the drawings and data of the reciprocating internal combustion engine whose type approval 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 reciprocating internal combustion engine manufactured by the licensee is to be regarded as a different engine type and is 2.1.1-2 is to apply to the reciprocating internal combustion engine.</u> <u>(c) In applying (b) above, modifications applied by the licensee are to be provided with appropriate quality requirements.</u> <u>(d) The Society returns the drawings and data specified in (a) and (b) above to the licensee with confirmation that the design has been approved.</u> <u>(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</u>	

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Amended	Original	Remarks
(3) <u>Licensee assessment</u> The Society <u>verifies</u> conformity of production with the Society's requirements for production facilities comprising manufacturing facilities and processes, machining tools, quality assurance, testing facilities, etc. (Deleted) (4) <u>Engine assembly and testing</u> The licensee is to assemble and test the reciprocating internal combustion engine according to the Society's technical rules. <u>The testing of each reciprocating internal combustion engine is to be witnessed by the Surveyor unless the manufacturer of the 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.</u> (5) <u>Issue of certificates of reciprocating internal</u>	<u>reciprocating internal combustion engine and its components.</u> (3) <u>Additional drawings and data</u> <u>In addition to the drawings and data for the inspection and testing specified in 2.1.3-1, the licensee is to be able to provide to the Surveyor performing the test specified in 2.6.1 upon request the relevant detail drawings, production quality control specifications and acceptance criteria. These drawings and data are for supplemental purposes to the survey only.</u> (4) <u>Licensee approval</u> (a) <u>The Society <u>assesses</u> conformity of production with the Society's requirements for production facilities comprising manufacturing facilities and processes, machining tools, quality assurance, testing facilities, etc. <u>as specified separately by the Society.</u></u> (b) <u>Satisfactory conformance with (a) above results in the issue of a document showing the licensee has been approved by the Society.</u> (5) <u>Engine assembly and testing</u> The licensee is to assemble and test the reciprocating internal combustion engine according to the Society's technical rules <u>each of the reciprocating internal combustion engine <u>assembly and testing procedure</u> is to be witnessed by the Surveyor unless the manufacturer of the 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.</u> (6) <u>Issue of certificates of reciprocating internal</u>	

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Amended	Original	Remarks
combustion engines and components (a) The attending Surveyors, at the licensee/subcontractors, will issue product certificates as necessary for components manufactured upon satisfactory inspections and tests. (b) An engine certificate is issued by the Surveyor upon satisfactory completion of assembly and tests specified in (4) above. (Deleted) <u>2</u> Components and sub-systems of licensor's design which are covered by the certificate of type approval of the relevant engine type are regarded as approved whether manufactured by the reciprocating internal combustion engine manufacturer or sub-supplied. For components and subsystems of subcontractor's design, necessary approvals are to be obtained by the relevant suppliers (e.g. exhaust gas turbochargers). <u>3</u> In case where the scope of a certificate of type approval or design evaluation is extended to allow the incorporation of an additional or alternative sub-system, the requirements specified separately by the Society are to apply. <u>4</u> In case where type approval for sub-systems is required by the Society or is voluntarily sought, the requirements specified separately by the Society are to apply. <u>5</u> The engine approval based on type approval specified	combustion engines and components (a) The attending Surveyors, at the licensee/subcontractors, will issue product certificates as necessary for components manufactured upon satisfactory inspections and tests. (b) An engine certificate is issued by the Surveyor upon satisfactory completion of assembly and tests specified in (5) above. <u>2</u> 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 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. <u>3</u> 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 reciprocating internal combustion engine manufacturer or sub-supplied. <u>4</u> For components of subcontractor's design, necessary approvals are to be obtained by the relevant suppliers (e.g. exhaust gas turbochargers, charge air coolers, etc.). (Newly added) (Newly added) (Newly added)	

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Amended	Original	Remarks
<u>in -1(1) may be substituted by individual approval when deemed appropriate by the Society. In such cases, requirements equivalent to those for approval based on type approval are to apply.</u> 2.1.4 Drawings and Data* 1 Drawings and data to be submitted are generally as follows: (1) Drawings and data for approval (a) <u>A list containing all drawings and data submitted (including relevant drawing numbers and revision status)</u> (b) <u>Engine particulars (The applicable items in the following i) to xvii) are to be included.)</u> i) <u>Engine type</u> ii) <u>Engine manufacturer</u> iii) <u>Maximum continuous rating (MCR)</u> iv) <u>Speed (rpm)</u> v) <u>Maximum combustion pressure</u> vi) <u>Mean effective pressure</u> vii) <u>Mean indicated pressure</u> viii) <u>Bore</u> ix) <u>Stroke</u> x) <u>Crankshaft materials</u> xi) <u>Type and number of exhaust driven turbochargers</u> xii) <u>Type of crankcase explosion relief valves</u> xiii) <u>Type of oil mist detection arrangements</u> xiv) <u>Type of electronic governors</u> xv) <u>Software name and version number of electronic control systems</u> xvi) <u>Sub-systems</u>	2.1.3 Drawings and Data* 1 Drawings and data to be submitted are generally as follows: (1) Drawings and data for approval <u>Drawings and data specified in Table 7.2.1(a)</u>	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
xvii) <u>Other items deemed necessary by the Society</u> (c) <u>In cases where the engine designer and the engine manufacturer are different, schematic layout or other equivalent drawings and data on the engine of the following i) to vii):</u> i) <u>Starting air system</u> ii) <u>Fuel system</u> iii) <u>Lubricating oil system</u> iv) <u>Cooling water system</u> v) <u>Hydraulic system</u> vi) <u>Hydraulic system (for valve lift)</u> vii) <u>Engine control and safety system</u> (d) <u>Drawings and data specified in -2, if applicable (this may be included in (a) above)</u> (2) <u>Drawings and data for reference</u> (a) <u>The following drawings and data for measures to prevent crankcase explosions:</u> i) <u>Documentation containing evidence of studies justifying the selected location of sample points and the sample extraction rate specified in 2.4.5-2(6) (may be omitted in cases where replaced by the test specified in 2.4.5-2(7))</u> ii) <u>Documentation of alternative methods to prevent the build-up of oil mist within the crankcase specified in 2.4.5-3 (if applicable)</u> iii) <u>Documentation of the introduction of inert gas into the crankcase specified in 2.4.6-1 (if applicable)</u> (b) <u>Other drawings and data deemed necessary by the Society</u>	(2) <u>Drawings and data for reference</u> <u>Drawings and data specified in Table 7.2.1(b)</u>	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(Deleted) <u>2 The drawings and data specified in -1(1)(d) are to be submitted in accordance with the following (1) and (2).</u> (Deleted)	<u>2 The drawings and data for the inspection and testing specified in -1 (the items represented by the mark ○ in Table 7.2.1(a) and Table 7.2.1(b), hereinafter indicated in the same way throughout this Chapter) are to be submitted in accordance with 2.1.4-1 by the engine manufacturer producing engines with the drawings and data whose type approval has been obtained in accordance with 2.1.1-2 (hereinafter referred to as “licensee” in this Chapter). Such drawings and data, however, may be submitted by the licensor in accordance with 2.1.4-2.</u> (hereinafter referred to as 2.1.4-1(1) of the current Rules) <u>(c) The licensor is to review the drawings and data of the reciprocating internal combustion engine whose type approval has been obtained for the application and develop, if necessary, application specific drawings and data for production of reciprocating internal combustion engines for the use of the licensee in developing the reciprocating internal combustion engine specific production drawings and data for the inspection and testing specified in 2.1.3-1.</u> <u>(d) If substantive modifications to the drawings and data of the reciprocating internal combustion engine whose type approval has been obtained have been made in the drawings and data of 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.</u>	

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Amended	Original	Remarks
(1) <u>If there are differences in the drawing numbers or content of the licensee's production drawings and data compared to the drawings and data whose type approval has been obtained by the licensor, a comparison list is to be prepared and submitted to the Society.</u> (2) If there are differences in the technical content of the licensee's production drawings and data compared to the drawings and data whose type approval 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 reciprocating internal combustion engine manufactured by the licensee is to be regarded as a different engine type and is 2.1.1-2 is to apply to the reciprocating internal combustion engine.	(hereinafter referred to as 2.1.4-1(2) of the current Rules) (a) <u>The licensee is to develop the drawings and data for the inspection and testing specified in 2.1.3-1 and a comparison list of these drawings and data to the drawings and data of the reciprocating internal combustion engine whose type approval has been obtained by the licensor and submit these drawings and the comparison list to the Society.</u> (b) <u>As for the drawings and data for the inspection and testing specified in 2.1.3-1, if there are differences in the technical content on the licensee's production drawings and data of the reciprocating internal combustion engine compared to the drawings and data of the reciprocating internal combustion engine whose type approval 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 reciprocating internal combustion engine manufactured by the licensee is to be regarded as a different engine type and is 2.1.1-2 is to apply to the reciprocating internal combustion engine.</u> (c) <u>In applying (b) above, modifications applied by the licensee are to be provided with appropriate quality requirements.</u> (d) <u>The Society returns the drawings and data specified in (a) and (b) above to the licensee with confirmation that the design has been approved.</u>	

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Amended	Original	Remarks
3 The licensee is to be able to provide to the Surveyor performing the test specified in 2.6.1 upon request the <u>drawings and data listed in Table 7.2.1</u>, the relevant detail drawings, production quality control specifications and acceptance criteria. These drawings and data are for supplemental purposes to the survey only.	(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 reciprocating internal combustion engine and its components. (hereinafter referred to as 2.1.4-1(3) of the current Rules) (3) <u>Additional drawings and data</u> In addition to the drawings and data for the inspection and testing specified in 2.1.3-1, the licensee is to be able to provide to the Surveyor performing the test specified in 2.6.1 upon request the relevant detail drawings, production quality control specifications and acceptance criteria. These drawings and data are for supplemental purposes to the survey only.	

Table 7.2.1(a) Drawings and Data for Approval

	Items	For inspection and testing
(1)	Engine particulars (in the format designated by the Society)	⊖
(2)	Material specifications of main parts with information on non destructive testing and pressure testing as applicable to the material	⊖
(3)	Bedplate and crankcase of welded design, with welding details and welding instructions ⁽⁺⁾	⊖
(4)	Thrust bearing bedplate of welded design, with welding details and welding instructions ⁽⁺⁾	⊖
(5)	Frame/framebox/gearbox of welded design, with welding details and instructions ⁽⁺⁾	⊖
(6)	Crankshaft, assembly and details	⊖
(7)	Thrust shaft or intermediate shaft (if integral with engine)	⊖
(8)	Shaft coupling bolts	⊖
(9)	Connecting rod bearings (four stroke design)	—
(10)	Bolts and studs for connecting rods (four stroke design)	⊖

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Amended		Original		Remarks
(11)	Schematic layout or other equivalent drawings and data on the reciprocating internal combustion engine of the following (a) to (g) (details of the system so far as supplied by the licensee such as: main dimensions, operating media and maximum working pressures): (a) Starting air system (b) Fuel oil system (c) Lubricating oil system (d) Cooling water system (e) Hydraulic system (f) Hydraulic system (for valve lift) (g) Engine control and safety system		⊖	
(12)	High pressure oil pipes for driving exhaust valves with its shielding		—	
(13)	Shielding of high pressure fuel pipes, assembly (all engines)		⊖	
(14)	High pressure parts for fuel oil injection system The documentation to contain specifications for pressures, pipe dimensions and materials.		⊖	
(15)	Arrangement and details of the crankcase explosion relief valve (only for engines of a cylinder diameter of 200 mm or more or a crankcase volume of 0.6 m ³ or more)		⊖	
(16)	Oil mist detection and/or alternative alarm arrangements		⊖	
(17)	Connecting rod with cap (four stroke design)		⊖	
(18)	Arrangement of foundation (for main engines only)		⊖	
(19)	The drawings, data, etc. required by 2.1.4.		⊖	
(20)	The following drawings and data for exhaust driven turbochargers: (a) Category A turbochargers (upon request) i) Sectional assembly (including principal dimensions and names of components) ii) Containment test report iii) Test procedures		—	

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Amended		Original	Remarks
	(b) Category B turbochargers i) Sectional assembly (including principal dimensions and materials of housing components for containment evaluation.) ii) Documentation of containment in the event of the disc fracture specified in 2.5.1-6 iii) Documentation of following operational data and limitations • Maximum permissible operating speed (<i>rpm</i>) • Maximum permissible exhaust gas temperature at the turbine inlet • Minimum lubrication oil inlet pressure • Maximum permissible vibration levels (self and externally generated vibrations) • 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) iv) Diagram of lubrication oil systems (diagrams included in piping arrangements fitted to engines may be accepted instead) v) Test report of type approval test (only for type approval tests) vi) Test procedure (only for type approval tests) (c) Category C turbochargers i) Drawings listed in (b) above ii) Drawings of the housing and rotating parts (including details of blade fixing) iii) Material specifications (including mechanical properties and chemical composition) of the parts mentioned in ii) above iv) Welding details and welding procedures for the parts mentioned in ii) above, if made of welded construction		
(21)	Other drawings and data deemed necessary by the Society	⊖	
Note: (1) For approval of materials and weld procedure specifications, the weld procedure specification is to include details of pre and post weld heat treatment, weld consumables and fit up conditions.			

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Amended		Original	Remarks
Table 7.2.1(b) Drawings and Data for Reference			
	Items	For inspection and testing	
(1)	A list containing all drawings and data submitted – (including relevant drawing numbers and revision status)	⊖	
(2)	Bolts and studs for main bearings	⊖	
(3)	Connecting rod bearings (two-stroke design)	—	
(4)	Bolts and studs for cylinder heads and exhaust valve (two-stroke design)	⊖	
(5)	Bolts and studs for connecting rods (two-stroke design)	⊖	
(6)	Tie rods	⊖	
(7)	Piston pins	—	
(8)	Construction of accumulators for hydraulic oil and fuel oil	⊖	
(9)	Cylinder head fixing bolts and valve box fixing bolts	—	
(10)	Rocker valve gears	—	
(11)	Cylinder head	⊖	
(12)	Cylinder block, engine block	⊖	
(13)	Cylinder liner	⊖	
(14)	Counterweights (if not integral with crankshaft), including fastening	⊖	
(15)	Connecting rod with cap (two-stroke design)	⊖	
(16)	Crosshead	⊖	
(17)	Piston rod	⊖	
(18)	Piston, assembly, including identification (e.g. drawing number) of components	⊖	
(19)	Piston head	⊖	
(20)	Camshaft drive, assembly, including identification (e.g. drawing number) of components	⊖	
(21)	Flywheel	⊖	
(22)	Fuel oil injection pump	⊖	
(23)	Shielding and insulation of exhaust pipes and other parts of high temperature which may be impinged as a result of a fuel system failure, assembly	⊖	
(24)	Construction and arrangement of dampers	⊖	
(25)	Construction and arrangement of detuners, balancers or compensators, bracings as well as all calculation sheets related to engine balancing and engine vibration prevention	—	

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Amended		Original	Remarks
(26)	For electronically controlled engines, assembly drawings or arrangements of the following (a) to (d): (a) Control valves (b) High pressure pumps (c) Drive for high pressure pumps (d) Valve bodies, if applicable	⊖	
(27)	Operation and service manuals ⁽¹⁾	⊖	
(28)	Engine control system diagram (including the monitoring, safety and alarm systems)	=	
(29)	Test program resulting from FMEA (for engine control system) in cases of engines that rely on hydraulic, pneumatic or electronic control of fuel injection and/or valves	⊖	
(30)	Production specifications for castings and welding (sequence)	⊖	
(31)	Certification of a type approval for environmental tests, control components ⁽²⁾	⊖	
(32)	Quality requirements for engine production	⊖	
(33)	Location of measures preventing oil from spraying out from joints in flammable oil piping (if fitted)	=	
(34)	The following drawings and data for exhaust driven turbochargers (only for category C turbochargers): (a) Documentation of the safe torque transmission specified in 2.5.1-6 when the disc is connected to the shaft by an interference fit (b) Information on expected lifespan (creep, low cycle fatigue and high cycle fatigue are to be considered) (c) Operation and maintenance manuals	=	
(35)	The following drawings and data for measures to prevent crankcase explosions: (a) Documentation containing evidence of studies justifying the selected location of sample points and the sample extraction rate specified in 2.4.5-2(6) (may be omitted in cases where replaced by the test specified in 2.4.5-2(7)) (b) Documentation of alternative methods to prevent the build-up of oil mist within the crankcase specified in 2.4.5-3 (if applicable) (c) Documentation of the introduction of inert gas into the crankcase specified in 2.4.6-1 (if applicable)	⊖	
(36)	Other drawings and data deemed necessary by the Society	⊖	
Notes: (1) Operation and service manuals are to contain maintenance requirements (servicing and repair) including details of any special tools and gauges that are to be used with their fitting/settings together with any test requirements on completion of maintenance. (2) Drawings and data modified for a specific application are to be submitted to the Society for reference or approval, as applicable.			

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Amended	Original	Remarks																																																												
Table 7.2.1 Drawings and Data for the Inspection and Testing of Reciprocating Internal Combustion Engines																																																														
	<table><tr><th></th><th>Items</th></tr><tr><td>(1)</td><td><u>Material specifications of main parts with information on non-destructive testing and pressure testing as applicable to the material</u></td></tr><tr><td>(2)</td><td><u>Bedplate and crankcase of welded design, with welding details and welding instructions</u></td></tr><tr><td>(3)</td><td><u>Thrust bearing bedplate of welded design, with welding details and welding instructions</u></td></tr><tr><td>(4)</td><td><u>Frame/framebox/gearbox of welded design, with welding details and instructions</u></td></tr><tr><td>(5)</td><td><u>Crankshaft, assembly and details</u></td></tr><tr><td>(6)</td><td><u>Thrust shaft or intermediate shaft (if integral with engine)</u></td></tr><tr><td>(7)</td><td><u>Shaft coupling bolts</u></td></tr><tr><td>(8)</td><td><u>Bolts and studs for main bearings</u></td></tr><tr><td>(9)</td><td><u>Bolts and studs for cylinder heads and exhaust valve (two-stroke design)</u></td></tr><tr><td>(10)</td><td><u>Bolts and studs for connecting rods</u></td></tr><tr><td>(11)</td><td><u>Tie rods</u></td></tr><tr><td>(12)</td><td><u>Shielding of high pressure fuel pipes, assembly (all engines)</u></td></tr><tr><td>(13)</td><td><u>Construction of accumulators for hydraulic oil and fuel oil</u></td></tr><tr><td>(14)</td><td><u>High pressure parts for fuel oil injection system</u> <u>The documentation to contain specifications for pressures, pipe dimensions and materials.</u></td></tr><tr><td>(15)</td><td><u>Arrangement and details of the crankcase explosion relief valve (only for engines of a cylinder diameter of 200 mm or more or a crankcase volume of 0.6 m³ or more)</u></td></tr><tr><td>(16)</td><td><u>Oil mist detection and/or alternative alarm arrangements</u></td></tr><tr><td>(17)</td><td><u>Cylinder head</u></td></tr><tr><td>(18)</td><td><u>Cylinder block, engine block</u></td></tr><tr><td>(19)</td><td><u>Cylinder liner</u></td></tr><tr><td>(20)</td><td><u>Counterweights (if not integral with crankshaft), including fastening</u></td></tr><tr><td>(21)</td><td><u>Connecting rod with cap</u></td></tr><tr><td>(22)</td><td><u>Crosshead</u></td></tr><tr><td>(23)</td><td><u>Piston rod</u></td></tr><tr><td>(24)</td><td><u>Piston, assembly, including identification (e.g. drawing number) of components</u></td></tr><tr><td>(25)</td><td><u>Piston head</u></td></tr><tr><td>(26)</td><td><u>Camshaft drive, assembly, including identification (e.g. drawing number) of components</u></td></tr><tr><td>(27)</td><td><u>Flywheel</u></td></tr><tr><td>(28)</td><td><u>Arrangement of foundation (for main engines only)</u></td></tr><tr><td>(29)</td><td><u>Fuel injection pump</u></td></tr></table>		Items	(1)	<u>Material specifications of main parts with information on non-destructive testing and pressure testing as applicable to the material</u>	(2)	<u>Bedplate and crankcase of welded design, with welding details and welding instructions</u>	(3)	<u>Thrust bearing bedplate of welded design, with welding details and welding instructions</u>	(4)	<u>Frame/framebox/gearbox of welded design, with welding details and instructions</u>	(5)	<u>Crankshaft, assembly and details</u>	(6)	<u>Thrust shaft or intermediate shaft (if integral with engine)</u>	(7)	<u>Shaft coupling bolts</u>	(8)	<u>Bolts and studs for main bearings</u>	(9)	<u>Bolts and studs for cylinder heads and exhaust valve (two-stroke design)</u>	(10)	<u>Bolts and studs for connecting rods</u>	(11)	<u>Tie rods</u>	(12)	<u>Shielding of high pressure fuel pipes, assembly (all engines)</u>	(13)	<u>Construction of accumulators for hydraulic oil and fuel oil</u>	(14)	<u>High pressure parts for fuel oil injection system</u> <u>The documentation to contain specifications for pressures, pipe dimensions and materials.</u>	(15)	<u>Arrangement and details of the crankcase explosion relief valve (only for engines of a cylinder diameter of 200 mm or more or a crankcase volume of 0.6 m³ or more)</u>	(16)	<u>Oil mist detection and/or alternative alarm arrangements</u>	(17)	<u>Cylinder head</u>	(18)	<u>Cylinder block, engine block</u>	(19)	<u>Cylinder liner</u>	(20)	<u>Counterweights (if not integral with crankshaft), including fastening</u>	(21)	<u>Connecting rod with cap</u>	(22)	<u>Crosshead</u>	(23)	<u>Piston rod</u>	(24)	<u>Piston, assembly, including identification (e.g. drawing number) of components</u>	(25)	<u>Piston head</u>	(26)	<u>Camshaft drive, assembly, including identification (e.g. drawing number) of components</u>	(27)	<u>Flywheel</u>	(28)	<u>Arrangement of foundation (for main engines only)</u>	(29)	<u>Fuel injection pump</u>	
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Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended		Original	Remarks
(30)	<u>Shielding and insulation of exhaust pipes and other parts of high temperature which may be impinged as a result of a fuel system failure, assembly</u>		
(31)	<u>Construction and arrangement of dampers</u>		
(32)	<u>For electronically controlled engines, assembly drawings or arrangements of the following (a) to (d):</u> <u>(a) Control valves</u> <u>(b) High-pressure pumps</u> <u>(c) Drive for high pressure pumps</u> <u>(d) Valve bodies, if applicable</u>		
(33)	<u>Operation and service manuals⁽¹⁾</u>		
(34)	<u>Test program resulting from FMEA (for engine control system) in cases of engines that rely on hydraulic, pneumatic or electronic control of fuel injection and/or valves</u>		
(35)	<u>Production specifications for castings and welding (sequence)</u>		
(36)	<u>Certification of a type approval for environmental tests, control components⁽²⁾</u>		
(37)	<u>Quality requirements for engine production</u>		
(38)	<u>Other drawings and data deemed necessary by the Society</u>		
<u>Notes:</u> (1) <u>Operation and service manuals are to contain maintenance requirements (servicing and repair) including details of any special tools and gauges that are to be used with their fitting/settings together with any test requirements on completion of maintenance.</u> (2) <u>Drawings and data modified for a specific application are to be submitted to the Society for reference or approval, as applicable</u>			
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (C)			

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended				Original							Remarks	
2.2 Materials, Construction and Strength				2.2 Materials, Construction and Strength								
Table 7.2.2 Application of Materials and Non-destructive Tests as well as Surface Inspections and Dimension Inspections to Principal Components of Reciprocating Internal Combustion 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	
(Omitted)												
23	Turbine discs, blades, blower impellers and rotor shafts of exhaust driven turbochargers ⁽¹⁶⁾	Category A	$\ominus^{(9)}$				$\ominus^{(9)}$			$\ominus^{(9)}$		
		Category B	$\ominus$	$\ominus$	$\ominus^{(17)}$	$\ominus$	$\ominus$	$\ominus^{(17)}$	$\ominus$	$\ominus$	$\ominus^{(17)}$	
		Category C	$\ominus$	$\ominus$	$\ominus^{(17)}$	$\ominus$	$\ominus$	$\ominus^{(17)}$	$\ominus$	$\ominus$	$\ominus^{(17)}$	
24	Casings of exhaust driven turbochargers ⁽¹⁶⁾⁽¹⁸⁾	Category A	$\ominus^{(9)}$				$\ominus^{(9)}$			$\ominus^{(9)}$		
		Category B	$\ominus$			$\ominus$			$\ominus$			
		Category C	$\ominus$			$\ominus$			$\ominus$			
Notes:												
(1) to (15) are omittd.)												
(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.												
(18) Chemical composition analysis may be omitted.												
2.4 Safety Devices				2.4 Safety Devices								
2.4.5 Crankcase Oil Mist Detection Arrangements*				2.4.5 Crankcase Oil Mist Detection Arrangements*								
2 The crankcase oil mist detection arrangements required in -1 above are to be of an approved type and in accordance with the following requirements:				2 The crankcase oil mist detection arrangements required in -1 above are to be of an approved type and in accordance with the following requirements:								
((1) to (5) are omitted.)				((1) to (5) are omitted.)								
(6) Plans showing details and arrangements of oil mist				(6) Plans showing details and arrangements of oil mist								

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
detection and alarm arrangements are to be submitted for approval in accordance with <u>2.1.4-1(2)</u>. Documentation containing evidence of studies justifying the selected location of sample points and the sample extraction rate (if applicable), supported by a confirmation from the oil mist detection system manufacturer, from the crankcase and the spaces mentioned in <u>2.4.3-3</u>, is to be submitted to the Society for reference purposes only. ((7) to (10) are omitted.) <u>2.4.7 Safety Measures for Exhaust Driven Turbochargers</u> <u>1 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.</u> <u>2 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.</u> <u>3 Turbochargers are to have compressor characteristics that allows 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</u>	detection and alarm arrangements are to be submitted for approval in accordance with <u>(16) of Table 7.2.1(a)</u>. Documentation containing evidence of studies justifying the selected location of sample points and the sample extraction rate (if applicable), supported by a confirmation from the oil mist detection system manufacturer, from the crankcase and the spaces mentioned in <u>2.4.3-3</u>, is to be submitted to the Society for reference purposes only. ((7) to (10) are omitted.) (Newly added) (Moved) (Moved) (Moved)	Moved from 2.5.1-2 Moved from 2.5.1-3 Moved from 2.5.1-9

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
<u>abnormal, but permissible, operation conditions, such as misfiring and sudden load reduction, repeated surging (hereinafter referred to as “continuous surging”) is not to occur.</u> 2.5 Associated Installations 2.5.1 Exhaust Gas Arrangements (Deleted) (Moved) (Moved) (Moved) (Moved)	2.5 Associated Installations 2.5.2 Exhaust Gas Arrangements <u>2.5.1 Exhaust Driven Turbochargers</u> <u>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.</u> <u>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.</u> <u>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.</u> <u>4 Exhaust driven turbochargers are to be designed to operate under conditions given in 1.3.1-4 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.</u>	Moved to 2.7.3-1 Moved to 2.4.7-1 Moved to 2.4.7-2 Moved to 2.7.3-2

