RULES FOR CLASSIFICATION OF STEEL SHIPS

(Development Review : External Opinion Inquiry)

Part 5 Machinery Installation

2021. 8.

Machinery Rule Development Team

- Main Amendments -

(1) Reflecting IACS URs <ships contracted for construction on or after 2021/07/01>

- ◉ UR F15 (Rev.6 Feb 2021)
- ◉ UR P2.7.4 (Rev.10 Jan 2021)
- ◉ UR P2.11 (Rev.5 Jan 2021)
- ◉ UR P2.12 (Rev.3 Feb 2021)
- ◉ UR P2.13 (Rev.1 Jan 2021)
- ◉ UR P4 (Rev.6 Feb 2021)

(2) Reflecting Requests for revision of rules <ships contracted for construction on or after 2021/07/01>

- ◉ Capacity of bilge pumps(TST4800-93-2021)

Present	Amendment	Reason
CHAPTER 6 AUXILIARIES AND PIPING ARRANGEMENT	**CHAPTER 6 AUXILIARIES AND PIPING ARRANGEMENT**	
Section 1 General	**Section 1 General**	
101. <omitted>	**101. <same as the present>**	
102. Pipes	**102. Pipes**	
1.to 5. <omitted>	**1.to 5. <same as the present>**	
6. Required wall thickness of pipes	**6. Required wall thickness of pipes**	
(1) The minimum wall thickness of steel pipes is not to be less than the greater of the minimum wall thickness calculated by Par 7 or the minimum wall thickness shown in Table 5.6.2. and 5.6.3.	(1) The minimum wall thickness of steel pipes is not to be less than the greater of the minimum wall thickness calculated by Par 7 or the minimum wall thickness shown in Table 5.6.2. and 5.6.3.	
Table 5.6.2 Minimum Wall Thickness for Steel Pipes (mm) [See Guidance]	**Table 5.6.2 Minimum Wall Thickness for Steel Pipes (mm) [See Guidance]**	
Nominal diameter (A) / Pipes in general / 1. Ballast piping passing through cargo tanks(1) 2. Cargo oil pipes passing through segregated ballast tanks(2)	Nominal diameter (A) / Pipes in general / 1. Ballast piping passing through cargo tanks(1) 2. Cargo oil pipes passing through segregated ballast tanks(2)	
NOTES: 1.to 5. <omitted> 6. (1) and (2) in this Table apply to the pipes passing through dangerous zone and the minimum wall thickness of following pipes is not to be less than 16 mm : (A) Overboard discharge pipes(bilge and ballast pipes) passing through cargo oil tanks. (B) In case where ballast pipes passing through cargo oil tanks are led to ballast tank located forward of the collision bulkhead. 7.to 8. <omitted>	NOTES: 1.to 5. <osame as the present> ~~6. (1) and (2) in this Table apply to the pipes passing through dangerous zone and the minimum wall thickness of following pipes is not to be less than 16 mm :~~ ~~(A) Overboard discharge pipes(bilge and ballast pipes) passing through cargo oil tanks.~~ ~~(B) In case where ballast pipes passing through cargo oil tanks are led to ballast tank located forward of the collision bulkhead.~~ 7.to 8. <same as the