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
(Moved)	<u>5 The air inlets of exhaust driven turbochargers are to be fitted with filters.</u>	Moved to 2.7.3-3
(Moved)	<u>6 Exhaust driven turbochargers 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.</u>	Moved to 2.7.3-4
(Moved)	<u>7 In the case of category C turbochargers 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.</u>	Moved to 2.7.3-5
(Moved)	<u>8 For categories B and C turbochargers, the indications and alarms listed in Table 7.2.6 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.</u>	Moved to 2.7.3-6
(Moved)	<u>9 Turbochargers are to have compressor characteristics that allows 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.</u>	Moved to 2.4.7-3

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
(Moved)	10 Certificates for categories <i>B</i> and <i>C</i> turbochargers issued by the Society will, at a minimum, cite the applicable type approval.	Moved to 2.7.3-7
(Moved)	11 Certification and test requirements specified in this chapter apply to the replacement of rotating parts and casings.	Moved to 2.7.3-8
Table 7.2.6 Alarms and Indications of Turbochargers (Table is omitted.)		Moved after 2.7.3, with the table number revised to Table 7.2.9.
2.5.1 Exhaust Gas Arrangements (Omitted)	2.5.2 Exhaust Gas Arrangements (Omitted)	
2.5.2 Starting Arrangements (Omitted)	2.5.3 Starting Arrangements (Omitted)	
2.5.3 Fuel Oil Arrangements (Omitted)	2.5.4 Fuel Oil Arrangements (Omitted)	
2.5.4 Lubricating Oil Arrangements (Omitted)	2.5.5 Lubricating Oil Arrangements (Omitted)	
2.5.5 Cooling Arrangements (Omitted)	2.5.6 Cooling Arrangements (Omitted)	
2.5.6 Control Valves for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Omitted)	2.5.7 Control Valves for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Omitted)	
2.5.7 Accumulators and Common Accumulators for Electronically-controlled Engines which are used as the Main Propulsion Machinery	2.5.8 Accumulators and Common Accumulators for Electronically-controlled Engines which are used as the Main Propulsion Machinery	
1 Accumulators and common accumulators are to	1 Accumulators and common accumulators are to	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
comply with the requirements in Chapter 10, Part D of the Rules for the Survey and Construction of Steel Ships. However, notwithstanding this requirement, material and non-destructive tests as well as surface inspections and dimension inspections are to be in accordance with Table D2.2, Part D of the Rules for the Survey and Construction of Steel Ships and hydrostatic tests are to be in accordance with Table D2.5, Part D of the Rules for the Survey and Construction of Steel Ships. 2.5.8 Fuel Oil Piping Systems and Hydraulic Oil Piping Systems for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Omitted) 2.5.9 Electronic Control Systems for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Omitted) 2.5.10 Failure Mode Effect Analysis for Electronically-controlled Engines which are used as the Main Propulsion Machinery Failure Mode Effect Analysis (FMEA) is to be carried out, for electronic control systems, in order to confirm that any one equipment or circuits in such systems which lose function may not cause any malfunction or deterioration in other equipment or circuits, in accordance with the following: ((1) and (2) are omitted.) (3) FMEA results are to be created in table form as shown in Table 7.2.6 or be of equivalent forms thereto. ((4) and (5) are omitted.)	comply with the requirements in Chapter 10, Part D of the Rules for the Survey and Construction of Steel Ships. However, notwithstanding this requirement, material and non-destructive tests as well as surface inspections and dimension inspections are to be in accordance with Table D2.2, Part D of the Rules for the Survey and Construction of Steel Ships and hydrostatic tests are to be in accordance with Table D2.6, Part D of the Rules for the Survey and Construction of Steel Ships. 2.5.9 Fuel Oil Piping Systems and Hydraulic Oil Piping Systems for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Omitted) 2.5.10 Electronic Control Systems for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Omitted) 2.5.11 Failure Mode Effect Analysis for Electronically-controlled Engines which are used as the Main Propulsion Machinery Failure Mode Effect Analysis (FMEA) is to be carried out, for electronic control systems, in order to confirm that any one equipment or circuits in such systems which lose function may not cause any malfunction or deterioration in other equipment or circuits, in accordance with the following: ((1) and (2) are omitted.) (3) FMEA results are to be created in table form as shown in Table 7.2.7 or be of equivalent forms thereto. ((4) and (5) are omitted.)	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
Table 7.2.76 Failure Mode Effect Analysis Table for Electronically-controlled Engines which are used as the Main Propulsion Machinery (Table is omitted.)		
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)		

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
2.6 Tests 2.6.1 Shop Tests* 1 For components or accessories specified in Table 7.2.7, 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 7.2.7. 2 For reciprocating internal combustion engines, the purpose of the shop trials 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) <u>For tests of reciprocating internal combustion engines, the documents specified below are to be submitted to the Surveyor before, during and after the tests. Where deemed appropriate by the Society after consideration has been given to the engine type and production, a part of or all of the documentations may be omitted.</u> (a) <u>Before test</u> i) <u>Valid certificate of type approval or design evaluation covering the tested engine.</u> ii) <u>Evidence of the Society's approval of the drawings and data.</u> (b) <u>During test</u> i) <u>Calibration records for the test bed instrumentation used to collect data.</u> ii) <u>Certificate or reports of components.</u>	2.6 Tests 2.6.1 Shop Tests* 1 For components or accessories specified in Table 7.2.8, 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 7.2.8. 2 For reciprocating internal combustion engines, the purpose of the shop trials 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: (Newly added)	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
<u>iii) Necessary internal test results, when requested by the Surveyor.</u> <u>(c) After test</u> <u>The manufacturer is to submit a formal report to the Society, which includes,</u> <u>i) Valid certificate of type approval or design evaluation covering the tested engine.</u> <u>ii) Calibration records for the instrumentation used to collect data</u> <u>iii) Documentation and test results with the signature of attending Surveyor</u> <u>iv) Surveyor's comments during shop trials, and the manufacturer's replies/explanations.</u> <u>(2) The following preparations are to be made before carrying out the engine tests:</u> <u>(a) All relevant equipment for the safety of attending personnel such as safety barrier, safety railings, information and marking of escape routes, sirens, crankcase explosive conditions protection (e.g. oil mist detection arrangements), overspeed protective devices and any other shut down functions are to be made available and are to be operational, and its correct functioning is to be verified. The overspeed protective device is to be set to a value which is not higher than the allowable overspeed value.</u> <u>(Deleted)</u> <u>(b) Jacketing of high-pressure fuel oil lines and screening of pipe connections in piping containing flammable liquids required in (9)(a) and (b) are to be verified.</u>	<u>(1) The following preparations are to be made before carrying out the engine tests:</u> <u>(a) All relevant equipment for the safety of attending personnel such as oil mist detection arrangements, overspeed protective devices and any other shut down functions are to be made available and are to be operational.</u> <u>(b) The overspeed protective device is to be set to a value which is not higher than the allowable overspeed value. This set point is to be verified by the surveyor.</u> <u>(c) The engines are to be run as prescribed by the engine manufacturer.</u> <u>(Newly added)</u>	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
(c) All fluids used for testing purposes (fuel oils, lubrication oils, cooling water, etc., including all fluids used temporarily or repeatedly for testing purposes only) are to be suitable for their intended purposes (i.e. they are to be clean, preheated if necessary and cause no harm to engine parts). (3) For all stages of testing, the following (a) to (c) ambient conditions are to be recorded and the pertaining operation values (normally the following (d) to (l) items) for each load point are to be measured and recorded by the engine manufacturer. All results are to be compiled in an acceptance protocol to be issued by the manufacturer. Calibration records for the instrumentation are to be presented to the attending Surveyor. ((a) to (k) are omitted.) (l) <u>All engine parameters required for control and monitoring for the intended use (propulsion, auxiliary or emergency), if applicable to the scope of delivery</u> (4) All measurements conducted at the various load points are to be carried out under steady operating conditions. However, provision is to be made for time needed by the surveyor to carry out visual inspections for all load points. The readings for 100 % power (rated power at rated speed) are to be taken twice at an interval of at least 30 <i>minutes</i>. (5) During all load points, engine parameters are to be	(d) All fluids used for testing purposes (fuel oils, lubrication oils, cooling water, etc., including all fluids used temporarily or repeatedly for testing purposes only) are to be suitable for their intended purposes (i.e. they are to be clean, preheated if necessary and cause no harm to engine parts). (2) For all stages of testing, the following (a) to (c) ambient conditions are to be recorded and the pertaining operation values (normally the following (d) to (k) items) for each load point are to be measured and recorded by the engine manufacturer. All results are to be compiled in an acceptance protocol to be issued by the manufacturer. Calibration records for the instrumentation are to be presented to the attending surveyor. <u>In addition, crankshaft deflection is to be checked and recorded in the results in cases where such a check is required by the manufacturer during the operating life of the engine.</u> ((a) to (k) are omitted.) (Newly added) (3) All measurements conducted at the various load points are to be carried out under steady operating conditions. However, provision is to be made for time needed by the surveyor to carry out visual inspections for all load points. The readings for 100 % power (rated power at rated speed) are to be taken twice at an interval of at least 30 <i>minutes</i>. (Newly added)	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
<u>within the specified and approved values.</u> (6) In cases where a no-load operation is conducted for adjusting engine conditions, the fuel delivery system, manoeuvring system and safety devices are to be properly adjusted by the manufacturer before the operation. (7) Tests of safety precautions are to be carried out in accordance with the manufacturer's specification to the extent applicable for the scope of delivery of the engine, especially for overspeed protective devices and safeguards of the low pressure of lubricating oil systems. If applicable, oil mist detection systems and other safeguards are also to be tested. The shutdown tests of safety devices are to be carried out at running condition. Testing by simulating the concerned parameter or adjusting the set-point may be accepted subject to special consideration by the Society. (8) The programme shown in Table 7.2.8 is to be used for the shop trials of reciprocating internal combustion engines. In this case, refer to the <i>JIS</i> 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) and (b) are omitted.) (9) 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.	(4) In cases where a no-load operation is conducted for adjusting engine conditions, the fuel delivery system, manoeuvring system and safety devices are to be properly adjusted by the manufacturer before the operation. (Newly added) (5) The programme shown in Table 7.2.9 is to be used for the shop trials of reciprocating internal combustion engines. In this case, refer to the <i>JIS</i> 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) and (b) are omitted.) (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.	

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Amended	Original	Remarks
(a) Jacketing of high-pressure fuel oil lines, including the system used for the detection of leakage (b) Screening of pipe connections in piping containing flammable liquids (c) Temperature of hot surface insulation <u>Proper insulation of hot surfaces is to be verified. Readings of surface temperatures are to be done randomly by using of infrared thermoscanning equipment while the engine is running at rated power. Equivalent measurement equipment may be used when approved by the Society.</u> If the insulation is modified subsequently to the type approval test, the Society may request temperature measurements as required by the type approval test. <u>(10)</u> Category C turbochargers installed on 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) For 4-stroke engines, the operations given in the following i) and ii) are to be performed without any indication of surging.	(a) Jacketing of high-pressure fuel oil lines, including the system used for the detection of leakage (b) Screening of pipe connections in piping containing flammable liquids (c) Temperature of hot surface insulation <u>Random temperature readings are to be compared with corresponding readings obtained during the type approval test. This is to be done while running at the rated power of engine.</u> If the insulation is modified subsequently to the type approval test, the Society may request temperature measurements as required by the type approval test. <u>In the case of 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 approval test, temperature measurements are to be performed by a procedure deemed appropriate by the Society.</u> <u>(7)</u> Category C turbochargers installed on 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) For 4-stroke engines, the operations given in the following i) and ii) are to be performed without any indication of surging.	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
i) While at maximum continuous rating (maximum continuous power and speed), speed is to be reduced with the constant torque (fuel index) down to 90 % power. ii) While at 50 % power and speed <u>according to propeller curve depending on application (see Note (9) of Table 7.2.6)</u>, speed is to be reduced <u>with</u> constant torque (fuel index) down to 45 % power. (b) For 2-stroke engines, the surge margin is to be demonstrated by at least one of the following i) to iii): i) The engine working characteristics established at shop tests of the engine is to be plotted into the compressor chart of the turbocharger (<u>which was established</u>) by the <u>turbocharger manufacturer's testing</u>. There is to be at least a 10 % surge margin in the full load range, i.e., working flow is to be 10 % above the theoretical mass flow at the surge limit where there are no pressure fluctuations. ii) A sudden fuel cut-off to at least one cylinder at the following 1) and 2) loads is not to result in continuous surging and the turbocharger is to be stabilised at the new loads within 20 <i>seconds</i>. For applications with more than one turbocharger, the fuel supply to the cylinders closest upstream to each turbocharger is to be cut off. 1) The maximum power permitted for one cylinder misfiring.	i) While at maximum continuous rating (maximum continuous power and speed), speed is to be reduced with the constant torque (fuel index) down to 90 % power. ii) While at 50 % power and <u>80 % speed</u>, speed is to be reduced <u>to 72 % while keeping</u> constant torque (fuel index). (b) For 2-stroke engines, the surge margin is to be demonstrated by at least one of the following i) to iii): i) The engine working characteristics established at shop tests of the engine is to be plotted into the compressor chart of the turbocharger (<u>established in a test rig</u>). There is to be at least a 10 % surge margin in the full load range, i.e., working flow is to be 10 % above the theoretical mass flow at the surge limit where there are no pressure fluctuations. ii) A sudden fuel cut-off to at least one cylinder at the following 1) and 2) loads is not to result in continuous surging and the turbocharger is to be stabilised at the new loads within 20 <i>seconds</i>. For applications with more than one turbocharger, the fuel supply to the cylinders closest upstream to each turbocharger is to be cut off. 1) The maximum power permitted for one cylinder misfiring.	

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Amended	Original	Remarks
2) The <u>maximum</u> engine load corresponding to a charge air pressure of about 0.06 <i>MPa</i>, but without auxiliary blowers running. iii) No continuous surging and the turbocharger is to be stabilised at the new load within 20 <i>seconds</i> when the power is abruptly reduced from 100 % to 50 % of the maximum continuous power. (11) <u>Integration tests for sub-system acceptance</u> are to be made to verify that the response of the complete mechanical, hydraulic and electronic system is as predicted. <u>If the tests are technically unfeasible on the test bed, they may be conducted during the sea trials.</u> The scope of these tests is to be <u>proposed by the designer taking into account of multiple engine operational mode, a risk analysis approved by the Society and the impact of the test on engine, and agreed with the Society, prior to the tests. Typical examples of extended tests include, but are not limited to, the following.</u> The tests may be carried out using other alternative methods, subject to special consideration by the Society. (a) <u>Safety test of sub-systems</u> (b) <u>Functional test of sub-systems</u> (c) <u>Operational mode switch/Changeover test: Switch between multiple operational mode or turn on/off sub-systems</u> (d) <u>Extended performance and load test for engines with multiple operational modes, if applicable</u>	2) The engine load corresponding to a charge air pressure of about 0.06 <i>MPa</i>, but without auxiliary blowers running. iii) No continuous surging and the turbocharger is to be stabilised at the new load within 20 <i>seconds</i> when the power is abruptly reduced from 100 % to 50 % of the maximum continuous power. (8) <u>For electronically controlled engines, integration tests</u> are to be made to verify that the response of the complete mechanical, hydraulic and electronic system is as predicted. The scope of these tests is to be <u>determined based on a risk analysis by a method deemed appropriate</u> by the Society and agreed with the Society, prior to the tests. The tests may be carried out using other alternative methods, subject to special consideration by the Society.	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (D)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(Moved)	<u>3 For rotating assemblies of exhaust driven turbochargers of categories B and C, dynamic balancing tests are to be carried out.</u>	Move to 2.7.4-4
(Moved)	<u>4 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. For forged impellers and inducers subject to quality control through an approved non-destructive test method, overspeed tests may be dispensed with.</u> <u>(1) 120 % of the alarm level speed at room temperature;</u> <u>or</u> <u>(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.</u>	Move to 2.7.4-5
(Moved)	<u>5 For categories B and C turbochargers, tests are to be carried out to verify durability according to procedures deemed appropriate by the Society.</u>	Move to 2.7.4-6

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Amended		Original		Remarks
Table 7.2.87 Hydrostatic Test Pressure				
Part		Cylinder bore D (mm)		Test Pressure ⁽²⁾⁽³⁾ (MPa)
		$D \leq 300$	$300 < D$	
(Omitted)				
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 10.6
Notes:				
(1) to (6) are omitted.)				
(7) In cases where the manufacturer has a quality system deemed appropriate by the Society, hydrostatic tests for category 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 reciprocating internal combustion engines.				
(9) Only when capacity exceeds 0.5l.				
(10) Only when engine power exceeds 800 kW/cyl.				
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)				

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Amended		Original			Remarks
Table 7.2.98 Programme for Shop Trials of Engines					
Test items		Use of engines			
		Reciprocating internal combustion engines used as main propulsion machinery ⁽¹⁾	Reciprocating internal combustion engines driving generators (including those used as main propulsion machinery of electric propulsion ships) ⁽²⁾	Reciprocating internal combustion engines driving auxiliaries (excluding auxiliary machinery for specific use etc.) ⁽¹⁾	
Load test	110 % power run ⁽³⁾	15 minutes or until after having reached steady conditions have been reached, which is shorter, at 1.032 n_0 or more (where n_0 is the rated engine speed) ^{(4), (5), (6)}	15 minutes after having reached steady conditions at n_0 ⁽⁷⁾	15 minutes after having reached steady conditions at n_0	
	100 % power run	60 minutes at n_0	60 minutes at n_0	30 minutes at n_0	
	90 % power run (or normal continuous cruise power) ^{(6), (7)}	20 minutes at engine speed in accordance with the nominal propeller curve ⁽⁹⁾	-	-	
	75 % power ^{(6), (7)}		20 minutes at n_0	20 minutes in accordance with the nominal power consumption curve ^(8,10)	
	50 % power ^{(6), (7)}				
	25 % power ^{(6), (7)}				
	Idle run ⁽⁶⁾		-	An adequate time at n_0	-
Reversing manoeuvres ^(9,11)		○	-	-	
Intermittent overload ^(10,12)		○	-	○	
Governor test		-	○ ⁽¹³⁾	-	
Performance of monitoring, alarm and safety devices		○	○	○	
Open-up inspection ^(11,14)		○	○	○	

Notes:

(1) After testing has been completed, the fuel delivery system is to be blocked so as to limit the engines to run at not more than 100 % power, unless (Unless intermittent overload power is approved by the Society. In that case, the fuel delivery system is to be limited to that power). In the case of propulsion engines also driving power take-off generators, the fuel delivery system is to be adjusted so that overload of generator (110 % power) can be given in service and the electrical protection of downstream system components is activated before the engine stalls.

(2) After testing has been completed, the fuel delivery system is to be adjusted such that overload (110 % power) can

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Amended	Original	Remarks
be given in service after installation on board, so that the governing characteristics (including the activation of generator protective devices) can be fulfilled at all times. (3) For dual fuel engines, tests in the gas mode are not required in accordance with 2.6.1-3(2), Part D of the Rules for the Survey and Construction of Steel Ships. (4) Submission of test reports for identical engines and turbocharger configurations proving their compatibility for over-loaded operation may be accepted as substitutions for the 110 % power run. <u>(5) In the case of propulsion engines driving controllable pitch propeller, tests are to be carried out at n_0 for 15 minutes after having reached a steady operating condition.</u> (5) In the case of propulsion engines also driving power take-off generators, tests are to be carried out at n_0 for 15 minutes after having reached a steady operating condition. (6) The sequence is to be selected by the engine manufacturer. <u>(7) 10% overload power may not require for e.g. variable speed engines driving electrical machines for electric propulsion, when they are connected to a DC grid where the inverter is limiting the requested power.</u> (7) A shorter time may be considered by the Society provided that the time specified in 2.6.1-2(34), Part D of the Rules for the Survey and Construction of Steel Ships is allowed. <u>(9) The engine speed is to be as follows:</u> <u>(a) In accordance with the nominal propeller curve, for an engine driving a fixed pitch propeller, waterjet. Or</u> <u>(b) In accordance with the nominal propeller curve or modified propeller curve for an engine driving controllable pitch propeller with variable speed and pitch. Or</u> <u>(c) At constant speed for an engine driving a controllable pitch propeller with constant speed.</u> (8) Only for variable speed engines. (9) The test item applies only to direct reversible engines. (10) Only for engines for which intermittent overload is approved, and tests are to be for the duration agreed upon with the manufacturer. <u>(13) Only for engines driving constant speed (synchronous) generators.</u> (11) The scope of the open-up inspection is to be as deemed appropriate by the surveyor. The omission of the open-up inspection may be considered by the Society provided that all of the following (a) through (g) are met: (a) It is not the open-up inspection to be carried out during the <u>type</u> approval test specified in Chapter 8, Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use. (b) No abnormality is found in the temperature measurement for each bearing of the main bearings and the crank pin bearings after the load test, and in the visual inspection of the inner surfaces of the cylinder liners from the inspection ports of the crankcase. (In the case of a 2-stroke engine, the cylinder liners, pistons, piston rings and piston rods are to be inspected from the scavenging space.) (c) No abnormality is found in the visual inspection of the lubrication oil after the load test (including the visual inspection of the filter in cases where the open-up of the strainer is reasonable). (d) Flushing of the parts through which the lubrication oil passes is carried out during the manufacturing process. (e) The manufacturer of the reciprocating internal combustion engine is approved by the Society in accordance		

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Amended	Original	Remarks
with the Rules for Approval of Manufacturers and Service Suppliers. (f) There is agreement between the involved parties. (manufacturer, shipyard, prospective owner, etc.) (g) Other items deemed necessary by the Society.		
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Amended	Original	Remarks
<u>2.7 Exhaust Driven Turbochargers</u> <u>2.7.1 General</u> <u>The requirements of exhaust driven turbochargers specified in 2.7 also apply, in principle, to engine driven chargers.</u> <u>2.7.2 Terminology</u> <u>In 2.7, exhaust driven turbochargers are categorised into the following three groups according to the engine power at maximum continuous rating (MCR) supplied by a group of cylinders served by the actual turbocharger (e.g. turbocharger size is to be 50 % of total engine power for a V-engine with one turbocharger serving each bank of cylinders).</u> (1) <u>Category A turbochargers</u> <u>The engine power at MCR supplied by a group of cylinders served by the turbocharger is not more than 1,000 kW.</u> (2) <u>Category B turbochargers</u> <u>The engine power at MCR supplied by a group of cylinders served by the turbocharger is not less than 1,000 kW, but not more than 2,500 kW.</u> (3) <u>Category C turbochargers</u> <u>The engine power at MCR supplied by a group of cylinders served by the turbocharger is not less than 2,500 kW.</u> <u>2.7.3 Requirements for Design, Safety and Alarm Arrangements, etc.</u> <u>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.</u>	(Newly added) (Newly added) (Moved) (Newly added) (Moved) (Newly added) (Moved)	Moved from 2.1.1-3 Moved from 2.1.2-1 Moved from 2.5.1-1

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Amended	Original	Remarks
<u>2 Exhaust driven turbochargers are to be designed to operate under conditions given in 1.3.1-4 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.</u>	(Moved)	Moved from 2.5.1-4
<u>3 The air inlets of exhaust driven turbochargers are to be fitted with filters.</u>	(Moved)	Moved from 2.5.1-5
<u>4 Exhaust driven turbochargers 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.</u>	(Moved)	Moved from 2.5.1-6
<u>5 In the case of Category C turbochargers 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.</u>	(Moved)	Moved from 2.5.1-7
<u>6 For Category B and C turbochargers, the indications and alarms listed in Table 7.2.9 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.</u>	(Moved)	Moved from 2.5.1-8
<u>7 Certificates for Category B and C turbochargers issued by the Society will, at a minimum, cite the applicable type approval.</u>	(Moved)	Moved from 2.5.1-10
<u>8 Certification and test requirements specified in 2.7 apply to the replacement of rotating parts and casings.</u>	(Moved)	Moved from 2.5.1-11

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Amended	Original	Remarks
Table 7.2.69 Alarms and Indications of Turbochargers (Table is omitted.)		Moved from Table 7.2.6
2.7.4 Tests*		
1 The materials used for turbine discs, blades, blower impellers and rotor shafts of Category <i>B</i> and <i>C</i> turbochargers are to be manufactured in accordance with 1.2.1-1, Part K and are to be subjected to the following tests. Those tests are to be conducted in the presence of the Surveyor.	(Newly added) (Moved)	Moved from No.23 of Table 7.2.2
(1) Chemical composition analysis		
(2) Mechanical property tests		
(3) Ultrasonic tests and Magnetic particle tests or liquid penetrant tests		
(4) Dimension inspections		
2 Materials used for casings of Category <i>B</i> and <i>C</i> turbochargers are to comply with the requirements in Part K. However, chemical composition analysis may be omitted.	(Moved)	Moved from No.24 of Table 7.2.2
3 For the cooling space of Category <i>B</i> and <i>C</i> turbochargers, hydrostatic tests are to be carried out at a pressure of 0.4 MPa or 1.5 times the maximum working pressure, whichever is greater.	(Moved)	Moved from Table 7.2.7
4 For rotating assemblies of exhaust driven turbochargers of Categories <i>B</i> and <i>C</i> , dynamic balancing tests are to be carried out.	(Moved)	Moved from 2.6.1-3
5 For the impellers and inducers of exhaust driven turbochargers of Categories <i>B</i> and <i>C</i> , overspeed tests for a duration of 3 minutes at either of the following (1) or (2) are to be carried out. For forged impellers and inducers subject to quality control through an approved non-destructive test method, overspeed tests may be dispensed with.	(Moved)	Moved from 2.6.1-4
(1) 120 % of the alarm level speed at room temperature;		

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Amended	Original	Remarks
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. 6 For <u>Category B</u> and <u>C</u> turbochargers, tests are to be carried out to verify durability according to procedures deemed appropriate by the Society.	(Moved)	Moved from 2.6.1-5
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Amended	Original	Remarks
Chapter 6 TORSIONAL VIBRATION OF SHAFTINGS 6.1 General 6.1.2 Data to be Submitted 1 Torsional vibration calculation sheets covering the following items are to be submitted for approval: (1) Natural frequency calculation tables for one node and two nodes vibration, and also for more nodes vibrations if necessary (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 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) having its critical speed above 120 % of the number of maximum continuous revolutions. (3) Arrangement of crank throws and firing order (in cases of shafting systems driven by reciprocating internal combustion engines) (4) For propulsion shafting systems intended to be continuously operated under one cylinder misfiring condition, calculation results of the torsional vibration stress with any one cylinder misfiring giving rise to the highest torsional vibration stress. (5) Calculation results of the torsional vibration stress in	Chapter 6 TORSIONAL VIBRATION OF SHAFTINGS 6.1 General 6.1.2 Data to be Submitted 1 Torsional vibration calculation sheets covering the following items are to be submitted for approval: (1) Natural frequency calculation tables for one node and two nodes vibration, and also for more nodes vibrations if necessary (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 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) having its critical speed above 120% of the number of maximum continuous revolutions. (3) Arrangement of crank throws and firing order (in cases of shafting systems driven by reciprocating internal combustion engines) (4) For propulsion shafting systems intended to be continuously operated under one cylinder misfiring condition, calculation results of the torsional vibration stress with any one cylinder misfiring giving rise to the highest torsional vibration stress. (Newly added)	

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Amended	Original	Remarks
<u>the fuel and operating mode resulting in the worst-case scenario during acceleration in the ship's actual operation (only where 6.4.2-1 is applicable).</u> <u>6.4 Measurements</u> <u>6.4.1 General</u> Torsional vibration measurements are to be carried out to confirm the correctness of the estimated values of calculation results if deemed necessary by the Society; for example, cases where the torsional vibration calculations indicate the possibility of dangerous critical speeds in the operating speed range, etc. <u>6.4.2 Time for Passing Through Barred Speed Range*</u> <u>1 Where a barred speed range is required in accordance with 6.3.1, the passage through this barred speed range is to be demonstrated. The time taken to transit the barred speed range is to be recorded and when accelerating ahead is not to exceed the time determined from the following formula:</u> $T_{bsr} = 5 \cdot (\tau_{max}/\tau_2)^{-7.2}$ <u>where:</u> T_{bsr}: <u>Maximum allowable time to transit the barred speed range (s)</u> τ_{max}: <u>Maximum stress amplitude of the steady state torsional vibration at the critical speed as per calculation (N/mm²)</u> τ_2: <u>Permissible stress amplitude due to steady state torsional vibration at the critical speed as determined from 6.2.2 (N/mm²)</u>	<u>6.1.3 Measurements</u> (Newly added) <u>1</u> Torsional vibration measurements are to be carried out to confirm the correctness of the estimated values of calculation results if deemed necessary by the Society; for example, cases where the torsional vibration calculations indicate the possibility of dangerous critical speeds in the operating speed range, etc. (Newly added) (Newly added)	

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Amended	Original	Remarks
<u>The required value for T_{bsr} is to be included within the torsional vibration calculation submission.</u> 2 <u>The designer is to ensure that sufficient torque and/or power reserve exists within the main propulsion system such that the barred speed range transit time required in -1 is not exceeded.</u> 3 <u>As an alternative to the requirements of -1 and -2 above, either of the following documents may be submitted to the Society:</u> (1) <u>When carried out in accordance with 6.2.6, alternative formulae for T_{bsr} may be presented. The submission is to demonstrate that the fatigue life is conservative with respect to the shafting material.</u> (2) <u>Documented evidence of satisfying the barred speed range transit time requirement on similar propulsion systems in terms of power, rpm and mass-elastic properties for vessels of similar type, displacement and hull form.</u> 6.4.3 Shipboard Trials 1 <u>For cases where calculations carried out in accordance with 6.3.1 indicate the necessity for a barred speed range, measurements are to be taken and recorded to confirm that the torsional vibration response characteristics satisfy the requirements of the submitted torsional vibration calculations and barred speed range transit time calculation.</u> 2 <u>Measurements are to be taken at vessel draughts which are, as far as practicable, the maximum achievable during shipboard trials. The trial draughts are to be included in the measurement report.</u> 3 <u>Verification of the torsional response characteristics is to be demonstrated by, at least, measurement of the following:</u>	(Newly added) (Newly added) (Newly added) (Newly added) (Newly added) (Newly added)	

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Amended	Original	Remarks
(1) <u>The mean torsional stress throughout the operating range of main engine revolutions (limited when strain gauges are used); and</u> (2) <u>The stress amplitude of the steady state torsional vibration throughout the operating range of main engine revolutions under normal firing conditions.</u> 4 <u>The measurement procedures adopted to verify the torsional vibration response characteristics are to identify the maximum stress amplitude of the steady state torsional vibration at any resonant condition which exists within the operating range of main engine revolutions. For resonances at which the stress amplitude of the steady state torsional vibration exceeds that permissible for continuous operation (τ_1), as defined in 6.2, the critical speeds are to be identified. Identification of any critical speed will, as defined in 6.3.1, determines the lower and upper boundaries of its associated barred speed range.</u> 5 <u>Verification of the barred speed range transit time is to begin at telegraph setting closest to the position below the lower border of the barred speed range. Allow the vessel to accelerate to a steady ship speed and then pass through the barred speed range as recommended for this operation. The time taken to pass through the barred speed range from lower to upper rpm limits is to be within the calculated maximum T_{bsr}.</u> 6 <u>The following are also to be satisfied for barred speed range transit:</u> (Deleted)	(Newly added) (Newly added) 2 <u>In cases where the barred speed ranges specified in 6.3.1 are marked for reciprocating internal combustion engine used as main propulsion machinery, engines, the following (1) and (2) are to be confirmed and recorded.</u> (1) <u>Passing time as well as the ship draft and speed of passing through the barred speed range (accelerating and decelerating). In the case of a controllable pitch</u>	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(1) <u>Measurement and reporting of stable running of the main engine at the lower and upper boundaries of the barred speed range is to be carried out. Stable running is defined by an oscillation of the fuel index/metering which is less than 5_% of the effective stroke or metered fuel quantity (from idle to maximum continuous power). Alternatively, in the case of engines which do not have means to confirm fuel index/metering, an oscillation range of speed less than 5_% of maximum continuous revolution may be confirmed and recorded.</u> (2) <u>The vessel speed, in knots, and main engine operating speed (rpm) are to be stable prior to commencement of the transit across the barred speed range. The main engine revolutions per minute are to be in accordance with the designed engine telegraph settings.</u> (3) <u>For propulsion systems employing controllable pitch propellers, the pitch is to be recorded and included in the measurement report.</u> (4) <u>For main engines employing devices or control systems to improve the torque and/or power reserve to assist acceleration through the barred speed range, details of equipment and settings are to be included in the measurement report.</u> <u>7 Measurement accuracy tolerances are, in general, recommended to be within the following:</u> (1) <u>Mean torsional stress (applicable when strain gauges are used): $\pm 5 \%$</u> (2) <u>Vibratory torsional stress amplitude: $\pm 5 \%$</u> (3) <u>Transit time: $\pm 3 \%$</u>	<u>propeller, the pitch is also to be confirmed and recorded.</u> (2) <u>Running condition of engines at both the upper and lower borders of the barred speed range. In this case, the oscillation range of fuel index (fuel injection quantity (fuel rack position)) is normally to be less than 5% of the effective stroke (maximum fuel injection quantity (possible fuel rack range)). Alternatively, in the case of engines which do not have means to confirm fuel index, an oscillation range of speed less than 5% of maximum continuous revolution may be confirmed and recorded.</u> (Newly added) (Newly added) (Newly added) (Newly added)	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
<u>(4) Main engine revolutions per minute, including that of tachometers located at main control positions: $\pm 1\%$</u> <u>8 For installations where the calculated maximum vibratory stress amplitude is greater than 85 % of the permissible vibratory stress ($\tau_{max} > 0.85 \tau_2$), the measurement of torsional stress is to be carried out using a strain gauge-based technique. The accuracy of the strain gauge measurement is expected to be within $\pm 3\%$.</u> <u>9 A measurement programme is to be provided by the shipyard or engine manufacturer and accepted by the Society. On completion of the shipboard trials, a report detailing the trials measurements and results is to be presented to the Society for acceptance. The report is to be received prior to vessel delivery and no later than three months after completion of the trials.</u> <u>10 The measurement results obtained on the first ship in a series may be applied to the remaining ships in that series, provided that the main propulsion plant (including the main propulsion engine, shafting, clutches/couplings as applicable and propeller) are identical.</u> <u>11 In cases where the measured barred speed range transit time exceeds the required allowable value (T_{bsr}), consideration may be given to the maximum stress amplitude (τ_{max}) measured by a strain gauge based technique. The shipyard is to submit a detailed report of the impact this will have on the accumulation of fatigue cycles. In such cases, the measurement result will prevail (only if determined as applicable by the manufacturer).</u> <u>12 The fuel and operating mode used in the measurement is to be selected based on the worst-case scenario and considering the fuel used during acceleration in the ship's actual operation.</u>	(Newly added) (Newly added) (Newly added) (Newly added) (Newly added)	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (B)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
Chapter 11 PIPING SYSTEMS 11.13 Pneumatic Piping Systems 11.13.3 Number and Total Capacity of Air Compressors 3 The total capacity of air compressors is to be sufficient to supply air into the air reservoirs from atmospheric pressure to the pressure required for the consecutive starts prescribed in 2.5.2-2 within one <i>hour</i>. The capacity is to be approximately equally divided between the number of starting air compressors (excluding emergency compressors installed to satisfy 1.3.1-5) fitted for main propulsion machinery. Chapter 14 AUTOMATIC AND REMOTE CONTROL 14.3 Automatic and Remote Control of Main Propulsion Machinery or Controllable Pitch Propellers 14.3.2 Remote Control Devices for Main Propulsion Machinery or Controllable Pitch Propellers* 4 Remote starting of main propulsion machinery in 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:	Chapter 11 PIPING SYSTEMS 11.13 Pneumatic Piping Systems 11.13.3 Number and Total Capacity of Air Compressors 3 The total capacity of air compressors is to be sufficient to supply air into the air reservoirs from atmospheric pressure to the pressure required for the consecutive starts prescribed in 2.5.3-2 within one <i>hour</i>. The capacity is to be approximately equally divided between the number of starting air compressors (excluding emergency compressors installed to satisfy 1.3.1-5) fitted for main propulsion machinery. Chapter 14 AUTOMATIC AND REMOTE CONTROL 14.3 Automatic and Remote Control of Main Propulsion Machinery or Controllable Pitch Propellers 14.3.2 Remote Control Devices for Main Propulsion Machinery or Controllable Pitch Propellers* 4 Remote starting of main propulsion machinery in 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:	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(1) The number of times of starting main propulsion machinery is to satisfy the number specified in 2.5.2. ((2) to (4) are omitted.) 14.5 Automatic and Remote Control of Electric Generating Sets 14.5.1 General 3 In cases where 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 2.5.2. Chapter 15 BARGES 15.2 Internal Combustion Engines 15.2.1 General Construction 4 The fuel oil arrangements for internal combustion engines having a carburetor are to comply with the requirements in 15.4.5 and additionally, the requirements in 2.5.3.	(1) The number of times of starting main propulsion machinery is to satisfy the number specified in 2.5.3. ((2) to (4) are omitted.) 14.5 Automatic and Remote Control of Electric Generating Sets 14.5.1 General 3 In cases where 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. Chapter 15 BARGES 15.2 Internal Combustion Engines 15.2.1 General Construction 4 The fuel oil arrangements for internal combustion engines having a carburetor are to comply with the requirements in 15.4.5 and additionally, the requirements in 2.5.4.	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part D MACHINERY INSTALLATIONS D1 GENERAL D1.1 General D1.1.4 Modification of Requirements For those machinery installations specified in 1.1.4, Part D of the Rules (excluding those specified in other parts of the Rules), some requirements of Part D of the Rules may be modified as follows: (1) Prime movers (including power transmission systems and shafting systems) driving generators, auxiliary machinery essential for main propulsion and auxiliary machinery for manoeuvring and the safety. (a) Prime movers with an output <u>of 110 kW or less</u> i) Submission of drawings may be omitted. ii) Materials which comply with the requirements of any national standard may be accepted for the principal components. In this case, materials (excluding valves and pipe fittings) are to be manufactured by a manufacturer approved by the Society. iii) Shop tests in the presence of the Surveyor may be substituted for manufacturer's tests.	GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part D MACHINERY INSTALLATIONS D1 GENERAL D1.1 General D1.1.4 Modification of Requirements For those machinery installations specified in 1.1.4, Part D of the Rules (excluding those specified in other parts of the Rules), some requirements of Part D of the Rules may be modified as follows: (1) Prime movers (including power transmission systems and shafting systems) driving generators, auxiliary machinery essential for main propulsion and auxiliary machinery for manoeuvring and the safety. (a) Prime movers with an output <u>less than 100 kW</u> i) Submission of drawings may be omitted. ii) Materials which comply with the requirements of any national standard may be accepted for the principal components. In this case, materials (excluding valves and pipe fittings) are to be manufactured by a manufacturer approved by the Society. iii) Shop tests in the presence of the Surveyor may be substituted for manufacturer's tests.	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
In this case, submission or presentation of test records may be required by the surveyor. (b) Prime movers with an output <u>more</u> than <u>110 kW</u> but less than 375 kW i) Materials used for principal components may be dealt with under the requirements specified in (a)ii). ii) Hydrostatic tests as well as dynamic balancing tests, overspeed tests and trial runs of turboblowers at the manufacturer may be dealt with under the requirements specified in (a)iii). ((2) to (8) are omitted.) D2 RECIPROCATING INTERNAL CONBUSTION ENGINES D2.1 General D2.1.1 General <u>1</u> The wording “as specified separately by the Society” specified in 2.1.1-3, Part D of the Rules means “in accordance with Chapter 8, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use”. <u>2</u> For the approval procedure for reciprocating internal combustion engines by the Society, reference is to be made to <u>Fig. D2.1.1-1</u>.	In this case, submission or presentation of test records may be required by the surveyor. (b) Prime movers with an output <u>not less</u> than <u>100 kW</u> but less than 375 kW i) Materials used for principal components may be dealt with under the requirements specified in (a)ii). ii) Hydrostatic tests as well as dynamic balancing tests, overspeed tests and trial runs of turboblowers at the manufacturer may be dealt with under the requirements specified in (a)iii). ((2) to (8) are omitted.) D2 RECIPROCATING INTERNAL CONBUSTION ENGINES D2.1 General D2.1.1 General The wording “as specified separately by the Society” specified in 2.1.1-3, Part D of the Rules means “in accordance with Chapter 8, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use”. (Newly added)	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
Fig. D2.1.1-1 Type Approval and Individual Engine Certification Process <pre> graph TD A[Application for Type Approval/Design Evaluation Certificate (by engine designer)] --> B[Design Appraisal] B --> C[Type Test] C --> D{Engine designer is manufacture?} D -- Yes --> E[Licensee Assessment] E --> F[Type Approval Certificate] F --> G[Application for engine certificate (by manufacturer with TAC)] D -- No --> H[Design Evaluation] H --> I[Application for engine certificate (by manufacturer without TAC)] G --> J(()) I --> J J --> K[Licensee Assessment (if necessary)] K --> L{Is design modified?} L -- Yes --> M[Submission of drawings and data for the inspection and testing (if applicable) and comparison list] L -- No --> N[Submission of comparison list] M --> O[Drawing Review (if applicable)] N --> O O --> P[Components inspection and test] P --> Q[Shop Tests] Q --> R[Engine Certificate] R --> S[On-board Trials] </pre>		

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
D2.1.3 Approval of Reciprocating Internal Combustion Engines 1 In applying 2.1.3, Part D of the Rules, reference for the approval procedures is to be made to Fig. D2.1.3-1. (Deleted) (Moved) (Deleted) (Deleted) (Deleted) 2 The wording “the requirements specified separately by the Society” specified in 2.1.3-3 and -4, Part D of the Rules means “the requirements specified in Chapter 8, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use”.	D2.1.4 Approval of Reciprocating Internal Combustion Engines 1 In applying 2.1.4, Part D of the Rules, reference for the approval procedures is to be made to Fig. D2.1.4-1. 2 The phrase “design approval is to be obtained as specified separately by the Society” specified in 2.1.4-1(1)(a), Part D of the Rules means that the design approval and design appraisal are to be obtained in accordance with Chapter 8, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use. 3 The wording “the drawings and data of the reciprocating internal combustion engine whose type approval 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 of Materials and Equipment for Marine Use. 4 The wording “as specified separately by the Society” specified in 2.1.4-1(1)(d), Part D of the Rules means “in accordance with 8.2.2-2, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use”. 5 In applying 2.1.4-1(2)(c), Part D of the Rules, quality requirements specified by the licensor are to be satisfied. 6 The wording “as specified separately by the Society” specified in 2.1.4-1(4)(a), Part D of the Rules means “in accordance with 8.2.2-4, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use”. (Newly added)	Moved to D2.1.4-2 Deleted to align with the existing practice.

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
3 The wording “requirements equivalent to those for approval based on type approval” specified in 2.1.3-5, Part D of the Rules means “requirements specified in Chapter 2, Part D of the Rules and Chapter 8, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use”. Fig. D2.1.43-1 Flow of Approval of Reciprocating Internal Combustion Engines (Table is omitted.) 1) Branch offices with responsibility for licensees and/or component manufacturers in different locations 2) In cases of modifications by the licensee, refer to (b) and (c) of 2.1.4-12(2), Part D of the Rules D2.1.4 Drawings and Data (Deleted) 1 The wording “a list containing all drawings and data” specified in 2.1.4-1(1)(a), Part D of the Rules means a list of the drawings and data applicable to the engine concerned from among the following: (1) <u>Bedplate and crankcase of welded design, with welding details and welding instructions</u> (2) <u>Thrust bearing bedplate of welded design, with welding details and welding instructions</u> (3) <u>Bedplate/oil sump welding drawings</u>	(Newly added) D2.1.3 Drawings and Data For the following data, 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. (1) <u>The documentation for safe torque transmission specified in (34)(a), Table D2.1(b), Part D of the Rules</u> (2) <u>The operation and maintenance manuals listed in (34)(c), Table D2.1(b), Part D of the Rules</u> (Newly added)	Paragraph 3, 1 of UR M87 Clarification of the drawings and data to be included in the “list of drawings and data” referred to in 2.1.4-1(1)(a), Part D of the Rules.

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(4) <u>Frame/framebox/gearbox of welded design, with welding details and instructions</u> (5) <u>Engine frames, welding drawings</u> (6) <u>Crankshaft, details</u> (7) <u>Crankshaft, assembly</u> (8) <u>Thrust shaft or intermediate shaft (if integral with engine)</u> (9) <u>Shaft coupling bolts</u> (10) <u>Material specifications of main parts</u> (11) <u>Shielding of high pressure fuel pipes, assembly</u> (12) <u>Construction of accumulators (for electronically controlled engine)</u> (13) <u>Construction of common accumulators (for electronically controlled engine)</u> (14) <u>Arrangement and details of the crankcase explosion relief valve (only for engines of a cylinder diameter of 200 mm or more or a crankcase volume of 0.6 m³ or more)</u> (15) <u>High pressure parts for fuel oil injection system</u> (16) <u>Details of mechanical joints of piping systems</u> (17) <u>Engine cross section</u> (18) <u>Engine longitudinal section</u> (19) <u>Bedplate and crankcase of cast design</u> (20) <u>Thrust bearing assembly (if integral with engine and not integrated in the bedplate)</u> (21) <u>Frame/framebox/gearbox of cast design</u> (22) <u>Tie rod</u> (23) <u>Connecting rod</u> (24) <u>Connecting rod, assembly</u> (25) <u>Crosshead, assembly</u> (26) <u>Piston rod, assembly</u> (27) <u>Piston, assembly</u>		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(28) <u>Cylinder jacket/ block of cast design</u> (29) <u>Cylinder cover, assembly</u> (30) <u>Cylinder liner</u> (31) <u>Counterweights (if not integral with crankshaft)</u> (32) <u>Camshaft drive, assembly</u> (33) <u>Flywheel</u> (34) <u>Fuel oil injection pump</u> (35) <u>Shielding and insulation of exhaust pipes and other parts of high temperature which may be impinged as a result of a fuel system failure, assembly</u> (36) <u>For electronically controlled engines, construction and arrangement of the following i) to iii):</u> i) <u>Control valves</u> ii) <u>High-pressure pumps</u> iii) <u>Drive for high pressure pumps</u> (37) <u>Other drawings and data deemed necessary by the Society</u> <u>2 The wording “the drawings and data whose type approval has been obtained by the licensor” specified in (1) and (2) of 2.1.4-2, Part D of the Rules means those listed in 8.2.2, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use.</u>	(Moved)	Moved from D2.1.4-3
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (C)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
D2.5 Associated Installations D2.5.3 Starting Arrangements The wording “effective arrangement to prevent the accumulation of combustibles” specified in 2.5.2-1(5), Part D of the Rules means a construction of the starting air manifold from which combustibles can be easily (e.g. the starting air manifold has a gentle slope and a well at the lowermost position) discharged through a drain pipe which is normally open.	D2.5 Associated Installations D2.5.3 Starting Arrangements The wording “effective arrangement to prevent the accumulation of combustibles” specified in 2.5.3-1(5), Part D of the Rules means a construction of the starting air manifold from which combustibles can be easily (e.g. the starting air manifold has a gentle slope and a well at the lowermost position) discharged through a drain pipe which is normally open.	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
D2.6 Tests D2.6.1 Shop Tests (Deleted) The wording “a procedure deemed appropriate by the Society” in 2.6.1-3(8), Part D of the Rules means the tests specified in 8.3, Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use.	D2.6 Tests D2.6.1 Shop Tests <u>1</u> The wording “a procedure deemed appropriate by the Society” in 2.6.1-2(6)(c), Part D of the Rules means the tests specified in 8.5.2-2(10), Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use. <u>2</u> The wording “a procedure deemed appropriate by the Society” in 2.6.1-3(5), Part D of the Rules means the tests specified in 8.3, Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use.	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (D)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(Moved)	3 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 category <i>B</i> turbochargers may be substituted by manufacturer tests. In such cases, the submission or presentation of test records may be required by the Society.	Moved to D2.7.4-1, with the wording revised.
(Moved)	4 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 categories <i>B</i> turbochargers may be substituted for by manufacturer tests. In such cases, the submission or presentation of test records may be required by the Society.	Moved to D2.7.4-2, with the wording revised.
(Moved)	5 The wording “a procedure deemed appropriate by the Society” in 2.6.1-7, Part D of the Rules means the tests specified in Chapter 11, Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use.	Moved to D2.7.4-3
<u>D2.7 Exhaust Driven Turbochargers</u>	(Newly added)	
<u>D2.7.4 Tests</u>	(Newly added)	
1 In cases where compliance with internationally recognised quality standards can be confirmed, attendance by the Surveyor at the tests and inspections specified in 2.7.4-1 and -2, Part D of the Rules may not require for materials used in Category <i>B</i> turbochargers. In such cases, the submission or presentation of test records may be required by the Society.	(Moved)	Moved from D2.6.1-3, with the wording revised.
2 In cases where compliance with internationally recognised quality standards can be confirmed, the hydrostatic tests, the dynamic balancing tests and the overspeed tests specified in 2.6.1-3 to -5, Part D of the Rules for Category <i>B</i> turbochargers may be substituted for by manufacturer tests. In	(Moved)	Moved from D2.6.1-4, with the wording revised.

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
<u>such cases, the submission or presentation of test records may be required by the Society.</u> 3 <u>The wording “a procedure deemed appropriate by the Society” in 2.7.4-6, Part D of the Rules means the tests specified in Chapter 11, Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use.</u>	(Moved)	Moved from D2.6.1-5.
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
D8 TORSIONAL VIBRATION OF SHAFTINGS <u>D8.4 Measurements</u> <u>D8.4.2 Time for Passing Through Barred Speed Range</u> <u>In applying 8.4.2-2, Part D of the Rules, a minimum power margin at the upper boundary of the barred speed range (PM_{BSR}) of 10 % against the bollard pull propeller curve and a minimum light running margin (LRM) of 4 % are recommended. Power margin is defined as the excess ratio of power which exists between the engine torque/power limiting curve and propeller bollard pull curve. Light running margin is defined as the ratio between the engine rpm value on the light propeller curve and the engine rpm value at the nominal (100 %) propeller curve at the maximum continuous rating. Both parameters are shown in Figure D8.4.2-1.</u>	D8 TORSIONAL VIBRATION OF SHAFTINGS (Newly added) (Newly added) (Newly added)	Paragraph 6, 5.4.1 of UR M88

Amended-Original Requirements Comparison Table (Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
Fig. D8.4.2-1 Light Running Margin and Power Margin: Example Relationship to Engine Load Diagram The diagram is a graph of normalized power P/P_{MCR} on the y-axis (0.0 to 1.2) versus normalized engine speed n/n_{MCR} on the x-axis (0.0 to 1.2). Curve 1 (solid) represents engine limits. Curve 2 (dashed) is the 100% propeller curve. Curve 3 (dashed) is the light condition propeller curve. Curve 4 (dashed) is the bollard condition propeller curve. Curve 5 (dashed) is the power margin curve. A 'Barred Speed Range (BSR)' is indicated between a 'Lower Boundary' and an 'Upper Boundary'. The 'Light Running Margin (LRM)' is shown as $(n_L - n_{MCR}) / n_{MCR}$. Power margins are shown as $(P_{TOU} - P_{BOLL}) / P_{BOLL}$ and $(P_{TOU} - P_{BOLL-U}) / P_{BOLL-U}$.		Figure 1 of UR M88
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (B)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
D10 PRESSURE VESSELS D10.9 Tests D10.9.1 Shop Tests 2 Notwithstanding the requirements in 10.9.1, Part D of the Rules, hydrostatic tests of heat exchangers fitted to engines having cylinder bores of 300 <i>mm</i> or less may be omitted (see Table D2.5 of the Rules). D18 AUTOMATIC AND REMOTE CONTROL D18.3 Automatic and Remote Control of Main Propulsion Machinery or Controllable Pitch Propellers D18.3.2 Remote Control Devices for Main Propulsion Machinery or Controllable Pitch Propellers 5 With respect to those requirements specified in 18.3.2-4, Part D of the Rules, even though low pressure alarms for main engine starting air reservoirs are activated before the required number of starts specified in 2.5.2-2, Part D of the Rules has not been completed, engines are to be capable of being started from remote controls station and to complete the required number of starts after activating such alarms.	D10 PRESSURE VESSELS D10.9 Tests D10.9.1 Shop Tests 2 Notwithstanding the requirements in 10.9.1, Part D of the Rules, hydrostatic tests of heat exchangers fitted to engines having cylinder bores of 300 <i>mm</i> or less may be omitted (see Table D2.6 of the Rules). D18 AUTOMATIC AND REMOTE CONTROL D18.3 Automatic and Remote Control of Main Propulsion Machinery or Controllable Pitch Propellers D18.3.2 Remote Control Devices for Main Propulsion Machinery or Controllable Pitch Propellers 5 With respect to those requirements specified in 18.3.2-4, Part D of the Rules, even though low pressure alarms for main engine starting air reservoirs are activated before the required number of starts specified in 2.5.3-2, Part D of the Rules has not been completed, engines are to be capable of being started from remote controls station and to complete the required number of starts after activating such alarms.	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part GF SHIPS USING LOW-FLASHPOINT FUELS GF1 GENERAL GF1.1 General GF1.1.3 Approval of Systems and Equipment, etc. 3 In applying 1.1.3, Part GF of the Rules, Annex 1.1.3-3, Part GF of the Rules is to be dealt with as follows: (1) The wording “specified separately by the Society” specified in 1.1-4, Annex 1.1.3-3, Part GF of the Rules refers to 8.3-1(4)(i), Chapter 8, Part 6 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use. (2) The wording “specified separately by the Society” specified in 2.4.2-4, Annex 1.1.3-3, Part GF of the Rules refers to Annex 1. (3) The wording “specified separately by the Society” specified in 2.4.2-5(6)(a)ii), Annex 1.1.3-3, Part GF of the Rules refers to GF9.6.2. (4) The wording “deemed appropriate by the Society” specified in 3.1-9, Annex 1.1.3-3, Part GF of the Rules refers to 8.3, Chapter 8, Part 6 of the Guidance for the Approval and Type Approval of	GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part GF SHIPS USING LOW-FLASHPOINT FUELS GF1 GENERAL GF1.1 General GF1.1.3 Approval of Systems and Equipment, etc. 3 In applying 1.1.3, Part GF of the Rules, Annex 1.1.3-3, Part GF of the Rules is to be dealt with as follows: (1) The wording “specified separately by the Society” specified in 1.1-5, Annex 1.1.3-3, Part GF of the Rules refers to 8.3(4)(i), Chapter 8, Part 6 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use. (2) The wording “specified separately by the Society” specified in 2.4.2-4, Annex 1.1.3-3, Part GF of the Rules refers to Annex 1. (3) The wording “specified separately by the Society” specified in 2.4.2-5(7)(a)ii), Annex 1.1.3-3, Part GF of the Rules refers to GF9.6.2. (4) The wording “deemed appropriate by the Society” specified in 3.1-8, Annex 1.1.3-3, Part GF of the Rules refers to 8.3, Chapter 8, Part 6 of the Guidance for the Approval and Type Approval of	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
Materials and Equipment for Marine Use. GF9 FUEL SUPPLY TO CONSUMERS GF9.6 Fuel Supply to Consumers in Gas-safe Machinery Spaces GF9.6.1 Fuel Piping 3 In addition to -2 above, vent pipes of internal combustion engines should be of double-walled construction unless single-walled construction is justified in the safety concept of the engine specified in 1.4-<u>18</u>, Annex 1.1.3-3, Part GF of the Rules.	Materials and Equipment for Marine Use. GF9 FUEL SUPPLY TO CONSUMERS GF9.6 Fuel Supply to Consumers in Gas-safe Machinery Spaces GF9.6.1 Fuel Piping 3 In addition to -2 above, vent pipes of internal combustion engines should be of double-walled construction unless single-walled construction is justified in the safety concept of the engine specified in 1.4-<u>16</u>, Annex 1.1.3-3, Part GF of the Rules.	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (C)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
Annex 2 GUIDANCE FOR GAS-FUELLED BOILERS Chapter 1 GENERAL 1.3 Submission of Plans and Documents The plans and documents to be submitted are as follows. (1) Plans and documents for approval (a) Items specified in 9.1.3, Part D of the Rules (Deleted) (b) Gas fuel burning devices (c) Boiler control system diagrams related to the burning of gas fuel (including monitor, safety and alarm devices) (d) Gas leak protection devices for connections between boilers and gas fuel supply piping systems (e) Gas fuel preparation plants (including construction, equipment and control system) (f) Gas fuel supply piping systems (including details of valves and pipe fittings) and devices to protect surrounding areas, etc. from gas leakages (g) Automatic control and remote control systems for gas fuel supply systems (h) Prototype test plans for gas fuel burning devices and test results (i) Onboard test plans (j) Sea trial plans (k) Other drawings and data deemed necessary by	Annex 2 GUIDANCE FOR GAS-FUELLED BOILERS Chapter 1 GENERAL 1.3 Submission of Plans and Documents The plans and documents to be submitted are as follows. (1) Plans and documents for approval (a) Items specified in 9.1.3, Part D of the Rules (b) <u>Items specified in 18.1.3(1)(a), (c) ,(e) and (f), Part D of the Rules</u> (c) Gas fuel burning devices (d) Boiler control system diagrams related to the burning of gas fuel (including monitor, safety and alarm devices) (e) Gas leak protection devices for connections between boilers and gas fuel supply piping systems (f) Gas fuel preparation plants (including construction, equipment and control system) (g) Gas fuel supply piping systems (including details of valves and pipe fittings) and devices to protect surrounding areas, etc. from gas leakages (h) Automatic control and remote control systems for gas fuel supply systems (i) Prototype test plans for gas fuel burning devices and test results (j) Onboard test plans (k) Sea trial plans (l) Other drawings and data deemed necessary by	Former item (b): Deleted because it is redundant, since the drawings are already required under Chapter 18, Part D.

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
the Society depending upon the type of boiler ((2) is omitted.) Annex 2A GUIDANCE FOR GAS COMBUSTION UNITS Chapter 1 GENERAL 1.3 Submission of Plans and Documents The plans and documents to be submitted are as follows. (1) Plans and documents for approval (a) General arrangement (Deleted) (b) Operating instructions for the automatic control devices and remote control devices (including sequential control, combustion control and safety devices). (c) Diagrams for automatic combustion control devices of <i>GCU</i> (d) Gas fuel burning devices (e) Gas leak protection devices for connections between <i>GCU</i>s and gas fuel supply piping systems (f) Gas fuel supply piping systems (including details of valves and pipe fittings) and devices to protect surrounding areas, etc. from gas leakages (g) Automatic control and remote control systems for gas fuel supply systems	the Society depending upon the type of boiler ((2) is omitted.) Annex 2A GUIDANCE FOR GAS COMBUSTION UNITS Chapter 1 GENERAL 1.3 Submission of Plans and Documents The plans and documents to be submitted are as follows. (1) Plans and documents for approval (a) General arrangement <u>(b) Items specified in 18.1.3(1), (3), (5) and (6), Part D of the Rules</u> (c) Operating instructions for the automatic control devices and remote control devices (including sequential control, combustion control and safety devices). (d) Diagrams for automatic combustion control devices of <i>GCU</i> (e) Gas fuel burning devices (f) Gas leak protection devices for connections between <i>GCU</i>s and gas fuel supply piping systems (g) Gas fuel supply piping systems (including details of valves and pipe fittings) and devices to protect surrounding areas, etc. from gas leakages (h) Automatic control and remote control systems for gas fuel supply systems	Former item (b): Deleted because it is redundant, since the drawings are already required under Chapter 18, Part D.

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(<u>h</u>) Prototype test plans for gas fuel burning devices and test results (<u>i</u>) Onboard test plans (<u>j</u>) Test plans of gas trials specified in 16.5.1, Part GF of the Rules (<u>k</u>) Other drawings and data deemed necessary by the Society depending upon the type of <i>GCU</i> (2) Plans and documents for reference (a) Instruction manuals (including guidance for onboard maintenance, inspection and overhaul) (b) Other drawings and data deemed necessary by the Society	(i) Prototype test plans for gas fuel burning devices and test results (j) Onboard test plans (<u>k</u>) Test plans of gas trials specified in 16.5.1, Part GF of the Rules (l) Other drawings and data deemed necessary by the Society depending upon the type of <i>GCU</i> (2) Plans and documents for reference (a) Instruction manuals (including guidance for onboard maintenance, inspection and overhaul) (b) Other drawings and data deemed necessary by the Society	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part N SHIPS CARRYING LIQUEFIED GASES IN BULK N16 USE OF CARGO AS FUEL N16.1 General N16.1.1 General 3 In applying 16.1.1, Part N of the Rules, Annex 16.1.1-3, Part N of the Rules is to be dealt with as follows: (1) The wording “specified separately by the Society” specified in 1.1-4, Annex 16.1.1-3, Part N of the Rules refers to 8.3-1(4)(i), Chapter 8, Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use. (2) The wording “specified separately by the Society” specified in 3.1.1-2, Annex 16.1.1-3, Part N of the Rules refers to Chapter 2 to Chapter 4 of Annex 1. (3) The wording “deemed appropriate by the Society” specified in 4.1-10, Annex 16.1.1-3, Part N of the Rules refers to 8.3, Chapter 8, Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use. (4) (Omitted) (5) (Omitted)	GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part N SHIPS CARRYING LIQUEFIED GASES IN BULK N16 USE OF CARGO AS FUEL N16.1 General N16.1.1 General 3 In applying 16.1.1, Part N of the Rules, Annex 16.1.1-3, Part N of the Rules is to be dealt with as follows: (1) The wording “specified separately by the Society” specified in 1.1-5, Annex 16.1.1-3, Part N of the Rules refers to 8.3(4)(i), Chapter 8, Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use. (2) The wording “specified separately by the Society” specified in 3.1.1-2, Annex 16.1.1-3, Part N of the Rules refers to Chapter 2 to Chapter 4 of Annex 1. (3) The wording “deemed appropriate by the Society” specified in 4.1-9, Annex 16.1.1-3, Part N of the Rules refers to 8.3, Chapter 8, Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use. (4) (Omitted) (5) (Omitted)	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (C)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
Annex 2 GUIDANCE FOR DUAL FUEL BOILERS Chapter 1 GENERAL 1.3 Drawings and Data The drawings and data to be submitted are as follows. (1) Drawings and data for approval (a) Items specified in 9.1.3, Part D of the Rules (Deleted) (b) Gas fuel burning devices (c) DF boiler control system diagram for burning gas fuel (including monitor, safety and alarm devices) (d) Gas leaks protection devices for connections between DF boilers and gas fuel supply piping systems (e) Gas fuel make-up plant (including construction, equipment and control system) (f) Gas fuel supply piping systems (including details of valves and pipe fittings) and protection device against gas leak from them (g) Automatic control and remote control systems for gas fuel supply system (h) Prototype test plan for gas fuel burning device and test results (i) Onboard test plan (j) Sea trial plan (k) Other drawings and data as deemed necessary by	Annex 2 GUIDANCE FOR DUAL FUEL BOILERS Chapter 1 GENERAL 1.3 Drawings and Data The drawings and data to be submitted are as follows. (1) Drawings and data for approval (a) Items specified in 9.1.3, Part D of the Rules (b) <u>Items specified in 18.1.3(1)(a), (c) and (e), Part D of the Rules</u> (c) Gas fuel burning devices (d) DF boiler control system diagram for burning gas fuel (including monitor, safety and alarm devices) (e) Gas leaks protection devices for connections between DF boilers and gas fuel supply piping systems (f) Gas fuel make-up plant (including construction, equipment and control system) (g) Gas fuel supply piping systems (including details of valves and pipe fittings) and protection device against gas leak from them (h) Automatic control and remote control systems for gas fuel supply system (i) Prototype test plan for gas fuel burning device and test results (j) Onboard test plan (k) Sea trial plan (l) Other drawings and data as deemed necessary by	Former item (b): Deleted because it is redundant, since the drawings are already required under Chapter 18, Part D.

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
the Society according to the type of DF boilers ((2) is omitted.) Annex 2A GUIDANCE FOR GAS COMBUSTION UNITS Chapter 1 GENERAL 1.3 Submission of Plans and Documents The plans and documents to be submitted are as follows. (1) Plans and documents for approval (a) General arrangement (Deleted) (b) Operating instructions for the automatic control devices and remote control devices (including sequential control, combustion control and safety devices). (c) Diagrams for automatic combustion control devices of <i>GCU</i> (d) Gas fuel burning devices (e) Gas leak protection devices for connections between <i>GCU</i>s and gas fuel supply piping systems (f) Gas fuel supply piping systems (including details of valves and pipe fittings) and devices to protect surrounding areas, etc. from gas leakages (g) Automatic control and remote control systems for gas fuel supply systems	the Society according to the type of DF boilers ((2) is omitted.) Annex 2A GUIDANCE FOR GAS COMBUSTION UNITS Chapter 1 GENERAL 1.3 Submission of Plans and Documents The plans and documents to be submitted are as follows. (1) Plans and documents for approval (a) General arrangement (b) <u>Items specified in 18.1.3(1), (3), (5) and (6), Part D of the Rules</u> (c) Operating instructions for the automatic control devices and remote control devices (including sequential control, combustion control and safety devices). (d) Diagrams for automatic combustion control devices of <i>GCU</i> (e) Gas fuel burning devices (f) Gas leak protection devices for connections between <i>GCU</i>s and gas fuel supply piping systems (g) Gas fuel supply piping systems (including details of valves and pipe fittings) and devices to protect surrounding areas, etc. from gas leakages (h) Automatic control and remote control systems for gas fuel supply systems	Former item (b): Deleted because it is redundant, since the drawings are already required under Chapter 18, Part D.

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(<u>h</u>) Prototype test plans for gas fuel burning devices and test results (<u>i</u>) Onboard test plans (<u>j</u>) Test plans of gas trials specified in 4.20.3, Part N of the Rules (<u>k</u>) Other drawings and data deemed necessary by the Society depending upon the type of <i>GCU</i> ((2) is omitted.)	(<u>i</u>) Prototype test plans for gas fuel burning devices and test results (<u>j</u>) Onboard test plans (<u>k</u>) Test plans of gas trials specified in 4.20.3, Part N of the Rules (<u>l</u>) Other drawings and data deemed necessary by the Society depending upon the type of <i>GCU</i> ((2) is omitted.)	

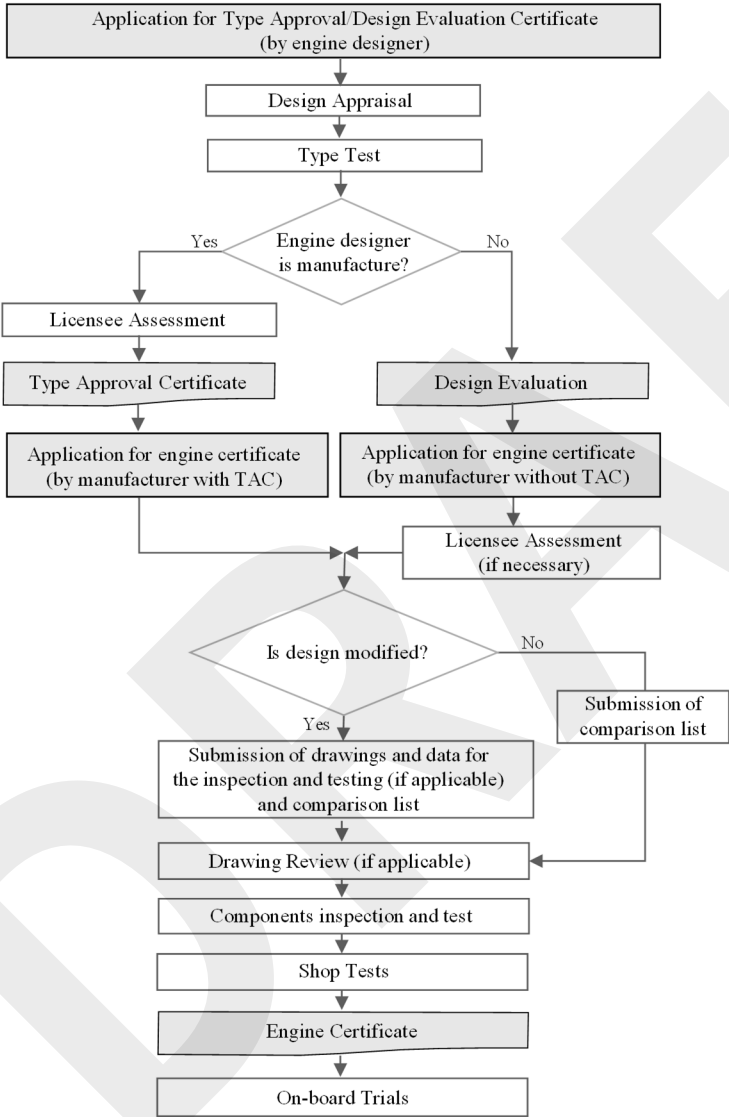
Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part I SHIPS OPERATING IN POLAR WATERS, POLAR CLASS SHIPS AND ICE CLASS SHIPS I8 ICE CLASS SHIPS I8.1 General I8.1.1 Application 2 For the ice class ship to be entitled to an ice notation, calculation sheet of main propulsion engine output is to be submitted in addition to drawings and data for reference in 2.1.4-1(2), Part D of the Rules.	GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS Part I SHIPS OPERATING IN POLAR WATERS, POLAR CLASS SHIPS AND ICE CLASS SHIPS I8 ICE CLASS SHIPS I8.1 General I8.1.1 Application 2 For the ice class ship to be entitled to an ice notation, calculation sheet of main propulsion engine output is to be submitted in addition to drawings and data for reference in 2.1.3-1(2), Part D of the Rules.	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)		

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Amended	Original	Remarks
GUIDANCE FOR HIGH SPEED CRAFT Part 9 MACHINERY INSTALLATIONS Chapter 2 RECIPROCATING INTERNAL COMBUSTION ENGINES <u>AND EXHAUST DRIVEN TURBOCHARGERS</u> 2.1 General 2.1.1 General 2 The wording “the requirements specified otherwise by the Society” in 2.1.1-<u>4</u>, Part 9 of the Rules means Annex 1.1.3-3, Part GF of the Rules for the Survey and Construction of Steel Ships. 3 For the approval procedure for reciprocating internal combustion engines by the Society, reference is to be made to <u>Fig. 2.1.1-1</u>.	GUIDANCE FOR HIGH SPEED CRAFT Part 9 MACHINERY INSTALLATIONS Chapter 2 RECIPROCATING INTERNAL COMBUSTION ENGINES 2.1 General 2.1.1 General 2 The wording “the requirements specified otherwise by the Society” in 2.1.1-<u>5</u>, Part 9 of the Rules means Annex 1.1.3-3, Part GF of the Rules for the Survey and Construction of Steel Ships. (Newly added)	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
Fig. 2.1.1-1 Type Approval and Individual Engine Certification Process  <pre> graph TD A[Application for Type Approval/Design Evaluation Certificate (by engine designer)] --> B[Design Appraisal] B --> C[Type Test] C --> D{Engine designer is manufacture?} D -- Yes --> E[Licensee Assessment] E --> F[Type Approval Certificate] F --> G[Application for engine certificate (by manufacturer with TAC)] D -- No --> H[Design Evaluation] H --> I[Application for engine certificate (by manufacturer without TAC)] I --> J[Licensee Assessment (if necessary)] G --> K{Is design modified?} J --> K K -- No --> L[Submission of comparison list] K -- Yes --> M[Submission of drawings and data for the inspection and testing (if applicable) and comparison list] L --> N[Drawing Review (if applicable)] M --> N N --> O[Components inspection and test] O --> P[Shop Tests] P --> Q[Engine Certificate] Q --> R[On-board Trials] </pre>		

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
2.1.3 Approval of Reciprocating Internal Combustion Engines 1 In applying 2.1.3, Part 9 of the Rules, reference for the approval procedures is to be made to Fig. 2.1.3-1. (Deleted) (Moved) (Deleted) (Deleted) (Deleted) 2 The wording “the requirements specified separately by the Society” specified in 2.1.3-3 and -4, Part 9 of the Rules means “the requirements specified in Chapter 8, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use”. 3 The wording “requirements equivalent to those for	2.1.4 Approval of Reciprocating Internal Combustion Engines 1 In applying 2.1.4, Part 9 of the Rules, reference for the approval procedures is to be made to Fig. 2.1.4-1. 2 The phrase “design approval is to be obtained as specified separately by the Society” specified in 2.1.4-1(1)(a), Part 9 of the Rules means that the design approval and design appraisal are to be obtained in accordance with Chapter 8, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use. 3 The wording “the drawings and data of the engine whose type approval has been obtained” specified in (1)(c), (1)(d), (2)(a) and (2)(b) of 2.1.4-1, Part 9 of the Rules means those listed in 8.2.2, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use. 4 The wording “as specified separately by the Society” specified in 2.1.4-1(1)(d), Part 9 of the Rules means “in accordance with 8.2.2-2, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use”. 5 In applying 2.1.4-1(2)(c), Part 9 of the Rules, quality requirements specified by the licensor are to be satisfied. 6 The wording “as specified separately by the Society” specified in 2.1.4-1(4)(a), Part 9 of the Rules means “in accordance with 8.2.2-4, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use”. (Newly added) (Newly added)	Moved to 2.1.4-2

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
<u>approval based on type approval” specified in 2.1.3-5, Part 9 of the Rules means “requirements specified in Chapter 2, Part D of the Rules and Chapter 8, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use”.</u> Fig. 2.1.43-1 Flow of Approval of Reciprocating Internal Combustion Engines (Table is omitted.) 1) Branch offices with responsibility for licensees and/or component manufacturers in different locations 2) In cases of modifications by the licensee, refer to (b) and (c) of 2.1.4-12(2), Part 9 of the Rules 2.1.4 Drawings and Data (Deleted) <u>1 The wording “a list containing all drawings and data” specified in 2.1.4-1(1)(a), Part 9 of the Rules means a list of the drawings and data applicable to the engine concerned from among the following:</u> (1) <u>Bedplate and crankcase of welded design, with welding details and welding instructions</u> (2) <u>Thrust bearing bedplate of welded design, with welding details and welding instructions</u> (3) <u>Bedplate/oil sump welding drawings</u> (4) <u>Frame/framebox/gearbox of welded design, with</u>	2.1.3 Drawings and Data <u>For the following data, those represented by two sizes in a generic range of turbochargers (i.e. the same components, materials, etc., with the only difference being the size) are acceptable.</u> (1) <u>The documentation of safe torque transmission specified in (34)(a), Table 9.2.1(b), Part 9 of the Rules.</u> (2) <u>The operation and maintenance manuals listed in (34)(c), Table 9.2.1(b), Part 9 of the Rules.</u> (Newly added)	

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Amended	Original	Remarks
<u>welding details and instructions</u> (5) <u>Engine frames, welding drawings</u> (6) <u>Crankshaft, details</u> (7) <u>Crankshaft, assembly</u> (8) <u>Thrust shaft or intermediate shaft (if integral with engine)</u> (9) <u>Shaft coupling bolts</u> (10) <u>Material specifications of main parts</u> (11) <u>Shielding of high pressure fuel pipes, assembly</u> (12) <u>Construction of accumulators (for electronically controlled engine)</u> (13) <u>Construction of common accumulators (for electronically controlled engine)</u> (14) <u>Arrangement and details of the crankcase explosion relief valve (only for engines of a cylinder diameter of 200 mm or more or a crankcase volume of 0.6 m³ or more)</u> (15) <u>High pressure parts for fuel oil injection system</u> (16) <u>Details of mechanical joints of piping systems</u> (17) <u>Engine cross section</u> (18) <u>Engine longitudinal section</u> (19) <u>Bedplate and crankcase of cast design</u> (20) <u>Thrust bearing assembly (if integral with engine and not integrated in the bedplate)</u> (21) <u>Frame/framebox/gearbox of cast design</u> (22) <u>Tie rod</u> (23) <u>Connecting rod</u> (24) <u>Connecting rod, assembly</u> (25) <u>Crosshead, assembly</u> (26) <u>Piston rod, assembly</u> (27) <u>Piston, assembly</u> (28) <u>Cylinder jacket/ block of cast design</u>		

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
<u>(29) Cylinder cover, assembly</u> <u>(30) Cylinder liner</u> <u>(31) Counterweights (if not integral with crankshaft)</u> <u>(32) Camshaft drive, assembly</u> <u>(33) Flywheel</u> <u>(34) Fuel oil injection pump</u> <u>(35) Shielding and insulation of exhaust pipes and other parts of high temperature which may be impinged as a result of a fuel system failure, assembly</u> <u>(36) For electronically controlled engines, construction and arrangement of the following (a) to (c):</u> <u>(a) Control valves</u> <u>(b) High-pressure pumps</u> <u>(c) Drive for high pressure pumps</u> <u>(37) Other drawings and data deemed necessary by the Society</u> <u>2 The wording “the drawings and data whose type approval has been obtained by the licensor” specified in (1) and (2) of 2.1.4-2, Part 9 of the Rules means those listed in 8.2.2, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use.</u>	(Moved)	Moved from 2.1.4-3
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (C)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF INLAND WATERWAY SHIPS Part 2 CLASS SURVEYS Chapter 1 GENERAL 1.4 Preparation for Surveys and Miscellaneous 1.4.2 Preparation for Surveys 8 The following preparations are to be made before carrying out the engine tests specified in 2.3.1-1(3), Part 2 of the Rules and 2.6.1-2, Part 7 of the Rules. (1) All relevant equipment for the safety of attending personnel such as <u>crankcase explosive condition protection</u> (e.g. oil mist detection arrangements), overspeed protective devices and any other shut down functions are to be made available and are to be operational. ((2) to (4) are omitted.)	GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF INLAND WATERWAY SHIPS Part 2 CLASS SURVEYS Chapter 1 GENERAL 1.4 Preparation for Surveys and Miscellaneous 1.4.2 Preparation for Surveys 8 The following preparations are to be made before carrying out the engine tests specified in 2.3.1-1(3), Part 2 of the Rules and 2.6.1-2, Part 7 of the Rules. (1) All relevant equipment for the safety of attending personnel such as oil mist detection arrangements, overspeed protective devices and any other shut down functions are to be made available and are to be operational. ((2) to (4) are omitted.)	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
Chapter 2 CLASSIFICATION SURVEYS 2.3 River Trials and Stability Experiments 2.3.1 River Trials 1 The Astern test required by 2.3.1-1(1), Part 2 of the Rules is to be carried out in accordance with the following (1) to (3). ((1) and (2) are omitted.) (3) For gas-fuelled dual fuel engines, the confirmation specified in (2) is to be carried out for all operating modes (i.e. the <u>applicable gas mode, fuel oil mode and variable fuel oil/gas ratio mode</u>). 3 The performance tests of machinery installations required by 2.3.1-1(3), Part 2 of the Rules are to include the following (1) to (10) in order to verify that the machinery installations have sufficient normal functions and reliability and are free from detrimental vibration within the numbers of revolutions used. However, these tests may be dispensed with where such tests have been conducted while the ship was anchored or at dockside. The details of these tests may be found in <i>JIS F 0801</i> “Test Code of Propelling Machinery at Sea Trials” or other documents considered equivalent thereto. The preparations specified in 1.4.2-8 are to be made before tests are carried out. (1) For reciprocating internal combustion engines, the output test shown in Table 2.2.3.1-5, is to be <u>carried out</u>. The scope of the tests may be expanded in cases <u>where deemed necessary by the Society</u>. For reciprocating internal combustion engines driving generators or auxiliary machinery (excluding	Chapter 2 CLASSIFICATION SURVEYS 2.3 River Trials and Stability Experiments 2.3.1 River Trials 1 The Astern test required by 2.3.1-1(1), Part 2 of the Rules is to be carried out in accordance with the following (1) to (3). ((1) and (2) are omitted.) (3) For gas-fuelled dual fuel engines, the confirmation specified in (2) is to be carried out for all operating modes (gas mode, <u>diesel mode, etc.</u>). 3 The performance tests of machinery installations required by 2.3.1-1(3), Part 2 of the Rules are to include the following (1) to (9) in order to verify that the machinery installations have sufficient normal functions and reliability and are free from detrimental vibration within the numbers of revolutions used. However, these tests may be dispensed with where such tests have been conducted while the ship was anchored or at dockside. The details of these tests may be found in <i>JIS F 0801</i> “Test Code of Propelling Machinery at Sea Trials” or other documents considered equivalent thereto. The preparations specified in 1.4.2-8 are to be made before tests are carried out. (1) For reciprocating internal combustion engines, the output test shown in Table 2.2.3.1-5, is to be <u>used as the standard</u>. For reciprocating internal combustion engines driving generators or auxiliary machinery (excluding auxiliary machinery for specific uses), operating tests may be carried out at the appropriate	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
auxiliary machinery for specific uses), operating tests may be carried out at the appropriate time after installation on board. (2) Operating tests for starting devices It is to be confirmed that the diesel engines start continuously for the number required by 2.5.2-2, Part 7 of the Rules. (3) Function tests of the alarms and safety devices Function tests of the alarms and safety devices required by 2.4, Part 7 of the Rules are to be carried out <u>to verify effectiveness of the actual installation. A part of or all of such tests may be substituted by the results of shop trials required by 2.6.1-2, Part 7 of the Rules.</u> (4) Fuel suitability The suitability of residual and other special fuels for use in the engine is to be confirmed. However, this test may be dispensed with where the suitability has already been demonstrated at the shop trial. (5) Governor tests For reciprocating internal combustion engines driving main sources of electrical power (including reciprocating internal combustion engines driving generators for both propulsion and main power supply), <u>integration tests of generators with power management systems are to be carried out. During the integration tests, the characteristics for governors specified in 2.4.1-5(1), Part 7 of the Rules</u> are to be confirmed. (6) Function tests of the safety devices and alarms of boilers (7) Function tests of the safety devices and alarms of	time after installation on board. (2) Operating tests for starting devices It is to be confirmed that the diesel engines start continuously for the number required by 2.5.3-2, Part 7 of the Rules. (3) Function tests of the alarms and safety devices Function tests of the alarms and safety devices required by 2.4, Part 7 of the Rules are to be carried out. (4) Fuel suitability The suitability of residual and other special fuels for use in the engine is to be confirmed. However, this test may be dispensed with where the suitability has already been demonstrated at the shop trial. (5) Governor tests For reciprocating internal combustion engines driving main sources of electrical power (including reciprocating internal combustion engines driving generators for both propulsion and main power supply), the characteristics for governors specified in 2.4.1-5(1), Part 7 of the Rules are to be confirmed. (6) Function tests of the safety devices and alarms of boilers (7) Function tests of the safety devices and alarms of	

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Amended	Original	Remarks
exhaust gas economizers (8) Gas-fuelled engines are to comply with the requirements specified in (1), (5) and for gas-fuelled dual fuel engines, the following (a) to (d) apply. (a) The output tests <u>specified in (a) and the governor tests specified in (f)</u> are to be carried out for all operating modes (i.e. the applicable gas mode, <u>fuel oil mode and variable fuel oil/as ratio mode</u>). The 110 % load test is not required <u>in the gas mode for dual fuel engines driving generators</u>, provided that changeover to oil fuel mode is automatically performed in case of overload. (b) During the output tests specified in (b), if a test load is performed in all applicable operation modes without interruption (direct changeover at same power and speed), the duration of 100 % power run required by Table 2.2.3.1-5. may be considered as the total duration demonstrated in all fuel modes. However, demonstration at each mode is not to be less than 1 <i>hour</i>. (c) <u>For engines starting in gas mode, the tests specified in (2) are to be carried out in applicable operating modes.</u> (d) Automatic switching over to oil fuel mode is to be tested. Further, manual changeover from diesel to gas mode and vice versa is to be tested. (9) <u>For gas-fuelled engines, the effectiveness of the ventilation and gas detection arrangement, or other approved principle, of the double walled gas piping system is to be demonstrated.</u> (10) <u>For engines fitted with sub-systems which are defined</u>	exhaust gas economizers (8) Gas-fuelled engines are to comply with the requirements specified in (1), (5) and for gas-fuelled dual fuel engines, the following (a) to (c) apply. (a) The output tests and governor tests are to be carried out for all operating modes (i.e. the applicable gas mode, <u>diesel mode, etc.</u>). The 110 % load test is not required <u>for the gas mode</u> provided that changeover to oil fuel mode is automatically performed in case of overload. (b) During the output tests specified in (b), if a test load is performed in all applicable operation modes without interruption (direct changeover at same power and speed), the duration of 100 % power run required by Table 2.2.3.1-5. may be considered as the total duration demonstrated in all fuel modes. However, demonstration at each mode is not to be less than 1 <i>hour</i>. (Newly added) (c) Automatic switching over to oil fuel mode is to be tested. Further, manual changeover from diesel to gas mode and vice versa is to be tested. (Newly added) (Newly added)	

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Amended		Original		Remarks
<u>in 2.1.2(32), Part 7 of the Rules, integration tests are to be carried out for those sub-systems that are assembled for the first time on board. The scope of these tests is to be determined by taking into account of multiple engine operational mode, FMEA reports and the impact of the test on the engine, and agreed with the Society, and is to at least include the following (a) to (c). In addition, any items of integration tests specified in 2.6.1-2(11), Part 7 of the Rules that have been postponed to shipboard testing are also to be conducted. For engines having multiple operating modes, extended performance and load tests may be required.</u> <u>(a) Safety tests of sub-systems</u> <u>(b) Functional tests of sub-systems</u> <u>(c) Changeover tests</u>				

Table 2.2.3.1-5 Trials of Reciprocating Internal Combustion Engines

Test items		Use of engines		
		Main engines of ships in which reciprocating internal combustion engines are used as main propulsion machinery (excluding electric propulsion ships) ⁽¹⁾	Reciprocating internal combustion engines driving generators (including main engines of electric propulsion ships) ⁽²⁾	Reciprocating internal combustion engines driving auxiliaries (excluding auxiliary machinery for specific use etc.)
Load test	110% power run	—	10 minutes at n_0 (n_0 is the rated engine speed.) ⁽³⁾	—
	100% power (rated power) run	4 hours at engine speed in accordance with propeller curve ^{(4) (5) (6)}	1 hour at n_0 ⁽³⁾	30 minutes at n_0
Overspeed run		30 minutes at $1.032n_0$ or more ^{(7) (8)}	—	—
Minimum revolution test of main engine ⁽⁹⁾		○ ⁽⁷⁾	—	—

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Amended		Original		Remarks
Intermittent overload (10)	○	—	○	
Notes: (1) After testing has been completed, the fuel delivery system is to be blocked so as to limit engines to run at not more than 100% power, excluding propulsion engines for which intermittent overload is approved as well as propulsion engines also driving generators. (2) The tests are to be performed based on the rated electrical powers of the driven generators. (3) This may, if possible, be done during the electrical propulsion plant test, which is tested at 100% propulsion power (i.e., total electric motor capacity for propulsion) by distributing the power on as few generators as possible. The duration of this test is to be sufficient to reach the stable operating temperatures of all rotating machines or for at least 4 hours. When some of the generator set(s) cannot be tested due to insufficient time during the propulsion system test mentioned above, those required tests are to be carried out separately. (4) In the case of controllable pitch propellers, the test is to be performed at rated engine speed n_0 at a propeller pitch leading to 100% power, or to the maximum achievable power if 100% power cannot be reached. (5) In the case of propulsion engines also driving generators, tests are to be also carried out for 2 hours at 100% propeller branch power (unless already covered in the test at 100% power) and 1 hour with 100% power take off branch power at rated engine speed n_0 in addition to the test for 4 hours at 100% powerthe tests specified in following (a) to (c) are to be carried out. <u>(a) 4 hours at 100% power at rated engine speed n_0.</u> <u>(b) 2 hours at 100% propeller branch power at rated engine speed n_0 (unless already covered in (a)).</u> <u>(c) 1 hour at 100% power take off branch power at the designed (maximum possible) engine speed (unless already covered in (a)).</u> (6) For ships in which the tests specified in 2.2.5-2(1), Rules for Automatic and Remote Control Systems are performed for not less than 4 hours at 100% power, the 100% power test specified in this table may be omitted. (7) Only for engines driving fixed pitch propellers. (8) The test may be omitted if a 100% power test is performed at $1.032n_0$ or more, In cases where engine speed cannot reach the specified speed due to the planned propeller curve, etc., an overspeed test may be performed at maximum achievable continuous revolution (i.e., maximum engine speed within the range of torque limit etc.). (9) The test is to be carried out to identify the minimum working revolution of the main engine when the ship is steered to the maximum rudder angle. (10) Only for engines for which intermittent overload is approved. The test is to be performed for the duration agreed upon with the manufacturer.				

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Amended	Original	Remarks
7 The measurements of the torsional vibration for shafting systems required by 2.3.1-1(7), Part 2 of the Rules are to be carried out in accordance with the requirements specified in 6.4, Part 7 of the Rules. In cases where the confirmation of engine running conditions specified in 6.4.3-6, Part 7 of the Rules is performed at the estimated upper and lower borders by calculation, it is recommended that the fuel index around estimated borders also be confirmed with consideration given to possible differences between estimated borders and actual borders confirmed through measurements.	7 The measurements of the torsional vibration for shafting systems required by 2.3.1-1(7), Part 2 of the Rules are to be carried out in accordance with the <u>following requirements.</u> (1) <u>Measurement is to be in accordance with the requirement specified in 6.1.3, Part 7 of the Rules.</u> In cases where the confirmation of engine running conditions specified in 6.1.3-2, Part 7 of the Rules is performed at the estimated upper and lower borders by calculation, it is recommended that the fuel index around estimated borders also be confirmed with consideration given to possible differences between estimated borders and actual borders confirmed through measurements. (2) <u>For gas-fuelled dual fuel engines, the measurements specified in (1) are to be carried out for both the diesel and gas mode. However, measurements in either diesel mode or in the gas mode (but not both modes) may be omitted where considered appropriate by the Society based upon relevant torsional vibration calculation sheets of diesel and gas mode.</u>	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (B)		

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Amended	Original	Remarks
Part 7 MACHINERY INSTALLATIONS Chapter 1 GENERAL 1.1 General 1.1.4 Modification of Requirements For those machinery installations specified in 1.1.4, Part 7 of the Rules (excluding those specified in other Parts of the Rules), some requirements of Part 7 of the Rules may be modified as follows: (1) Prime movers (including power transmission systems and shafting systems; hereinafter the same) driving main propulsion machinery, generators, auxiliary machinery essential for main propulsion and auxiliary machinery for manoeuvring and the safety: (a) Prime movers with an output <u>of 110 kW or less</u> i) Submission of drawings may be omitted. ii) Materials which comply with the requirements of any national standard may be accepted for the principal components. In this case, materials (excluding valves and pipe fittings) are to be manufactured by a manufacturer approved by the Society. iii) Shop tests in the presence of the Surveyor may be substituted for manufacturer's tests. In this case, submission or presentation of test records may be required by the Surveyor. (b) Prime Movers with an output <u>more</u> than 110 kW	Part 7 MACHINERY INSTALLATIONS Chapter 1 GENERAL 1.1 General 1.1.4 Modification of Requirements For those machinery installations specified in 1.1.4, Part 7 of the Rules (excluding those specified in other Parts of the Rules), some requirements of Part 7 of the Rules may be modified as follows: (1) Prime movers (including power transmission systems and shafting systems; hereinafter the same) driving main propulsion machinery, generators, auxiliary machinery essential for main propulsion and auxiliary machinery for manoeuvring and the safety: (a) Prime movers with an output <u>less than</u> 110 kW i) Submission of drawings may be omitted. ii) Materials which comply with the requirements of any national standard may be accepted for the principal components. In this case, materials (excluding valves and pipe fittings) are to be manufactured by a manufacturer approved by the Society. iii) Shop tests in the presence of the Surveyor may be substituted for manufacturer's tests. In this case, submission or presentation of test records may be required by the Surveyor. (b) Prime Movers with an output <u>not less</u> than 110	

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Amended	Original	Remarks
but less than 1,000 <i>kW</i>. i) Materials used for principal components may be dealt with under the requirements specified in (a)ii). ii) Hydrostatic tests as well as dynamic balancing tests, overspeed tests and trial runs of turboblowers at the manufacturer may be dealt with under the requirements specified in (a)iii). ((2) to (7) are omitted.) Chapter 2 RECIPROCATING INTERNAL COMBUSTION ENGINES <u>AND EXHAUST DRIVEN TURBOCHARGERS</u> 2.1 General 2.1.1 General 2 The wording “the requirements specified otherwise by the Society” in 2.1.1-4, Part 7 of the Rules means Annex 16.1.1-3, Part N of the Rules for the Survey and Construction of Steel Ships for gas-fuelled engines to which Chapter 16, Part N of the Rules apply, and Annex 1.1.3-3, Part GF of the Rules for the Survey and Construction of Steel Ships for gas-fuelled engines to which Chapter 16, Part N of the Rules does not apply (Part GF of the Rules applies instead). 3 For the approval procedure for reciprocating internal combustion engines by the Society, reference is to be made to <u>Fig. 7.2.1.1-1.</u>	<i>kW</i> but less than 1,000 <i>kW</i>. i) Materials used for principal components may be dealt with under the requirements specified in (a)ii). ii) Hydrostatic tests as well as dynamic balancing tests, overspeed tests and trial runs of turboblowers at the manufacturer may be dealt with under the requirements specified in (a)iii). ((2) to (7) are omitted.) Chapter 2 RECIPROCATING INTERNAL COMBUSTION ENGINES 2.1 General 2.1.1 General 2 The wording “the requirements specified otherwise by the Society” in 2.1.1-5, Part 7 of the Rules means Annex 16.1.1-3, Part N of the Rules for the Survey and Construction of Steel Ships for gas-fuelled engines to which Chapter 16, Part N of the Rules apply, and Annex 1.1.3-3, Part GF of the Rules for the Survey and Construction of Steel Ships for gas-fuelled engines to which Chapter 16, Part N of the Rules does not apply (Part GF of the Rules applies instead). (Newly added)	

Amended-Original Requirements Comparison Table (Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
Fig. 7.2.1.1-1 Type Approval and Individual Engine Certification Process <pre> graph TD A[Application for Type Approval/Design Evaluation Certificate (by engine designer)] --> B[Design Appraisal] B --> C[Type Test] C --> D{Engine designer is manufacture?} D -- Yes --> E[Licensee Assessment] E --> F[Type Approval Certificate] F --> G[Application for engine certificate (by manufacturer with TAC)] D -- No --> H[Design Evaluation] H --> I[Application for engine certificate (by manufacturer without TAC)] I --> J[Licensee Assessment (if necessary)] G --> K{Is design modified?} J --> K K -- Yes --> L[Submission of drawings and data for the inspection and testing (if applicable) and comparison list] K -- No --> M[Submission of comparison list] L --> N[Drawing Review (if applicable)] M --> N N --> O[Components inspection and test] O --> P[Shop Tests] P --> Q[Engine Certificate] Q --> R[On-board Trials] </pre>		

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(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
2.1.3 Approval of Reciprocating Internal Combustion Engines 1 In applying 2.1.3, Part 7 of the Rules, reference for the approval procedures is to be made to Fig. 7.2.1.3-1. (Deleted) (Moved) (Deleted) (Deleted) (Deleted) 2 The wording “the requirements specified separately by the Society” specified in 2.1.3-3 and -4, Part 7 of the Rules means “the requirements specified in Chapter 8, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use”.	2.1.4 Approval of Reciprocating Internal Combustion Engines 1 In applying 2.1.4, Part 7 of the Rules, reference for the approval procedures is to be made to Fig. 7.2.1.4-1. 2 The phrase “design approval is to be obtained as specified separately by the Society” specified in 2.1.4-1(1)(a), Part 7 of the Rules means that the design approval and design appraisal are to be obtained in accordance with Chapter 8, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use. 3 The wording “the drawings and data of the 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 7 of the Rules means those listed in 8.2.2, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use. 4 The wording “as specified separately by the Society” specified in 2.1.4-1(1)(d), Part 7 of the Rules means “in accordance with 8.2.2-2, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use”. 5 In applying 2.1.4-1(2)(c), Part 7 of the Rules, quality requirements specified by the licensor are to be satisfied. 6 The wording “as specified separately by the Society” specified in 2.1.4-1(4)(a), Part 7 of the Rules means “in accordance with 8.2.2-4, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use”. (Newly added)	Moved to 2.1.4-2

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Amended	Original	Remarks
3 The wording “requirements equivalent to those for approval based on type approval” specified in 2.1.3-5, Part 7 of the Rules means “requirements specified in Chapter 2, Part 7 of the Rules and Chapter 8, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use”. Fig. 2.1.43-1 Flow of Approval of Reciprocating Internal Combustion Engines (Table is omitted.) 1) Branch offices with responsibility for licensees and/or component manufacturers in different locations 2) In cases of modifications by the licensee, refer to (b) and (c) of 2.1.4-12(2), Part 7 of the Rules 2.1.4 Drawings and Data (Deleted) 1 The wording “a list containing all drawings and data” specified in 2.1.4-1(1)(a), Part 7 of the Rules means a list of the drawings and data applicable to the engine concerned from among the following: (1) Bedplate and crankcase of welded design, with welding details and welding instructions (2) Thrust bearing bedplate of welded design, with welding details and welding instructions (3) Bedplate/oil sump welding drawings	(Newly added) 2.1.3 Drawings and Data For the following data, those represented by two sizes in a generic range of turbochargers (i.e. the same components, materials, etc., with the only difference being the size) are acceptable. (1) The documentation for safe torque transmission specified in (34)(a), Table 7.2.1(b), Part 7 of the Rules. (2) The operation and maintenance manuals listed in (34)(c), Table 7.2.1(b), Part 7 of the Rules. (Newly added)	

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Amended	Original	Remarks
(4) <u>Frame/framebox/gearbox of welded design, with welding details and instructions</u> (5) <u>Engine frames, welding drawings</u> (6) <u>Crankshaft, details</u> (7) <u>Crankshaft, assembly</u> (8) <u>Thrust shaft or intermediate shaft (if integral with engine)</u> (9) <u>Shaft coupling bolts</u> (10) <u>Material specifications of main parts</u> (11) <u>Shielding of high pressure fuel pipes, assembly</u> (12) <u>Construction of accumulators (for electronically controlled engine)</u> (13) <u>Construction of common accumulators (for electronically controlled engine)</u> (14) <u>Arrangement and details of the crankcase explosion relief valve (only for engines of a cylinder diameter of 200 mm or more or a crankcase volume of 0.6 m³ or more)</u> (15) <u>High pressure parts for fuel oil injection system</u> (16) <u>Details of mechanical joints of piping systems</u> (17) <u>Engine cross section</u> (18) <u>Engine longitudinal section</u> (19) <u>Bedplate and crankcase of cast design</u> (20) <u>Thrust bearing assembly (if integral with engine and not integrated in the bedplate)</u> (21) <u>Frame/framebox/gearbox of cast design</u> (22) <u>Tie rod</u> (23) <u>Connecting rod</u> (24) <u>Connecting rod, assembly</u> (25) <u>Crosshead, assembly</u> (26) <u>Piston rod, assembly</u> (27) <u>Piston, assembly</u>		

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Amended	Original	Remarks
(28) <u>Cylinder jacket/ block of cast design</u> (29) <u>Cylinder cover, assembly</u> (30) <u>Cylinder liner</u> (31) <u>Counterweights (if not integral with crankshaft)</u> (32) <u>Camshaft drive, assembly</u> (33) <u>Flywheel</u> (34) <u>Fuel oil injection pump</u> (35) <u>Shielding and insulation of exhaust pipes and other parts of high temperature which may be impinged as a result of a fuel system failure, assembly</u> (36) <u>For electronically controlled engines, construction and arrangement of the following (a) to (c):</u> (a) <u>Control valves</u> (b) <u>High-pressure pumps</u> (c) <u>Drive for high pressure pumps</u> (37) <u>Other drawings and data deemed necessary by the Society</u> <u>2 The wording “the drawings and data whose type approval has been obtained by the licensor” specified in (1) and (2) of 2.1.4-2, Part 7 of the Rules means those listed in 8.2.2, Part 6 of Guidance for the Approval of Materials and Equipment for Marine Use.</u>	(Moved)	Moved from 2.1.4-3
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (C)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(Deleted)	<u>2.6 Tests</u>	
(Deleted) (Deleted)	<u>2.6.1 Shop Tests</u> <u>1 The wording “a procedure deemed appropriate by the Society” in 2.6.1-2(6)(c), Part 7 of the Rules means the tests specified in 8.5.2-2(10), Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use.</u>	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (D)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(Moved)	2 In cases where the manufacturer has a quality system deemed appropriate by the Society, the dynamic balancing tests specified in 2.6.1-3, Part 7 of the Rules for category <i>B</i> turbochargers may be substituted for by manufacturer tests. In such cases, the submission or presentation of test records may be required by the Society.	Moved to 2.7.4-1, with the wording revised.
(Moved)	3 In cases where the manufacturer has a quality system deemed appropriate by the Society, the overspeed tests specified in 2.6.1-4, Part 7 of the Rules for categories <i>B</i> turbochargers may be substituted for by manufacturer tests. In such cases, the submission or presentation of test records may be required by the Society.	Moved to 2.7.4-2, with the wording revised.
(Moved)	4 The wording “procedures deemed appropriate by the Society” in 2.6.1-5, Part 7 of the Rules means the tests specified in Chapter 11, Part 6 of the Guidance for the Approval of Materials and Equipment for Marine Use.	Moved to 2.7.4-3
<u>2.7 Exhaust Driven Turbochargers</u>	(Newly added)	
<u>2.7.4 Tests</u>	(Newly added)	
1 In cases where compliance with internationally recognised quality standards can be confirmed, attendance by the Surveyor at the tests and inspections specified in 2.7.4-1 and -2, Part 7 of the Rules may not require for materials used in Category <i>B</i> turbochargers. In such cases, the submission or presentation of test records may be required by the Society.	(Moved)	Moved from 2.6.1-2, with the wording revised.
2 In cases where compliance with internationally recognised quality standards can be confirmed, the hydrostatic tests, the dynamic balancing tests and the overspeed tests specified in 2.7.4-3 to -5, Part 7 of the Rules for Category <i>B</i> turbochargers may be substituted for by manufacturer tests. In	(Moved)	Moved from 2.6.1-3, with the wording revised.

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Amended	Original	Remarks
such cases, the submission or presentation of test records may be required by the Society. 3 The wording “a procedure deemed appropriate by the Society” in 2.7.4-6, Part 7 of the Rules means the tests specified in Chapter 11, Part 6 of the Guidance for the <u>Approval of Materials and Equipment for Marine Use.</u>	(Moved)	Moved from 2.6.1-4.
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)		

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Amended	Original	Remarks
Chapter 6 TORSIONAL VIBRATION OF SHAFTINGS <u>6.4 Measurements</u> <u>6.4.2 Time for Passing Through Barred Speed Range</u> <u>In applying 6.4.2-2, Part 7 of the Rules, a minimum power margin at the upper boundary of the barred speed range (PM_{BSR}) of 10 % against the bollard pull propeller curve and a minimum light running margin (LRM) of 4 % are recommended. Power margin is defined as the excess ratio of power which exists between the engine torque/power limiting curve and propeller bollard pull curve. Light running margin is defined as the ratio between the engine rpm value on the light propeller curve and the engine rpm value at the nominal (100 %) propeller curve at the maximum continuous rating. Both parameters are shown in Figure 7.6.4.2-1.</u>	Chapter 6 TORSIONAL VIBRATION OF SHAFTINGS (Newly added) (Newly added) (Newly added)	

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Amended	Original	Remarks
Fig. 7.8.4.2-1 Light Running Margin and Power Margin: Example Relationship to Engine Load Diagram The diagram is a graph of Power (P/P_{MCR}) on the y-axis (0.0 to 1.2) versus Engine rpm (n/n_{MCR}) on the x-axis (0.0 to 1.2). It shows the relationship between engine power limits and propeller requirements under different conditions. Curve 1 represents the engine's power/torque limits. Curves 2, 3, and 4 represent propeller requirements for 100% condition, light condition, and bollard condition, respectively. Curve 5 represents the power margin. The diagram identifies the Barred Speed Range (BSR) between the lower and upper boundaries of the engine's operating range. It also shows the Light Running Margin (LRM) and Power Margin (PM) at the upper boundary of the BSR.		
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (B)		

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Amended	Original	Remarks
Chapter 8 PRESSURE VESSELS 8.9 Tests 8.9.1 Shop Tests 2 Notwithstanding the requirements in 8.9.1-2, Part 7 of the Rules, hydrostatic tests of heat exchangers fitted to engines having cylinder bores of 300 <i>mm</i> or less may be omitted (see Table 7.2.7, Part 7 of the Rules). Chapter 14 AUTOMATIC AND REMOTE CONTROL 14.3 Automatic and Remote Control of Main Propulsion Machinery or Controllable Pitch Propellers 14.3.2 Remote Control Devices for Main Propulsion Machinery or Controllable Pitch Propellers 5 With respect to those requirements specified in 14.3.2-4, Part 7 of the Rules, even though low pressure alarms for main engine starting air reservoirs are activated before the required number of starts specified in 2.5.2-2, Part 7 of the Rules has not been completed, engines are to be capable of being started from remote controls station and to complete the required number of starts after activating such alarms.	Chapter 8 PRESSURE VESSELS 8.9 Tests 8.9.1 Shop Tests 2 Notwithstanding the requirements in 8.9.1-2, Part 7 of the Rules, hydrostatic tests of heat exchangers fitted to engines having cylinder bores of 300 <i>mm</i> or less may be omitted (see Table 7.2.8, Part 7 of the Rules). Chapter 14 AUTOMATIC AND REMOTE CONTROL 14.3 Automatic and Remote Control of Main Propulsion Machinery or Controllable Pitch Propellers 14.3.2 Remote Control Devices for Main Propulsion Machinery or Controllable Pitch Propellers 5 With respect to those requirements specified in 14.3.2-4, Part 7 of the Rules, even though low pressure alarms for main engine starting air reservoirs are activated before the required number of starts specified in 2.5.3-2, Part 7 of the Rules has not been completed, engines are to be capable of being started from remote controls station and to complete the required number of starts after activating such alarms.	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (A)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
GUIDANCE FOR THE APPROVAL OF MATERIALS AND EQUIPMENT FOR MARINE USE Part 6 MACHINERY Chapter 8 TYPE APPROVAL OF RECIPROCATING INTERNAL COMBUSTION ENGINES 8.1 General 8.1.1 General 1 The requirements in this chapter and Annex 6.1 apply to the type approval for the following (1) <u>to (3)</u>. (1) Type approval of reciprocating internal combustion engines required by 2.1.1-3 and 2.6.1-3, Part D of the Rules for the Survey and Construction of Steel Ships, 2.1.1-2, Part 9, Rules for High Speed Craft as well as 2.1.1-2 and 2.6.1-3, Part 7, Rules for the Survey and Construction of Inland Waterway Ships. (2) Type approval of gas-fuelled engines required by 4.1, Annex 1.1.3-3, Part GF or 5.1, Annex 16.1.1-3, Part N of the Rules for the Survey and Construction of Steel Ships. (3) Type approval of sub-systems subject to 2.1.3-4,	GUIDANCE FOR THE APPROVAL OF MATERIALS AND EQUIPMENT FOR MARINE USE Part 6 MACHINERY Chapter 8 TYPE APPROVAL OF RECIPROCATING INTERNAL COMBUSTION ENGINES 8.1 General 8.1.1 General 1 The requirements in this chapter apply to the type approval for the following (1) <u>and (2)</u>. (1) Type approval of reciprocating internal combustion engines required by 2.1.1-3 and 2.6.1-3, Part D of the Rules for the Survey and Construction of Steel Ships, 2.1.1-2, Part 9 <u>of the</u> Rules for High Speed Craft as well as 2.1.1-2 and 2.6.1-3, Part 7 <u>of the</u> Rules for the Survey and Construction of Inland Waterway Ships; and (2) Type approval of gas-fuelled engines required by 4.1, Annex 1.1.3-3, Part GF or 5.1, Annex 16.1.1-3, Part N of the Rules for the Survey and Construction of Steel Ships.	Requirements for the type approval of sub-systems have been added.

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Amended	Original	Remarks
<u>Part D of the Rules for the Survey and Construction of Steel Ships or 2.1.3-4, Part 9, Rules for High Speed Craft.</u> 4 The requirements in this chapter apply, in general, to each engine type of which either of the following is different to that of an approved engine type. (1) Bore (2) Stroke (3) Method of injection (direct or indirect injection) (Deleted) (4) Working cycle (2-stroke, 4-stroke)_ (Deleted) (5) Method of pressure charging (pulsating system, constant pressure system) (6) Charging of cooling system (e.g. with or without intercooler) (7) Cylinder arrangement (in-line, <i>V</i>) One type test will be considered adequate to cover a range of different numbers of cylinders. However, a type test of an in-line engine may not always cover the <i>V</i>-version. Separate type tests may be required for the <i>V</i>-version where deemed necessary by the Society. On the other hand, a type test of a <i>V</i>-engine covers in-line engines, unless the brake mean effective pressure is higher. Items such as axial crankshaft vibration, torsional vibration in camshaft drives, and crankshafts, etc. may vary considerably with the number of cylinders and may influence the choice of engine to be selected for type testing. (8) Control method of fuel injection and exhaust valve drive (electronically-controlled, camshaft driven)	4 The requirements in this chapter apply, in general, to each engine type of which either of the following is different to that of an approved engine type. (1) Bore (2) Stroke (3) Method of injection (direct or indirect injection) (4) <u>Kind of fuel (liquid, dual-fuel, gaseous)</u> (5) Working cycle (2-stroke, 4-stroke) (6) <u>Cylinder power, speed and cylinder pressures (if increased)</u> (7) Method of pressure charging (pulsating system, constant pressure system) (8) Charging of cooling system (e.g. with or without intercooler) (9) Cylinder arrangement (in-line, <i>V</i>) One type test will be considered adequate to cover a range of different numbers of cylinders. However, a type test of an in-line engine may not always cover the <i>V</i>-version. Separate type tests may be required for the <i>V</i>-version where deemed necessary by the Society. On the other hand, a type test of a <i>V</i>-engine covers in-line engines, unless the brake mean effective pressure is higher. Items such as axial crankshaft vibration, torsional vibration in camshaft drives, and crankshafts, etc. may vary considerably with the number of cylinders and may influence the choice of engine to be selected for type testing. (10) Control method of fuel injection and exhaust valve drive (electronically-controlled, camshaft driven)	UR M87, 5.2.1 para. 1

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Amended	Original	Remarks
(9) For gas-fuelled engines, the following (a) to (d) are to be considered in addition to (1) to (8) above. (a) Gas admission method (cylinder injection after compression stroke, cylinder-individual injection before compression stroke or pre-mixed) (b) Gas admission valve operation (mechanical or electronically controlled) (c) Ignition system (pilot injection, spark ignition, glow plug or gas self-ignition) (d) Ignition system (mechanical or electronically controlled) (Note) Cylinder-individual injection before compression stroke specified in (a) may be port injection into the air inlet channel before the cylinder inlet valve, injection into the cylinder before or during compression stroke, or similar arrangements. <u>5 If an engine has varying parameters, new functions, or alternative sub-systems beyond those listed -4 above, it may still be defined as the same engine type, but an extended approval is required in accordance with the following -6 and -7 and Annex 6.1.</u> <u>6 Extension of the scope of type approval includes, but is not limited to, the following:</u> (1) <u>New place of production</u> (2) <u>Alternative sub-systems</u> (3) <u>Alternative or additional duty cycle or applications</u> (4) <u>Additional or extended ratings</u> <u>7 The engine is type approved up to the rating considered in the design approval and type test (whichever is the lower, in the case of differences). However, the following (1) to (3) engines may be regarded as being of the same type:</u> ((1) and (2) are omitted.)	(11) For gas-fuelled engines, the following (a) to (d) are to be considered in addition to (1) to (10) above. (a) Gas admission method (cylinder injection after compression stroke, cylinder-individual injection before compression stroke or pre-mixed) (b) Gas admission valve operation (mechanical or electronically controlled) (c) Ignition system (pilot injection, spark ignition, glow plug or gas self-ignition) (d) Ignition system (mechanical or electronically controlled) (Note) Cylinder-individual injection before compression stroke specified in (a) may be port injection into the air inlet channel before the cylinder inlet valve, injection into the cylinder before or during compression stroke, or similar arrangements. (Newly added) (Newly added) <u>5 Notwithstanding -4(6), the following (1) to (3) engines may be regarded as being of the same type:</u> ((1) and (2) are omitted.)	UR M87, 5.2.1 para.4 UR M87, 5.2.2 UR M71, 5.3

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Amended	Original	Remarks
(3) Engines which are manufactured according to approved drawings and documents, and internal testing per Stage <i>A</i> are documented to have a rating higher than the approved power, mean effective pressure or speed and the increase is within such ratings. In such cases, the tests given in the following (a) and (b) are to be documented at the increased power, mean effective pressure or speed, <u>and the test reports are to be submitted to the Society.</u> (a) The overspeed test specified in 8.5.2-2(1)(b) (only if nominal speed has increased) (b) The operation <u>test corresponding to the load points 1, 2 and 3 (or 3a) given in 8.5.2-2(4)(a).</u> <u>The test duration is to be 1 hour at load point 1 (with two measurements), and not less than 30 minutes at load points 2 and 3 (or 3a).</u> 8 <u>Note that where the same engine type is capable of using different fuels, its suitability is to be demonstrated by integration testing for each new fuel type.</u> 9 For reciprocating internal combustion engines, testing is to be carried out in accordance with this Chapter and is to be witnessed by the Surveyor. 10 In applying the procedures for type approval specified in this chapter, reference is to be made to Fig. 6.8-2. 11 <u>The Society may extend an existing type approval of an engine based on a design update. A function test may be required to be carried out if a substantial function of the updated component has been changed, added or omitted. In such cases, the test procedures are to be approved by the Society. In addition, Surveyor attendance is to be agreed upon with the Society on a per case basis.</u> 12 <u>For engines with the maximum continuous rating</u>	(3) Engines which are manufactured according to approved drawings and documents, and internal testing per Stage <i>A</i> are documented to have a rating higher than the approved power, mean effective pressure or speed and the increase is within such ratings. In such cases, the tests given in the following (a) and (b) are to be documented at the increased power, mean effective pressure or speed. (a) The overspeed test specified in 8.5.2-2(1) (only if nominal speed has increased) (b) The operation <u>at the load points given in 8.5.2-2(2)(a) to (c)</u> (Newly added) 6 For reciprocating internal combustion engines, testing is to be carried out in accordance with this Chapter and is to be witnessed by the Surveyor. 7 In applying the procedures for type approval specified in this Chapter, reference is to be made to Fig. 6.8-2. (Newly added) (Newly added)	(3): UR M71, 5.4 UR M87, 5.2.1 para.3 UR M71, 5.5 UR M87, 2. para.3

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Amended	Original	Remarks
<u>(MCR) of 110 kW or less (except for main propulsion engines), or engines not directly related to safe operation of the ship, the drawing approval and the type test may be simplified if agreed by the Society.</u> 8.1.2 Terminology 4 The terminology used in the application of 8.1.1-2, 8.1.1-10 of 8.1.1, 8.2.2, 8.2.3, 8.6.3, 8.6.4, 8.6.5(5) and Annex 6.1 is as specified in the 2.1.2, Part D of the Rules for the Survey and Construction of Steel Ships, 2.1.2, Part 9, Rules for High Speed Craft or 2.1.2, Part 7, Rules for the Survey and Construction of Inland Waterway Ships. 8.2 Application and Approval of Submitted Documents 8.2.2 Drawings and Data 1 Drawings and data to be submitted are as specified in the following (1) and (2), as appropriate for the type of the reciprocating internal combustion engine. Upon review and approval of the submitted drawings and data, they are returned to the licensor. (1) Drawings and data to be submitted for information for approval ((a) to (k) are omitted.) (l) Schematic layout or other equivalent drawings and data on the engine of the following i) to vii): i) Starting air system ii) Fuel system iii) Lubricating oil system iv) Cooling water system	8.1.2 Terminology 4 The terminology used in the application of 8.1.1-6, 8.1.1-7 of 8.1.1, 8.2.2, 8.2.3, 8.6.3, 8.6.4 and 8.6.5(5) is as specified in the 2.1.2, Part D of the Rules for the Survey and Construction of Steel Ships, 2.1.2, Part 9 of the Rules for High Speed Craft or 2.1.2, Part 7 of the Rules for the Survey and Construction of Inland Waterway Ships. 8.2 Application and Approval of Submitted Documents 8.2.2 Drawings and Data 1 Drawings and data to be submitted are as specified in the following (1) and (2), as appropriate for the type of the reciprocating internal combustion engine. Upon review and approval of the submitted drawings and data, they are returned to the licensor. (1) Drawings and data to be submitted for information for approval ((a) to (k) are omitted.) (l) Schematic layout or other equivalent drawings and data on the engine of the following i) to vii): i) Starting air system ii) Fuel <u>oil</u> system iii) Lubricating oil system iv) Cooling water system	

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Amended	Original	Remarks
<u>vii)</u> Schematic layout or other equivalent documents pilot fuel systems (only for dual fuel engines) <u>viii)</u> Shielding of high pressure fuel pipes for pilot fuel system, assembly (only for dual fuel engines) <u>ix)</u> <u>High pressure parts for pilot fuel injection systems (only for dual fuel engines)</u> <u>The documentation is to contain specifications of design pressures, design temperatures, pipe dimensions and materials.</u> <u>x)</u> Schematic layout or other equivalent documents of the ignition system (only for gas only engines) (2) Drawings and data to be submitted for information on an overview of the engine's design, engine characteristics and performance ((a) to (s) are omitted.) (t) Fuel injection pump ((u) to (ab) are omitted.) <u>(ac) Where a sub-system is provided for the engine, the following i) to ix). If the sub-system is either already certified for the relevant engine type or type approved by the Society or has been applied and approved for another engine type, the documents may be omitted where deemed appropriate by the Society.</u> <u>i) Sub-system specification and/or references to design standards, regulations, etc.</u> <u>ii) Description of the function and safety aspects of the sub-system</u> <u>iii) Relevant design drawings with specified</u>	<u>vi)</u> Schematic layout or other equivalent documents pilot fuel systems (only for dual fuel engines) <u>vii)</u> Shielding of high pressure fuel pipes for pilot fuel system, assembly (only for dual fuel engines) (Newly added) <u>viii)</u> Schematic layout or other equivalent documents of the ignition system (only for gas only engines) (2) Drawings and data to be submitted for information on an overview of the engine's design, engine characteristics and performance ((a) to (s) are omitted.) (t) Fuel <u>oil</u> injection pump ((u) to (ab) are omitted.) <u>(ac) Information on installation arrangements of auxiliary systems of the engine and the list of capacities, technical specifications and requirements, along with information needed for maintenance and operation of the engine</u>	(ac): UR M44, 7.

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Amended	Original	Remarks
<u>materials, catalogues, data sheets, calculations, functional descriptions, component lists where necessary, and marking of the product</u> iv) <u>Proposed field of application and operational limitations</u> v) <u>Risk assessment (FMEA or Qualitative Failure Analysis), when applicable</u> vi) <u>Test program, including a design verification test on a typical engine to demonstrate that the performance provisions of the specified standards in i) above are fulfilled and that failure modes identified in the risk assessment are verified</u> vii) <u>Certificates and reports for relevant tests previously obtained</u> viii) <u>Quality specification of the manufacturer, where necessary</u> ix) <u>Any other information that the Society considers necessary</u> (ad) For gas-fuelled engines, the following <u>i) and ii)</u>: (Deleted) i) Report of the risk analysis (see 8.3) ii) Gas specification ((ae) is omitted.) 2 Notwithstanding -1 above, after the Society has <u>type</u> approved the engine <u>and/or sub-system</u> for the first time, only those drawings and data as listed in -1 above, which have undergone substantive changes, will have to be resubmitted to the Society. (Deleted)	(ad) For gas-fuelled engines, the following <u>i) to iii)</u>: i) <u>Safety concept</u> ii) <u>Report of the risk analysis (see 8.3)</u> iii) <u>Gas specification</u> ((ae) is omitted.) 2 Notwithstanding -1 above, after the Society has approved the engine <u>type</u> for the first time, only those drawings and data as listed in -1 above, which have undergone substantive changes, will have to be resubmitted to the Society. 4 <u>In addition to those required by -1 to -3 above, those listed in the following (1) to (6) below, are to be submitted</u>	ad i): "Safety concept e" is specified as an approval drawing rather than a reference document. Deleted to align with the existing treatment.

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Amended	Original	Remarks
4 Design approvals are valid as long as no substantive modifications have been implemented. Where substantial modifications have been made the validity of the design approvals may be renewed based on evidence that the design is in conformance with all current Rules and statutory regulations (See -2 above). 8.3 Risk Analysis 1 For gas fuelled engines, risk analysis is to be carried out in accordance with the following (1) to (4). (1) Scope of the risk analysis The risk analysis is to address the following (a) to (d).	<u>for the purpose of confirming whether the manufacturing facility (including production and assembly lines, machining units, special tools and devices, assembly and testing rigs as well as all lifting and transportation devices) is equipped in a way which allows it to consistently produce engines and relevant engine components of a stable quality in accordance with required standards.</u> <u>(1) Outline of the manufacturing plant</u> <u>(2) Information on the manufacturing facility and the manufacture and quality control of the engine</u> <u>(3) Records of manufacture and delivery of the engine</u> <u>(4) Approval test plan (the place and scheduled date of the test are to be included)</u> <u>(5) Test records (when a preliminary test is carried out)</u> <u>(6) Other data considered necessary by the Society</u> 5 Design approvals are valid as long as no substantive modifications have been implemented. Where substantial modifications have been made the validity of the design approvals may be renewed based on evidence that the design is in conformance with all current Rules and statutory regulations (See -2 above). 8.3 Risk Analysis 1 For gas fuelled engines, risk analysis is to be carried out in accordance with the following (1) to (4). (1) Scope of the risk analysis The risk analysis is to address the following (a) to (d). <u>With regard to the scope of the risk analysis it is to be noted that failures in systems external to the engine, such as fuel storage or fuel gas supply</u>	UR M78, 1.4 (1): UR M78, 1.4.1 Relocated to after (d) and revised text revised.

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Amended	Original	Remarks
(a) A failure or malfunction of any system or component involved in the gas operation of the engine (b) A gas leakage downstream of the double block and bleed valves <u>(for methyl/ethyl alcohol fuels downstream of the remote operated shut-off valve required by 9.6.5 of MSC.1/Circ.1621)</u> (c) The safety of the engine in case of emergency shutdown or blackout, when running on gas (d) The interactions between the gas fuel <u>supply</u> system and the engine <u>With regard to the scope of the risk analysis, it is to be noted that failures in systems external to the engine, such as gas storage or gas supply systems, may require action from the engine control and monitoring system in the event of an alarm or fault condition. Conversely failures in these external systems may, from the vessel perspective, require additional safety actions from those required by the engine limited risk analysis required by this section. Such actions are to be detailed in the engine safety concept.</u> (2) Form of the risk analysis (Omitted) (3) Procedure for the risk analysis The risk analysis is to be <u>in</u> accordance with the following procedure. The results of the risk analysis are to be documented. (a) Identify all the possible failures in the concerned	<u>systems, may require action from the engine control and monitoring system in the event of an alarm or fault condition.</u> (a) A failure or malfunction of any system or component involved in the gas operation of the engine (b) A gas leakage downstream of the double block and bleed valves (c) The safety of the engine in case of emergency shutdown or blackout, when running on gas (d) The interactions between the gas fuel system and the engine (2) Form of the risk analysis (Omitted) (3) Procedure for the risk analysis The risk analysis is to be accordance with the following procedure. The results of the risk analysis are to be documented. (a) Identify all the possible failures in the concerned equipment and systems which could lead to the	The location of the Note has been changed, and the Note in UR M78, 1.4.1 has been incorporated. (2): Corresponds to UR M78, 1.4.2 (no change)

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Amended	Original	Remarks
equipment and systems which could lead to the following: i) the presence of gas in components or locations not designed for such purpose; and/or ii) <u>ignition, fire or explosion or toxic release (for methanol engines).</u> ((b) to (d) are omitted.) (4) Equipment and systems to be analysed The risk analysis required for engines is to cover at least the following aspects. Failures of the gas supply components not located directly on the engine, such as block and bleed valves and other components of the gas supply system, are not to be considered in the analysis, <u>unless within the scope of supply, or specification, of the engine designer and are integral to the engine safety concept.</u> (a) Failure of the gas-related systems or components, in particular the following i) and ii) i) gas piping and its enclosure, where provided ii) <u>cylinder gas supply valves and sealing systems, as applicable</u> (b) Failure of the ignition system (<u>pilot fuel</u> fuel injection, sparking plugs and glow plugs) (c) Failure of the air to fuel ratio control system (charge air by-pass, gas pressure control valve, etc.) (d) For engines where gas is supplied upstream of the turbocharger compressor, failure of a component likely to result in a source of ignition (hot spots) (e) Failure of the gas combustion or abnormal combustion (<u>e.g.</u> misfiring, knocking)	following: i) the presence of gas in components or locations not designed for such purpose; and/or ii) <u>ignition, fire or explosion.</u> ((b) to (d) are omitted.) (4) Equipment and systems to be analysed The risk analysis required for engines is to cover at least the following aspects. Failures of the gas supply components not located directly on the engine, such as block and bleed valves and other components of the gas supply system, are not to be considered in the analysis. (a) Failure of the gas-related systems or components, in particular the following i) and ii) i) gas piping and its enclosure, where provided ii) cylinder gas supply valves (b) Failure of the ignition system (<u>oil fuel pilot</u> injection, sparking plugs and glow plugs) (c) Failure of the air to fuel ratio control system (charge air by-pass, gas pressure control valve, etc.) (d) For engines where gas is supplied upstream of the turbocharger compressor, failure of a component likely to result in a source of ignition (hot spots) (e) Failure of the gas combustion or abnormal combustion (misfiring, knocking)	(3)ii): UR M78, 1.4.3 (4): UR M78, 1.4.4

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Amended	Original	Remarks
(f) Failure of the engine monitoring, control and safety systems (g) Presence of gas in engine components (e.g. air inlet manifold or scavenge space and exhaust manifold) and in the external systems connected to the engines (e.g. exhaust duct, cooling water system, hydraulic oil system, etc.). (h) Changes of operating modes for dual fuel engines (i) Hazard potential for crankcase fuel gas accumulation for trunk-piston engines <u>or gas accumulation in piston underside spaces for crosshead engines</u>, refer to 10.3.1-2, Part GF and 2.2.2-6, Part D of the Rules for the Survey and Construction of Steel Ships (j) Risk of crankcase explosion in connection with active crankcase ventilation which produces a flow of external air into the crankcase (see 2.2.2-6, Part D of the Rules for the Survey and Construction of Steel Ships). 2 For pre-mixed engines, failures of <u>charge air system</u> components likely to result in <u>a gas leakage</u> are to be considered in <u>the safety concept</u> and risk analysis. 3 The risk analysis is to cover the possible gas accumulation in a scavenge space and the possible failure of a piston rod stuffing box. <u>8.4 Safety Concept for Engines</u> <u>1</u> For gas-fuelled engines, the safety concept is to be documented in accordance with the following (1) to (3). <u>(1)</u> The safety concept is to describe the DF or GF	(f) Failure of the engine monitoring, control and safety systems (g) Presence of gas in engine components (e.g. air inlet manifold or scavenge space and exhaust manifold) and in the external systems connected to the engines (e.g. exhaust duct, cooling water system, hydraulic oil system, etc.). (h) Changes of operating modes for dual fuel engines (i) Hazard potential for crankcase fuel gas accumulation, for trunk-piston engines, refer to 10.3.1-2, Part GF and 2.2.2-6, Part D of the Rules for the Survey and Construction of Steel Ships (j) Risk of crankcase explosion in connection with active crankcase ventilation which produces a flow of external air into the crankcase (see 2.2.2-6, Part D of the Rules for the Survey and Construction of Steel Ships). 2 For pre-mixed engines, failures of <u>such</u> components likely to result in gas leakages are to be considered in risk analysis. 3 The risk analysis is to cover the possible gas accumulation in a scavenge space and the possible failure of a piston rod stuffing box. (Newly added) (Newly added)	UR M78, 3.3.1 UR M78, 1.5 UR M78, 1.5.1

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Amended	Original	Remarks
<u>arrangements of the engine and how the risks of using the gas or low-flashpoint fuel are mitigated, including any specific instructions to be included in the maintenance and operation manuals.</u> (2) <u>The safety concept is to identify the safety philosophy of the engine design and describe how the risks associated with the fuel are controlled under reasonably foreseeable abnormal conditions as well as possible failure scenarios and their control measures.</u> (3) <u>To support understanding of the safety philosophy, the document is to describe the established safety concepts, including, but not limited to</u> <u>(a) Combustion control</u> <u>(b) Operating modes</u> <u>(c) Double barriers including ventilation air requirements</u> <u>(d) Gas leakage detection</u> <u>(e) Sealing systems</u> <u>(f) Safety valve arrangements</u> <u>(g) Fuel supply system purging and draining philosophy</u> <u>(h) Crankcase venting arrangements</u> <u>(i) Crankcase or piston underside space monitoring of gas accumulation</u> <u>(j) Electrical equipment specifications including the necessity of using certified safe equipment</u> <u>(k) Required monitoring, control and safety actions related to fuel supply systems, covering double block and bleed and master gas valve actions</u> <u>(l) Fuel supply system specifications and engine control and safety system interaction</u> <u>(m) Nitrogen purging and venting systems</u>		

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Amended	Original	Remarks
<u>(n) Fuel return/vent treatment equipment</u> <u>(o) Off-engine exhaust system explosion relief devices</u> <u>(p) Off-engine exhaust system fan purging</u> <u>(q) Auxiliary system specifications and monitoring</u> 2 <u>The results of the risk analysis in accordance with 8.3 are to be reflected in the safety concept in addition to the items specified in -1 above. Information on items (1) to (8) below is also to be included in the safety concept.</u> <u>(1) A detailed evaluation regarding the hazard potential of overpressure in crankcases, air inlet manifolds, scavenge spaces and exhaust systems, including potential of injury from a possible explosion and/or toxic release, and including how crankcase overpressure or fault condition is to be monitored, is to be carried out and reflected in the safety concept of the engine. (see 2.4.1, Annex 1.1.3-3, Part GF or 2.1-4, Annex 16.1.1-3, Part N of the Rules for the Survey and Construction of Steel Ships)</u> <u>(2) Information regarding the crankcase ventilation and monitoring arrangements. (see 2.2.3-4, Annex 1.1.3-3, Part GF or 2.2.3-4, Annex 16.1.1-3, Part N of the Rules for the Survey and Construction of Steel Ships)</u> <u>(3) Details regarding any single cylinder cut off functionality in gas mode operation. (see 2.5.2, 3.1-6 and 3.1-7, Annex 1.1.3-3, Part GF or 2.5.2, 4.1-7 and 4.1-8, Annex 16.1.1-3, Part N of the Rules for the Survey and Construction of Steel Ships)</u> <u>(4) As applicable, information regarding potential gas leaks from pre-mixed engines. The safety concept is to consider the need for flame arresters before each</u>	(Newly added)	UR M78, 1.5.2

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Amended	Original	Remarks
<u>cylinder. (see 2.5.3, Annex 1.1.3-3, Part GF or 2.5.3, Annex 16.1.1-3, Part N of the Rules for the Survey and Construction of Steel Ships)</u> (5) <u>As applicable, information regarding possible gas accumulation in scavenge spaces and/or failure of piston rod stuffing box. (see 8.3-3)</u> (6) <u>The safety concept is to clearly identify the equipment that is part of the engine and fuel supply safety philosophy but is not within the scope of supply, or boundary, of the base engine. The equipment may be installed by (and is the responsibility of) third parties or integrators such as ship designers and shipyards. Exhaust system explosion relief valves and auxiliary system gas detection are examples.</u> (7) <u>Actions required of, or affecting, the engine control and monitoring system from equipment outside of the base engine, such as fuel gas storage or fuel gas supply systems, are to be detailed in the engine safety concept.</u> (8) <u>The safety concept is to demonstrate how the requirements of this chapter and the additional requirements of Part GF and Part N of the Rules for the Survey and Construction of Steel Ships are complied with, including how any applicable goals and functional requirements are satisfied. Where deviations or alternatives from the prescribed requirements exist, or conflicts exist between Part GF and Part N of the Rules for the Survey and Construction of Steel Ships, the arrangements are to be justified by the safety concept. Additionally, deviations from the statutory requirements are to be agreed with the responsible flag Administration on a</u>		

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Amended	Original	Remarks
<u>case-by-case basis.</u> (Deleted) (Relocated) (Relocated) (Deleted) (Relocated) (Relocated) 8.5 Approval Tests 8.5.1 Test Stages 2 Approval tests are to be arranged to represent typical foreseen service load profiles, as specified by the engine <u>designer</u>, as well as to confirm required safety margins for fatigue scatter and reasonably foreseen in-service deterioration. This requirement applies to the following (1) to (3). ((1) to (3) are omitted.) 3 Upon completion of <u>all type</u> approval tests given in -	8.4 Preparation for Surveys 1 <u>All relevant equipment for the safety of attending personnel is to be made available by the manufacturer or shipyard and is to be operational, and its correct functioning is to be verified before any test run is carried out.</u> 2 <u>-1 above applies especially to crankcase explosive condition protection, but also to overspeed protection and any other shut down function.</u> 3 <u>Inspections for jacketing of high-pressure fuel oil lines and proper screening of pipe connections are also to be carried out before the test runs.</u> 4 <u>Interlock tests for turning gear are to be performed when such gear is installed.</u> 5 <u>For gas-fuelled engines, measures to verify that gas fuel piping on engine is gas tight are to be carried out prior to start-up of the engine.</u> 8.5 Approval Tests 8.5.1 Test Stages 2 Approval tests are to be arranged to represent typical foreseen service load profiles, as specified by the engine <u>builder</u>, as well as to confirm required safety margins for fatigue scatter and reasonably foreseen in-service deterioration. This requirement applies to the following (1) to (3). <u>Special testing such as low cycle fatigue testing and endurance testing will normally be conducted during stage A.</u> ((1) to (3) are omitted.) 3 Upon completion of <u>the</u> approval tests given in -1, a	Relocated to 8.5.2-2(1). Relocated to 8.5.2-2(1). Deleted Relocated to 8.5.2-2(1). Relocated to 8.5.2-2(1). UR M71, 3.1 UR M71, 6.4

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Amended	Original	Remarks
1, a test report containing the following (1) to (4) is to be submitted to the Society for review. (1) Overall description of tests performed during stage A. Records are to be kept according to the manufacturer's quality assurance management procedures for presentation to the Society. (2) Detailed descriptions of the load and <u>safety functional tests as well as the inspection results of fire protective measures</u> conducted during stage B. <u>Test records are to be signed by the attending surveyor of the Society.</u> (3) Inspection results from stage C. (4) <u>Statement of conformity of the test engine to approved drawings and specifications.</u> 4 During all approval tests, ambient conditions (i.e. air temperature, air pressure and humidity) are to be recorded. At a minimum, the engine data listed in the following (1) to (10) are to be measured and recorded. <u>All measurements conducted at the various load points are to be carried out under steady state operating conditions.</u> Calibration records for the instrumentation used to collect data listed below are to be presented to the attending surveyor for review. Additional measurements may be required in connection with the design assessment as deemed necessary by the Society. (1) Speed (<i>rpm</i>) (2) <u>Power and/or torque</u> (3) Maximum combustion pressure and mean indicated pressure for each cylinder (Omitted) (4) Charging air pressure and temperature (5) <u>Exhaust gas temperature before turbine and from each cylinder (to the extent that monitoring is required in</u>	test report containing the following (1) to (3) is to be submitted to the Society for review. (1) Overall description of tests performed during stage A. Records are to be kept according to the manufacturer's quality assurance management procedures for presentation to the Society. (2) Detailed descriptions of the load and functional tests conducted during stage B. (3) Inspection results from stage C. (Newly added) 4 During all approval tests, ambient conditions (i.e. air temperature, air pressure and humidity) are to be recorded. At a minimum, the engine data <u>as</u> listed in the following (1) to (9) are to be measured and recorded. Calibration records for the instrumentation used to collect data listed below are to be presented to the attending surveyor for review. Additional measurements may be required in connection with the design assessment as deemed necessary by the Society. (1) Speed (<i>rpm</i>) (2) Torque (3) Maximum combustion pressure and mean indicated pressure for each cylinder (Omitted) (4) Charging air pressure and temperature (5) <u>Exhaust gas temperature</u>	(2): UR M71, 6.4 (4): Corresponds to the first paragraph of UR M71 6.4. UR M71, 7.

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Amended	Original	Remarks
<u>2.5.1, Part D of the Rules for the Survey and Construction of Steel Ships and Chapter 3, Rules for Automatic and Remote Control Systems)</u> (6) Fuel <u>command</u> / fuel index or equivalent reading, e.g. <u>fuel rack position</u> (7) Turbocharger speed <u>(to the extent that monitoring is required in 2.5.1, Part D of the Rules for the Survey and Construction of Steel Ships)</u> (8) All engine parameters that are required for control and monitoring for the intended use (propulsion, auxiliary, emergency). (9) <u>Specific parameters of relevant sub-systems</u> (10) For gas-fuelled engines, the following (a) to (d) are to be measured and recorded (a) Each fuel index for gas and <u>fuel oil</u> as applicable (or equivalent reading) (b) Gas pressure and temperature at the inlet of the gas manifold (c) Pilot fuel temperature and pressure (supply or common rail as appropriate) (d) Gas concentration in the crankcase (The gas concentration in the crankcase <u>may</u> be measured inside the crankcase or at the crankcase outlet (crankcase vent pipe). Gas concentration measurements may be carried out as part of stage A if the method and the results are properly documented.) (Deleted)	(6) Fuel rack position <u>or similar parameter related to engine load</u> (7) Turbocharger speed (8) All engine parameters that are required for control and monitoring for the intended use (propulsion, auxiliary, emergency). (Newly added) (9) For gas-fuelled engines, the following (a) to (d) are to be measured and recorded (a) Each fuel index for gas and <u>diesel</u> as applicable (or equivalent reading) (b) Gas pressure and temperature at the inlet of the gas manifold (c) Pilot fuel temperature and pressure (supply or common rail as appropriate) (d) Gas concentration in the crankcase (The gas concentration in the crankcase <u>should normally</u> be measured inside the crankcase or at the crankcase outlet (crankcase vent pipe). Gas concentration measurements may be carried out as part of stage A if the method and the results are properly documented.) <u>5 An integration test demonstrating the response of the complete mechanical, hydraulic and electronic system may be required for acceptance of any sub-systems (turbocharger, engine control system, dual fuel, exhaust gas treatment, etc.) separately approved. The scope of these tests are to be</u>	(10) (d): UR M78, 4.1.5 Deleted following the deletion of the integration test requirement in the former M71 3.3 Note. Revised relevant requirements have as the new M71 9.4 and incorporated into 8.5.2-2(3).

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Amended	Original	Remarks
(Deleted)	determined by the Society on a cases-by-case basis in consideration of the test items proposed by the designer (licensor) taking the impact on engine into account. 6 For gas-fuelled engines, the following are also to be applied. (1) For dual fuel engines, the load tests specified in 8.5.2-1(1) and 8.5.2-2(2) are to be carried out in gas mode. (2) The influence of the methane number and <i>LHV</i> of the fuel gas is not required to be verified during the stage <i>B</i>. It is, however, to be justified by the engine designer through tests or calculations at the stage <i>A</i> and documented in the type approval test report. (3) The integration tests of -5 are to be carried out to verify that the response of the complete mechanical, hydraulic and electronic engine system is as predicted for all intended operational modes. The scope of these tests is to be agreed with the Society for selected cases based on the risk analysis required in 8.3, and is to at least include the following incidents: (a) Failure of ignition (spark ignition or pilot injection systems), both for one cylinder unit and common system failure (b) Failure of a cylinder gas supply valve (c) Failure of the combustion (to be detected by e.g. misfiring, knocking, exhaust temperature deviation, etc.) (d) Abnormal gas pressure (e) Abnormal gas temperature (this test may be carried out using a simulation signal of the temperature)	-6.: UR M78, 4.1.7.3 (1) and (2): Deleted as the requirements are already covered in 8.5.2. (3): The relevant requirement is relocated to 8.5.2-2(6)(n).

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Amended	Original	Remarks
8.5.2 Details of Tests 1 During stage <i>A</i>, the following items of tests are to be included: (1) Operation at the load points <u>deemed important by the engine designer and at the load points specified in the applicable type approval test program. Additionally, the pertaining operating values are to be recorded.</u> (Deleted) (2) <u>Safety tests according to 8.5.2-2(1) are to be carried out.</u> (3) <u>Functional tests according to 8.5.2-2(2) are to be carried out.</u> (4) <u>Integration tests according to 8.5.2-2(3) and 8.5.2-2(6)(n) are to be carried out.</u> (5) <u>Applicable load points according to 8.5.2-2(4) are to be tested and recorded.</u> (6) <u>High-speed engines to be subjected to an endurance test of 100 <i>hours</i> at full load. The 100-hour test may</u>	8.5.2 Details of Tests 1 During stage <i>A</i>, the following items of tests are to be included: (1) Operation at the load points <u>25%, 50%, 75%, 100% and 110% of the maximum rated power for continuous operation and other load points considered important, at the following engine speeds:</u> (a) <u>along the nominal (theoretical) propeller curve and at constant speed for engines which may be used as main propulsion machinery of ships other than electric propulsion ships (if applicable mode of operation, i.e., driving controllable pitch propellers)</u> (b) <u>at constant speed for engines which may be used as main propulsion machinery for electric propulsion ships or as engines driving generating sets or auxiliary machinery (including a test at no load and rated speed)</u> (2) <u>Operation at the limit points of the permissible operating range. These limit points are to be defined by the engine manufacturer.</u> (Newly added) (Newly added) (Newly added) (Newly added) (3) <u>For high-speed engines, a 100-hour full load test.</u>	(1): UR M71, 8.1 (2): UR M71, 8.2 (3): UR M71, 8.3 (4): UR M71, 8.4 (5): UR M71, 8.5 (6): UR M71, 8.6

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<u>include the load tests (5) and the load cycles tests (7), deemed necessary by the engine designer. Omission or simplification of this test may be considered for the type approval of engines with long service experience from non-marine fields deemed appropriate by the Society.</u> (7) For engines which are classified as high-speed engines and may be used as main propulsion machinery for ships subject to the Rules for High Speed Craft, the <u>load cycle</u> fatigue test. In this case, load changes are to be the steepest load ramp that the control system (or operation manual if not automatically controlled) permits and are normally to be repeated at least 500 cycles (idle - full load - idle). The duration at each end is to be sufficient for reaching stable temperatures of the hot parts. (8) Specific tests of parts of the engine stipulated by the designer. (9) For electronically-controlled engines, continuous operation tests for the following components are to be carried out to confirm the durability within the period prescribed by the manufacturer. (a) Control valves (b) Accumulator diaphragms (Deleted) (Deleted) (10) For gas fuelled engines, the following (a) to (d) are also to be included.	(4) For engines which are classified as high-speed engines and may be used as main propulsion machinery for ships subject to the Rules for High Speed Craft, the <u>low cycle</u> fatigue test. In this case, load changes are to be the steepest load ramp that the control system (or operation manual if not automatically controlled) permits and are normally to be repeated at least 500 cycles (idle - full load - idle). The duration at each end is to be sufficient for reaching stable temperatures of the hot parts. (5) Specific tests of parts of the engine stipulated by the designer. (6) For electronically-controlled engines, continuous operation tests for the following components are to be carried out to confirm the durability within the period prescribed by the manufacturer. (a) Control valves (b) Accumulator diaphragms (7) <u>For electronically-controlled engines, the functions included in the software of the control system are to be confirmed.</u> (8) <u>For electronically-controlled engines, an operation test is to be carried out under one cylinder cut-off condition.</u> (9) For gas fuelled engines, the following (a) to (d) are also to be included.	(7): UR M71, 8.7 (8): UR M71, 8.8 As the control system of an electronically controlled engine forms part of the engine sub-system, former items (7) and (8) are covered by the test specified in the new item (4). (10): Corresponds to UR M78 4.1.6.

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Amended	Original	Remarks
(a) For dual fuel engines, the engines are to run the load points defined in (1) in both gas and diesel modes (with and without pilot injection in service) as found applicable for the engine type. (b) For dual fuel engines with variable liquid/gas ratio, the load tests are to be carried out at different ratios between the minimum and the maximum allowable values. (c) For dual fuel engines, switch over between gas and diesel modes are to be tested at different loads. (d) The influence of the methane number and <i>LHV</i> of the fuel gas on the engine's maximum continuous power available in gas mode is to be verified. (11) Other items deemed to be verified by the Society. 2 During stage <i>B</i>, the following items of tests are to be included. Deviations from the items, if any, are to be agreed with the Society. (1) <u>Safety tests</u> <u>Before any test run is carried out, the safety checks and tests specified in (a) through (d) are to be carried out.</u> (a) <u>All relevant equipment for the safety of attending personnel is to be made available by the manufacturer or shipyard and is to be operational, and its correct functioning is to be verified before any test run is carried out.</u> (b) <u>Particular attention is to be paid to crankcase explosion condition protection, overspeed protection and other shutdown functions.</u> <u>The overspeed test is to be carried out and is to demonstrate that the engine is not damaged by an</u>	(a) For dual fuel engines, the engines are to run the load points defined in (1) in both gas and diesel modes (with and without pilot injection in service) as found applicable for the engine type. (b) For dual fuel engines with variable liquid/gas ratio, the load tests are to be carried out at different ratios between the minimum and the maximum allowable values. (c) For dual fuel engines, switch over between gas and diesel modes are to be tested at different loads. (d) The influence of the methane number and <i>LHV</i> of the fuel gas on the engine's maximum continuous power available in gas mode is to be verified. (10) Other items deemed to be verified by the Society. 2 During stage <i>B</i>, the following items of tests are to be included. Deviations from the items, if any, are to be agreed with the Society. (1) <u>Overspeed test</u> <u>It is to demonstrate that the engine is not damaged by an actual engine overspeed within the overspeed shutdown system set-point. The manufacturer may decide whether the test is to be carried out with or without load during the speed overshoot.</u>	(1): UR M71, 9.2

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actual engine overspeed within the overspeed shutdown system set point. <u>This test may be carried out at the manufacturer's choice either with or without load during the speed overshoot.[WG1.1]</u> (c) <u>Interlock tests for turning gear are to be performed when such gear is installed.</u> (d) <u>For gas-fuelled engines, measures to verify that gas fuel piping on engine is gas tight are to be carried out prior to start-up of the engine.</u> (2) <u>Functional tests</u> (a) <u>For reciprocating internal combustion engines which may be used as main propulsion machinery, verification of the lowest engine speed (10 minutes), the lowest specified propulsion engine speed according to the nominal propeller curve as specified by the engine designer (even though it works on a water-brake). During this operation, rpm, power, T/C rpm, scavenge pressure, dynamometer torque are to be measured, and no alarm is to occur.</u> (b) <u>Starting tests, for non-reversible engines and/or starting and reversing tests, for reversible engines, for the purpose of determining the minimum air pressure and the consumption for a start.</u> (c) <u>Governor tests for compliance with 2.4.1, Part D of the Rules for the Survey and Construction of Steel Ships are to be carried out</u> (d) <u>For all single main propulsion engines which may be used as main propulsion machinery, the achievable continuous output is to be determined</u>	(4) For reciprocating internal combustion engines which may be used as main propulsion machinery, verification of the lowest specified propulsion engine speed according to nominal propeller curve as specified by the engine designer. During this operation, no alarm is to occur. (5) Starting tests, for non-reversible engines and/or starting and reversing tests, for reversible engines, for the purpose of determining the minimum air pressure and the consumption for a start. (6) <u>Governor test</u> (3) For 2-stroke engines which may be used as main propulsion machinery, the achievable continuous output is to be determined in the case of turbocharger damage. Reciprocating internal	(2): UR M71, 9.3

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in the case of turbocharger damage. <u>The test is to be performed with one turbocharger out of operation. Reciprocating internal combustion engines which may be used as main propulsion machinery driving propulsion system with a fixed pitch propeller are to be able to run continuously at a speed (<i>rpm</i>) of 40 % of full speed along the theoretical propeller curve (6.4 % power). Engines only intended for controllable pitch propeller application are to be able to run continuously at a power of 6.4 %. The engine speed is to be at the lower limit of the intended operation field according to the designer's specification.</u> (3) <u>Integration tests of sub-systems</u> <u>Integration tests for acceptance of sub-systems are to be carried out to verify that the response of the complete mechanical, hydraulic and electronic system is as predicted for all intended operational modes. The scope of these tests is to be proposed by the designer taking into account of multiple operation modes of the engine, FMEA reports required in 2.5.10, Part D of the Rules for the Survey and Construction of Steel Ships, and the impact of the test on engine, and is to be agreed upon with the Society.</u> (4) <u>Load tests</u> <u>(a) Load tests are to be carried out in accordance with Fig. 6.8-1 and Table 6.8-1. The data to be measured and recorded when testing the engine at each load point is to include all engine parameters listed in 8.5.1-4. During all these load</u>	combustion engines which may be used as main propulsion machinery driving a single propulsion system with a fixed pitch propeller are to be able to run continuously at a speed (<i>rpm</i>) of 40% of full speed along the theoretical propeller curve <u>when one turbocharger is out of operation. The test can be performed by either by-passing the turbocharger, fixing the turbocharger rotor shaft or removing the rotor.</u> (7) <u>For electronically-controlled engines, integration tests are to verify that the response of the complete mechanical, hydraulic and electronic system is as predicted for all intended operational modes. The scope of these tests is to be agreed upon with the Society for selected cases based upon the FMEA required in 2.5.11, Part D of the Rules for the Survey and Construction of Steel Ships.</u> (2) <u>Operation at each load point below (an operating time of two <i>hours</i> is to be required at the load point in (a) and two sets of readings are to be taken at a minimum interval of one <i>hour</i>. An operating time per each load point other than (a) depends upon the engine size (achievement of steady state condition) and on the time for collection of the operating values, but 0.5</u>	(3): UR M71, 9.4 (4): Corresponds to UR M71 9.5. The test conditions at each load setting point are summarized as a table.

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points, engine parameters are to be within the specified and approved values. If operation of the engine at the limits defined by its specified alarm system (e.g. at alarm levels of lubrication oil pressure and inlet temperature) is required, the test is to be made at the load point in <u>load point 1</u>.	<u>hours can be normally assumed. However, sufficient time is to be allowed for visual inspection by the surveyor.)</u> The data to be measured and recorded when testing the engine at each load point have to include all engine parameters listed in 8.5.1-4. During all these load points, engine parameters are to be within the specified and approved values. If operation of the engine at the limits defined by its specified alarm system (e.g. at alarm levels of lubrication oil pressure and inlet temperature) is required, the test is to be made at the load point in <u>(a)</u>. <u>(a) Rated power, i.e. 100% output at 100% torque and 100% speed (corresponding to load point 1 in Fig. 6.8-1)</u> <u>(b) 100% power at maximum permissible speed (corresponding to load point 2 in Fig. 6.8-1)</u> <u>(c) Maximum permissible torque (at least and normally 110%) at 100% speed (corresponding to load point 3 in Fig. 6.8-1) or maximum permissible power (at least and normally 110%) and at 103.2% speed according to nominal propeller curve (corresponding to load point 3a in Fig. 6.8-1). Load point 3a applies to reciprocating internal combustion engines only driving fixed pitch propellers or waterjet propulsion systems. Load point 3 applies to all other purposes.</u> <u>In the case of engines for which intermittent overload is approved, the following i) and ii) are to be applied.</u> <u>i) Where the intermittent overload rating is more than 110% of MCR:</u>	

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	<u>Load point 3 (or 3a as applicable) is to be replaced with a load that corresponds to the specified overload and duration approved for intermittent use.</u> <u>ii) Where the intermittent overload rating is less than 110% of <i>MCR</i>:</u> <u>Overload rating is to replace the load point 1 (100 % of <i>MCR</i>). In such cases, it is necessary to operate at load point 3 (or 3a as applicable).</u> <u>(d) Minimum permissible speed at 100% torque (corresponding to load point 4 in Fig. 6.8-1)</u> <u>(e) For reciprocating internal combustion engines which may be used as main propulsion machinery, minimum permissible speed at 90% torque (corresponding to load point 5 in Fig. 6.8-1)</u> <u>(f) Part loads, e.g. 25%, 50%, and 75% of rated power and speed according to nominal propeller curve (corresponding to load points 6, 7 and 8 in Fig. 6.8-1) for reciprocating internal combustion engines which may be used as main propulsion machinery</u> <u>(g) Part loads, e.g. 25%, 50%, and 75% of rated power and rated speed with constant governor setting (corresponding to load points 9,10 and 11 in Fig. 6.8-1) for reciprocating internal combustion engines which may be used for driving generator sets or auxiliary machinery</u> <u>(h) Crosshead engines not restricted for use with controllable pitch propellers are to be tested with no load at the associated maximum permissible</u>	

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<u>(b) Sub-systems are to be in operation during the load tests specified in (a), as intended by the designer. Where the operation of the sub-system or equipping the engine with the sub-system is optional, the following requirements are to be fulfilled.</u> <u>i) All load points are to be tested without the sub-system in operation</u> <u>ii) One load point (0.5 h) is to be tested with the sub-system in operation. The load point is to be the highest possible load at corresponding speed using the sub-system or 100 % load (load point 1 in Fig. 6.8-1), whichever is lower.</u> <u>iii) Part load points with the sub-system in operation if considered necessary.</u> <u>(5) Inspection of the fire protection measures</u> <u>(a) Inspections for jacketing of high-pressure fuel oil lines, including systems for the detection of leakage</u> <u>(b) Inspections for proper screening of pipe connections in piping containing flammable liquids.</u> <u>(c) Verification of proper insulation of hot surfaces</u> Readings of surface temperatures are to be done while running the engine at 100 % load required in <u>(1)</u>, alternatively at the overload approved for intermittent use, by use of infrared thermoscanning equipment. Equivalent measurement equipment may be used when approved by the Society. Readings	<u>engine speed.</u> (Newly added) (8) Inspections for jacketing of high-pressure fuel oil lines, including systems for the detection of leakage (9) Inspections for proper screening of pipe connections in piping containing flammable liquids. (10) Verification of proper insulation of hot surfaces Readings of surface temperatures are to be done while running the engine at 100% load required in (2), alternatively at the overload approved for intermittent use, by use of infrared thermoscanning equipment. Equivalent measurement equipment may be used when approved by the Society. Readings obtained are to be randomly verified through the use of contact	(5): UR M71, 9.6

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Amended	Original	Remarks
obtained are to be randomly verified through the use of contact thermometers. (6) For gas-fuelled engines, the following (a) to (n) are also to be applied. (a) For dual fuel engines, all load points of (1) are to be run in both gas and diesel modes that apply for the engine type as defined by the engine designer. (b) <u>The load tests are to be carried out in fuel oil mode and in gas mode at the different percentages of the engine's MCR.</u> (c) For dual fuel engines, the independent overspeed protection device <u>need only</u> be tested in <u>fuel oil modes</u>. <u>In addition, the operation with damaged turbocharger test need only be verified in the fuel oil mode.</u> (d) For dual fuel engines with variable liquid/gas ratios, selected load tests of (a) are to be carried out at different ratios between the minimum and the maximum allowable values. (The most relevant and critical loads and ratios are to be selected for the test.) (e) The maximum continuous power available in gas mode (see 2.5.1-1(1), Annex 1.1.3-3, Part GF or 2.5.1-1(1), Annex 16.1.1-3, Part N of the Rules for the Survey and Construction of Steel Ships) is to be demonstrated. (f) Overload testing is not required in gas mode for dual fuel engines, provided that changeover to oil fuel mode is automatically performed in case of overload. (Deleted)	thermometers. (11) For gas-fuelled engines, the following (a) to (k) are also to be applied. (a) For dual fuel engines, all load points of (2) are to be run in both gas and diesel modes that apply for the engine type as defined by the engine designer. (Newly added) (b) For dual fuel engines, the independent overspeed protection device <u>has to</u> be tested in <u>both gas and diesel</u> modes. (c) For dual fuel engines with variable liquid/gas ratios, selected load tests of (a) are to be carried out at different ratios between the minimum and the maximum allowable values. (The most relevant and critical loads and ratios are to be selected for the test.) (d) The maximum continuous power available in gas mode (see 2.5.1-1(1), Annex 1.1.3-3, Part GF or 2.5.1-1(1), Annex 16.1.1-3, Part N of the Rules for the Survey and Construction of Steel Ships) is to be demonstrated. (e) Overload testing is not required in gas mode for dual fuel engines, provided that changeover to oil fuel mode is automatically performed in case of overload. (f) <u>The load tests are to be carried out in diesel mode and in gas mode at the different percentages of</u>	(6): UR M78, 4.1.7 Relocated from (f). Former (f): Relocated to (b).

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
(g) For dual fuel engines, the lowest specified speed is to be verified in diesel mode and gas mode. (h) For dual fuel engines, switch over between gas and diesel modes are to be tested at different loads. (i) <u>For dual fuel engines, verification of automatic changeover to fuel oil mode when the load demand exceeds the maximum continuous power available in gas mode and when load demand leaves the gas mode operation range.</u> (j) <u>As applicable, the gas mode cylinder cut off functionality is to be demonstrated.</u> (k) <u>The effectiveness of the ventilation and gas detection arrangement or another approved method for the double walled gas piping system is to be demonstrated.</u> (l) For engines which may be used as engines driving generator sets, the characteristics of governors specified in 2.4.1-5(1) and (2), Part D of the Rules for the Survey and Construction of Steel Ships are to be verified. <u>For dual fuel engines, automatic switchover to fuel oil during the test is acceptable.</u> (m) For gas only and pre-mixed engines which may be used as engines driving generator sets, the influences of <i>LHV</i>, methane number and ambient conditions on the governor test results are to be theoretically determined and specified in the test report. Referring to the limitations specified in 2.1-4(1) and (2), Annex 16.1.1-3, Part N or 2.1-	<u>the engine's MCR.</u> (g) For dual fuel engines, the lowest specified speed is to be verified in diesel mode and gas mode. (h) For dual fuel engines, switch over between gas and diesel modes are to be tested at different loads. (Newly added) (Newly added) (i) The <u>efficiency</u> of the ventilation arrangement of the double walled gas piping system is to be <u>verified</u>. (j) For engines which may be used as engines driving generator sets, the characteristics of governors specified in 2.4.1-5(1) and (2), Part D of the Rules for the Survey and Construction of Steel Ships are to be verified. (k) For gas only and pre-mixed engines which may be used as engines driving generator sets, the influences of <i>LHV</i>, methane number and ambient conditions on the governor test results are to be theoretically determined and specified in the test report. Referring to the limitations specified in 2.1-4(1) and (2), Annex 16.1.1-3, Part N or 2.1-	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
4(1) and (2), Annex 1.1.3-3, Part GF of the Rules for the Survey and Construction of Steel Ships, the margin for satisfying characteristics of governors are to be determined. (n) Gas only and dual fuel engines are to undergo integration tests. The scope of these tests is to be agreed on with the Society for selected cases based on the required safety concept (see 8.4), risk analysis and FMEA (see 8.4), and is to at least include the following incidents: i) Failure of ignition (spark ignition or pilot fuel injection systems), both for one cylinder unit and common system failure ii) Failure of a gas admission valve iii) Failure of the combustion (to be detected by misfiring, knocking, exhaust temperature deviation, etc.) iv) Abnormal gas pressure v) Abnormal gas temperature The above integration tests may be carried out using simulation or other alternative methods, subject to special consideration by the Society (7) Other test items deemed necessary by the Society 3 During stage C, the following items are to be included. (1) Measurement of crankshaft deflections To be measured according to specified (by designer) conditions (except for engines where no specification exists). (2) Upon completion of the test run, the components of one cylinder for in-line engines and two cylinders for V-engines are to be presented for inspection as follows.	Rules for the Survey and Construction of Steel Ships, the margin for satisfying characteristics of governors are to be determined. (Newly added) (12) Other test items deemed necessary by the Society 3 During stage C, the following items are to be included. (1) Measurement of crankshaft deflections To be measured according to specified (by designer) conditions (except for engines where no specification exists). (2) Upon completion of the test run, the components of one cylinder for in-line engines and two cylinders for V-engines are to be presented for inspection as follows.	(n).: UR M78, 4.1.7.3 UR M78, 4.1.7.3 Note UR M71, 10.

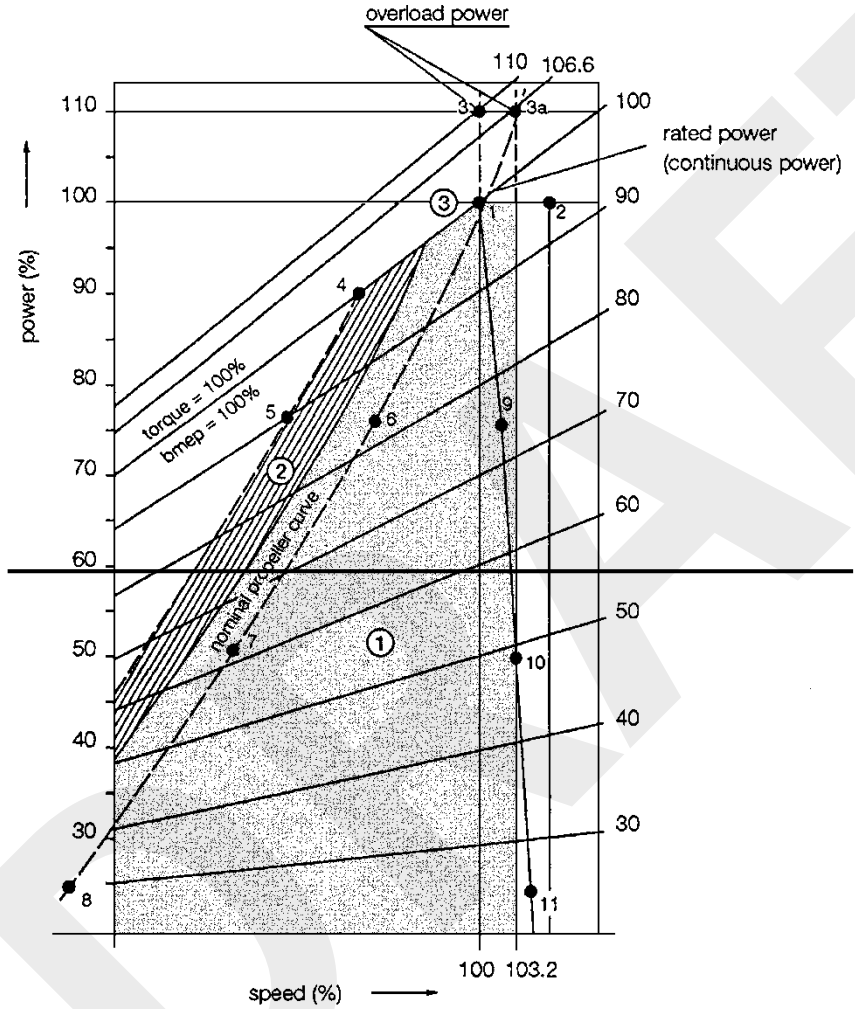
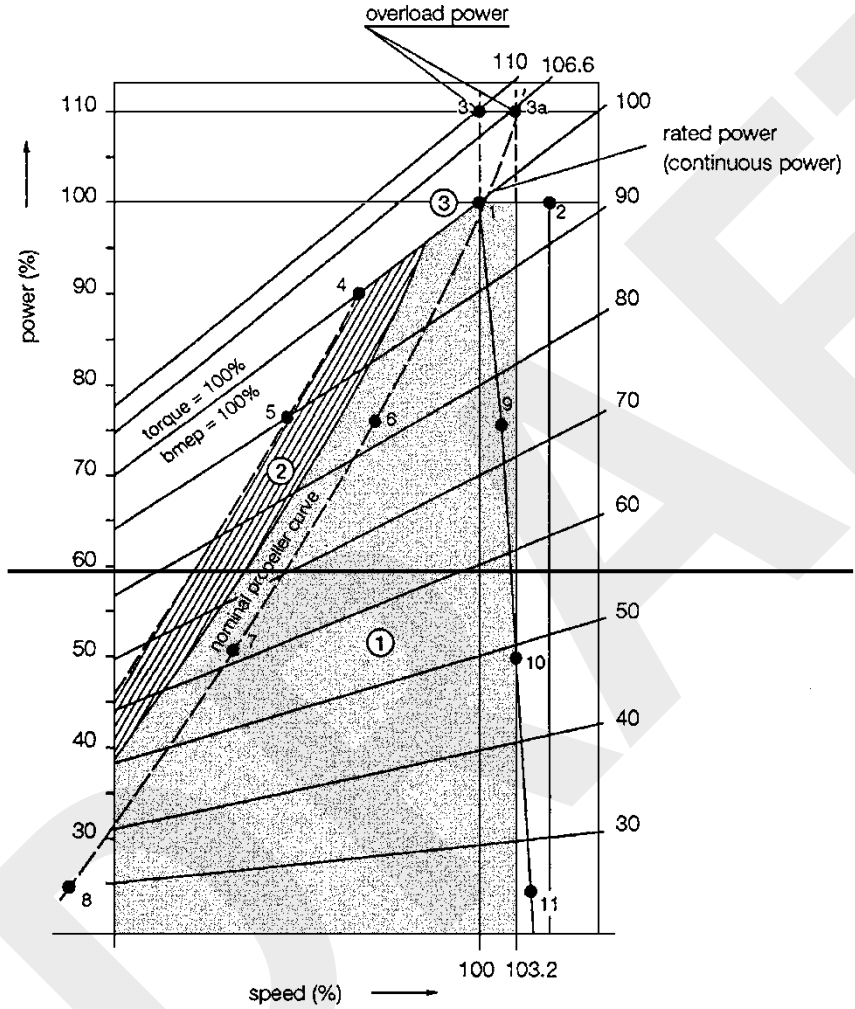
Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
For <i>V</i>-engines, the cylinder units are to be selected from both cylinder banks and different crank throws. For high-speed engines, two cylinders are normally to be stripped down for a complete inspection after the type test. (a) Piston removed and dismantled (b) Crosshead bearing, dismantled (c) Guide planes, dismantled (d) Connecting rod bearings (big and small end) dismantled Special attention is to be paid to serrations and fretting on contact surfaces with the bearing backsides (e) Main bearing, dismantled (f) Cylinder liner in the installed condition (g) Cylinder head, valves disassembled (h) Cam drive gear or chain, camshaft and crankcase with opened covers The engine is to be turnable by turning gear for this inspection. <u>(i) Components of relevant sub-systems may be dismantled for inspection</u> <u>Such inspections are to be carried out as agreed with the Society or in accordance with instructions from the engine designer when approved by the Society.</u> (j) For gas-fuelled engines, the following i) to iii) are also to be included. i) Gas admission valve including pre-chamber as found applicable ii) Spark igniter (for gas only engines) iii) Pilot fuel injection valve (for dual fuel engines)	For <i>V</i>-engines, the cylinder units are to be selected from both cylinder banks and different crank throws. For high-speed engines, two cylinders are normally to be stripped down for a complete inspection after the type test. (a) Piston removed and dismantled (b) Crosshead bearing, dismantled (c) Guide planes, dismantled (d) Connecting rod bearings (big and small end) dismantled Special attention is to be paid to serrations and fretting on contact surfaces with the bearing backsides (e) Main bearing, dismantled (f) Cylinder liner in the installed condition (g) Cylinder head, valves disassembled (h) Cam drive gear or chain, camshaft and crankcase with opened covers The engine is to be turnable by turning gear for this inspection. (Newly added) (i) For gas-fuelled engines, the following i) to iii) are also to be included. i) Gas admission valve including pre-chamber as found applicable ii) Spark igniter (for gas only engines) iii) Pilot fuel injection valve (for dual fuel engines)	(i): UR M71, 10.5

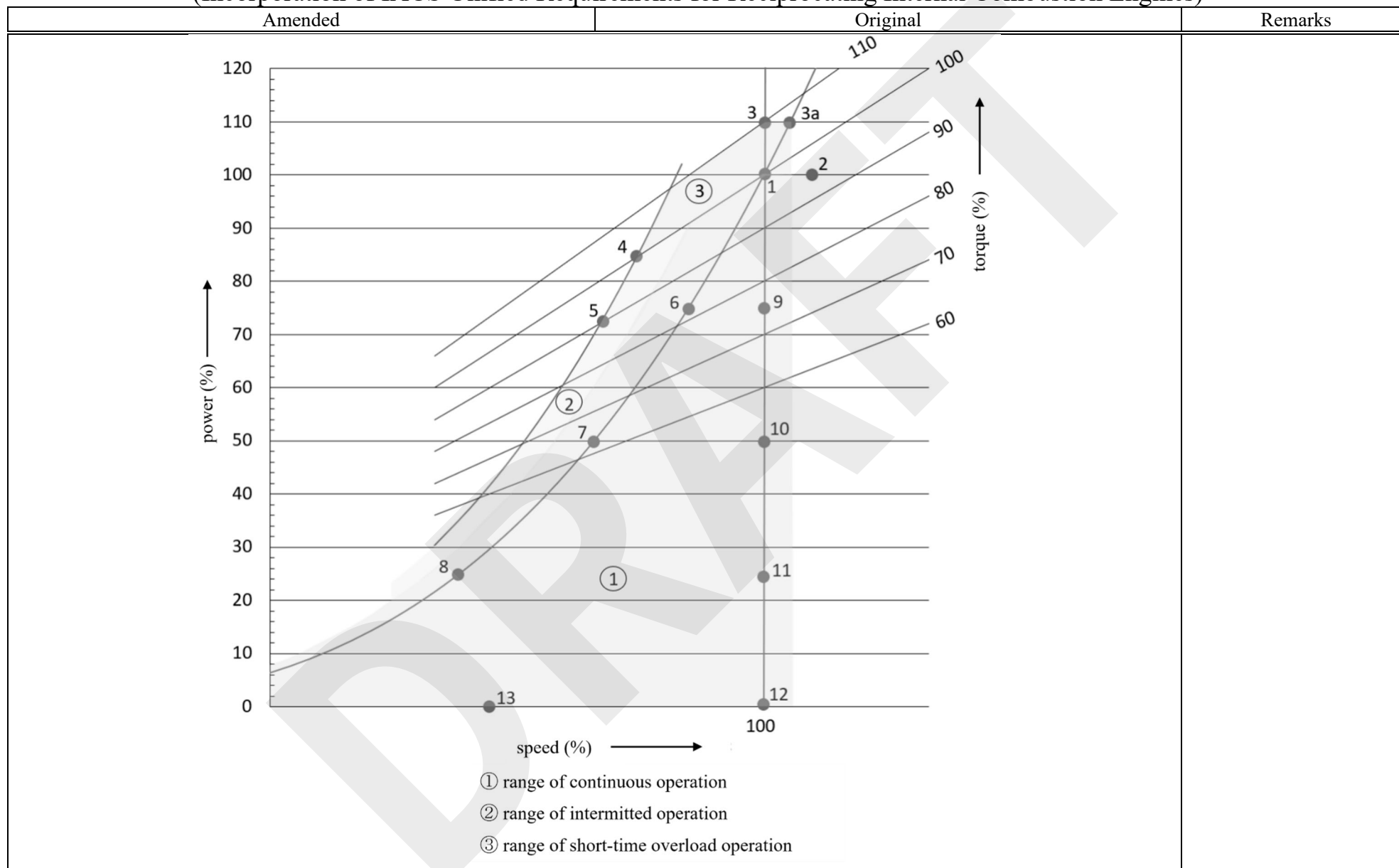
Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
(<u>k</u>) Further components deemed necessary by the Society	(j) Further components deemed necessary by the Society	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
Fig. 6.8-1 Power/Speed Diagram  The diagram is a graph with power (%) on the y-axis (30 to 110) and speed (%) on the x-axis (80 to 110). It shows several curves: a 'nominal power curve' (dashed), and lines for 'torque = 100%' and 'bmep = 100%'. Three shaded regions are identified: ① (continuous operation), ② (intermittent operation), and ③ (short-time overload operation). Key points include 3, 3a, 4, 5, 6, 8, 9, 10, and 11. A horizontal line at 60% power and a vertical line at 103.2% speed are also shown. ① = range of continuous operation ② = range of intermittent operation ③ = range of short-time overload operation	Fig. 6.8-1 Power/Speed Diagram  The diagram is a graph with power (%) on the y-axis (30 to 110) and speed (%) on the x-axis (80 to 110). It shows several curves: a 'nominal power curve' (dashed), and lines for 'torque = 100%' and 'bmep = 100%'. Three shaded regions are identified: ① (continuous operation), ② (intermittent operation), and ③ (short-time overload operation). Key points include 3, 3a, 4, 5, 6, 8, 9, 10, and 11. A horizontal line at 60% power and a vertical line at 103.2% speed are also shown. ① = range of continuous operation ② = range of intermittent operation ③ = range of short-time overload operation	UR M71 Figure 1

Amended-Original Requirements Comparison Table
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Amended-Original Requirements Comparison Table
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Amended				Original		Remarks
Table 6.8-1 Load Tests in Type Approval Testing						UR M71 Table 1
Load point ⁽³⁾	Power (%)	Speed (%)	Torque (%)	Test time ⁽⁴⁾	Remarks	
1	100	100	—	2 hours	MCR, 2 measurements with an interval of 1 hour	
2	100	Maximum permissible ⁽²⁾	—	0.5 hours	—	
3	110	100	Maximum permissible torque ⁽¹⁾		For constant speed applications	
3a	110	103.2			For propeller curve applications	
4	—	Minimum permissible ⁽²⁾	100		—	
5	—	Minimum permissible ⁽²⁾	90		For propeller curve applications	
6	75	90.8	—		Part load, nominal propeller curve	
7	50	79.3	—			
8	25	62.9	—			
9	75	100	—		Part load, constant rated speed	
10	50	100	—			
11	25	100	—			
12	No load	100	—		Engines for generator applications only	
13	No load	Maximum permissible ⁽²⁾	—	Crosshead engines intended for controllable pitch propellers only		

Notes:

(1) For engines where intermittent overload operation is permitted, the following are to apply:

(a) Where the approved intermittent overload rating exceeds 110 % of MCR, load point 3 (or 3a as applicable) is to be replaced with a load that corresponds to the specified overload and duration approved for intermittent use.

(b) Where the approved intermittent overload rating is less than or equal to 110 % of MCR, the load point 1 is to be replaced with the subject overload rating. In such cases, operation at load point 3 (or 3a as applicable) is to be carried out.

(2) Permissible speed to be defined by the engine designer.

(3) Load points not applicable for the intended application may be omitted.

(4) The operating time at each load point, except for load point 1, is to correspond to the time required to achieve a steady state condition and to collect the operating data. Normally, an operating time of 0.5 hours is to be assumed per load point; however, sufficient time is to be included to allow for visual inspection by the Surveyor.

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
8.6 Handling after Approval 8.6.1 Notification of Approval 1 After the requirements in the preceding sections have been satisfactorily completed, the Society will issue a certificate of <u>type</u> approval specifying the approval number, date and conditions, etc. upon examination of the submitted documents and surveyor reports. 2 For dual fuel engines, the maximum continuous power available in gas mode is specified on the certificate of <u>type</u> approval in addition to the maximum continuous rating in diesel mode if differing. 3 <u>Where the Society does not carry out the manufacturer assessment of the engine as specified in 2.1.4-1(4), Part D of the Rules for the Survey and Construction of Steel Ships and compliance with it has not been verified, the Society will issue a “Design Evaluation Certificate” in lieu of the “Type Approval Certificate” referred to in -1 in cases where compliance with 8.1 to 8.5 has been satisfactorily verified.</u>	8.6 Handling after Approval 8.6.1 Notification of Approval 1 After the requirements in the preceding sections have been satisfactorily completed, the Society will issue a certificate of approval specifying the approval number, date and conditions, etc. upon examination of the submitted documents and surveyor reports. 2 For dual fuel engines, the maximum continuous power available in gas mode is specified on the certificate of approval in addition to the maximum continuous rating in diesel mode if differing. (Newly added)	-3.: UR M87, 5.7

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
<u>Annex 6.1 EXTENSION OF THE SCOPE OF AN ENGINE TYPE APPROVAL AND APPROVAL OF SUB-SYSTEMS</u> <u>1.1 Definitions and Concepts</u> <u>1 A sub-system can be an assembly of components belonging to an engine, intended to achieve a defined function and engine performance (output, emission behaviour, availability, etc.). Examples of sub-systems are electronical engine control systems, dual fuel systems of dual fuel engines, etc.</u> <u>2 The sub-system can be separately approved before integration into the engine, if required by Society or on a voluntary basis. Using this modular system may simplify the certification process, design approval and testing. It does not affect the definition of the engine type.</u> <u>3 The Society will evaluate whether an assembly of components is to be considered as a sub-system or as an integral part of the engine, and in the latter will require a type approval to be obtained.</u> <u>4 The engine designer can also choose type approval for the sub-system voluntarily, when they deem it is helpful to get an extension of the scope of engine type approval. Basic engine parts are not to be regarded as sub-systems. Examples of such parts are crankshafts, con-rods, pistons, camshafts, intake and exhaust valve actuating systems, etc.</u> <u>1.2 Extension of Scope of Engine Type Approval</u> <u>1 In cases where an extension of scope of engine type approval is requested to allow the incorporation of additional</u>	(Newly added) (Newly added) (Newly added) (Newly added) (Newly added) (Newly added) (Newly added) (Newly added)	UR M87, Appendix 2

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
or modified sub-systems, the scope of the type approval of the <u>Type Approval Certificate issued in accordance with 8.6.1, Part 6</u> may be extended in accordance with -2 to -4 below. The approval procedure is to be in accordance with Fig. 6.1-1. 2 Drawings and documents listed below, as applicable to the additional or modified sub-systems, are to be submitted to the Society for approval: (1) Drawings and documents specified in 8.2.2-1(2)(ac), Part 6 (2) Other drawings and documents deemed necessary by the Society 3 The additional or modified sub-systems are to be subjected to an integration test, in the presence of a surveyor, as required by <u>8.5.2-2(3)</u> and/or <u>8.5.2-2(6)(n), Part 6</u>, to verify that the response of the complete mechanical, hydraulic and electronic systems is as predicted for the engine manufacturer defined operational modes. Furthermore, on completion of the test, a test report is to be submitted to the Society (Head Office) for approval. This test may be carried out as a shop tests. 4 The Society will issue a new Type Approval Certificate for the engine concerned, based on the test report and the surveyor's report, after verifying compliance with <u>1.2</u> and other relevant requirements. 1.3 Type Approval of Sub-system 1 The type (design) approval of sub-systems for reciprocating internal combustion engines is to comply with the requirements specified in -2 to -4 below. 2 Depending on the sub-system to be approved, the following drawings and documents are to be submitted to and	(Newly added) (Newly added) (Newly added) (Newly added) (Newly added) (Newly added) (Newly added)	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
<u>approved by the Society:</u> (1) <u>Drawings and documents specified in 8.2.2-1(2)(ac), Part 6.</u> (2) <u>Other drawings and documents as may be required by the Society.</u> 3 <u>The sub-system to be approved is to be subjected to inspections and tests in the presence of a Surveyor of the Society.</u> (1) <u>The aim of the inspections and tests is as follows:</u> (a) <u>Examine and test the materials and workmanship and confirm that the sub-system has been manufactured and tested in accordance with the applicable Rules, applicable design requirements, national and international standards, and the manufacturer's specifications, insofar as they are applicable;</u> (b) <u>Demonstrate that the product is able to perform its intended function; and</u> (c) <u>Establish the performance characteristics of the product and its constituent components, where applicable.</u> (2) <u>The test requirements for the sub-system subject to approval are to be determined taking into consideration the following (a) to (d). The tests are to be adequate to demonstrate that the product complies with the safety, functional and performance requirements specified in the applicable standards, codes, specifications, etc. Upon completion of the tests, a test report is to be submitted to the Society (Head Office) for approval.</u> (a) <u>The relevant requirements applicable to the sub-system;</u>	(Newly added)	

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
(b) <u>Product specification of the sub-system and/or references to design codes, standards, regulations, etc. on which the manufacture of the sub-system is based;</u> (c) <u>Relevant design drawings with materials specified, catalogues, data sheets calculations, functional description.</u> (d) <u>Tests required by Failure Mode and Effects Analysis (FMEA), when applicable.</u> (3) <u>The tests specified in (2) may be replaced by a design analysis, provided that the following (a) to (c) conditions are satisfied:</u> (a) <u>There is evidence, in the form of performance measurement data from similar products, to validate the findings of the analysis;</u> (b) <u>The analysis method employed is well established and recognized as appropriate by the Society; and</u> (c) <u>It is mutually agreed that the tests specified in (2) cannot be performed or are inappropriate.</u> <u>4 An approval certificate may be issued by the Society for a sub-system of an engine which is considered acceptable by the Society, upon confirmation that it complies with 1.3 and other relevant requirements, based on the approved design, test report and surveyor's report.</u>	(Newly added)	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
<u>Fig. 6.1-1 Certification Process of Extended Type Approval for Engine Using Sub-system Concept</u> <pre> graph TD A[Application for extension of a Type approval of an engine with alternative sub-system] --> B{Sub-system approved} B -- Yes --> F[Design approval of engine (with sub-system)] B -- No --> C[Design approval of sub-system] C --> D[Type testing of sub-system
Manufacturer assessment] D --> E[Type approval certificate or
design evaluation certificate of
sub-system (optional)] E --> F F --> G[Integration test
(Extended factory acceptance test, typically)] G --> H[Issuance of Approval Certificate (One of the following)
• Extended engine type approval certificate
• Extended design evaluation certificate] </pre>		UR M87Appendix 2 Figure 2
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (C)		

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
Chapter 11 TYPE APPROVAL FOR EXHAUST DRIVEN TURBOCHARGERS 11.1 General 11.1.1 Scope 1 The requirements in this chapter apply to tests and inspection for the approval of use for new type exhaust driven turbochargers (hereinafter referred to as “turbochargers”) intended for installation for the first time on board ships which are classed or to be classed with the Society and which the engine power at maximum continuous rating (<i>MCR</i>) supplied by a group of cylinders served by the turbocharger is not less than 1000 <i>kW</i>, on the basis of the requirements in 2.7.4-6, Part D of the Rules for the Survey and Construction of Steel Ships and 2.7.4-6, Part 7, Rules for the Survey and Construction of Inland Waterway Ships. 11.2 Application 11.2.2 Documents The drawings and data required listed in (1) and (2) below, are to be submitted together with the application form specified in 11.2.1. (Deleted)	Chapter 11 TYPE APPROVAL FOR EXHAUST DRIVEN TURBOCHARGERS 11.1 General 11.1.1 Scope 1 The requirements in this chapter apply to tests and inspection for the approval of use for new type exhaust driven turbochargers (hereinafter referred to as “turbochargers”) intended for installation for the first time on board ships which are classed or to be classed with the Society and which the engine power at maximum continuous rating (<i>MCR</i>) supplied by a group of cylinders served by the turbocharger is not less than 1000 <i>kW</i>, on the basis of the requirements in 2.6.1-7, Part D of the Rules for the Survey and Construction of Steel Ships and 2.6.1-6, Part 7 of the Rules for the Survey and Construction of Inland Waterway Ships. 11.2 Application 11.2.2 Documents The drawings and data required <u>by 2.1.3-1(1) and (2), Part D of the Rules for the Survey and Construction of Steel Ships</u> applicable to the turbocharger which is intended for type approval as well as the data listed in (1) through (6) below, are to be submitted together with the application form specified in 11.2.1. <u>(1) Outline of the manufacturing plant</u> <u>(2) Information on the manufacture and quality control of</u>	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
(1) Drawings and data for approval: (a) Category <i>B</i> turbochargers i) Sectional assembly (including principal dimensions and materials of housing components for containment evaluation.) ii) Documentation of containment in the event of the disc fracture specified in 2.7.3-4, Part D of Rules for the Survey and Construction of Steel Ships iii) Material specifications (including mechanical properties and chemical composition) of the parts mentioned in ii) above iv) Documentation of following operational data and limitations 1) Maximum permissible operating speed (<i>rpm</i>) 2) Alarm level for overspeed 3) Maximum permissible exhaust gas temperature at the turbine inlet 4) Alarm level for exhaust gas temperature at the turbine inlet 5) Minimum lubrication oil inlet pressure 6) Lubrication oil inlet pressure low alarm set point	<u>the turbocharger</u> (3) <u>Records of manufacture and delivery of the turbocharger</u> (4) <u>Approval test plan (the place and scheduled date of the test are to be included)</u> (5) <u>Test records (when a preliminary test is carried out)</u> (6) <u>Other documents considered necessary by the Society</u>	

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
7) <u>Maximum lubrication oil outlet temperature</u> 8) <u>Lubrication oil outlet temperature high alarm set point</u> 9) <u>Maximum permissible vibration levels (self- and externally generated vibrations)</u> v) <u>Diagram of lubrication oil systems</u> vi) <u>Test report of type approval test</u> vii) <u>Test procedure (only for type approval tests)</u> (b) <u>Category C turbochargers</u> i) <u>Drawings listed in (a) above</u> ii) <u>Drawings of the housing and rotating parts (including details of blade fixing)</u> iii) <u>Welding details and welding procedures for the parts mentioned in ii) above, if made of welded construction</u> (2) <u>Drawings and data for reference:</u> (a) <u>Category C turbochargers</u> i) <u>Documentation of the safe torque transmission specified in 2.5.1-6, Part D of Rules for the Survey and Construction of Steel Ships when the disc is connected to the shaft by an interference fit</u> ii) <u>Information on expected lifespan (creep, low cycle fatigue and high cycle fatigue are to be considered)</u> iii) <u>Operation and maintenance manuals</u> <u>The documentation relating to the safety of torque transmission specified in i) and iii) above, as well as the operation and maintenance manuals, are to cover two types</u>		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
<u>of turbochargers within the same turbocharger series having a similar design.</u> <u>(b) Other drawings and data deemed necessary by the Society</u> 11.3 Preliminary Examination 11.3.2 Confirmation of Manufacturing and Quality Control Procedure <u>The</u> Society may carry out an inspection of the conditions of the manufacturing plant when deemed necessary.	11.3 Preliminary Examination 11.3.2 Confirmation of Manufacturing and Quality Control Procedure <u>On the basis of the data submitted in accordance with 11.2.2(1), (2) and (3), the</u> Society may carry out an inspection of the conditions of the manufacturing plant when deemed necessary.	
The effective date of the amendment is according to EFFECTIVE DATE AND APPLICATION (F)		

Amended-Original Requirements Comparison Table
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Amended	Original	Remarks
EFFECTIVE DATE AND APPLICATION (A)		
1. The effective date of the amendments is 1 January 2027.		
EFFECTIVE DATE AND APPLICATION (B)		
1. The effective date of the amendments is 1 January 2027.		Application of UR M78 (Rev.3) requirements for shop trials and onboard trials, and of UR M88 (New).
2. Notwithstanding the amendments, the current requirements apply to 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.		
注： IACS 統一基準（UR, UI, Rec 等）に基づく規則改正のみ, IACS PR No.29 を参照する。		
EFFECTIVE DATE AND APPLICATION (C)		
1. The effective date of the amendments is 1 January 2027.		Application of UR M44 (New), UR M71 (Rev.11) and requirements of UR M78 (Rev.3) relating to design, type

Amended-Original Requirements Comparison Table (Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
2. Notwithstanding the amendments, the current requirements apply to reciprocating internal combustion engines other than those for which the application for type approval is submitted to the Society on or after the effective date. EFFECTIVE DATE AND APPLICATION (D) 1. The effective date of the amendments is 1 January 2027. 2. Notwithstanding the amendments, the current requirements apply to reciprocating internal combustion engines other than those which fall under the following: (1) Reciprocating internal combustion engines for which the application for approval is submitted to the Society on or after the effective date. (2) Reciprocating internal combustion engines installed in 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.		approval tests and related matters, and of UR M87 (Rev.1). Application of UR M51 (Rev.5)
注： IACS 統一基準（UR, UI, Rec 等）に基づく規則改正のみ，IACS PR No.29 を参照する。		

Amended-Original Requirements Comparison Table
(Incorporation of IACS Unified Requirements for Reciprocating Internal Combustion Engines)

Amended	Original	Remarks
EFFECTIVE DATE AND APPLICATION (E) - The effective date of the amendments is 1 January 2027. - Notwithstanding the amendments, the current requirements apply to crankshafts other than those for which the application for approval is submitted to the Society on or after the effective date. EFFECTIVE DATE AND APPLICATION (F) - The effective date of the amendments is 1 January 2027. - Notwithstanding the amendments, the current requirements apply to exhaust driven turbochargers other than those for which the application for type approval is submitted to the Society on or after the effective date.		Application of UR M53 (Rev.6)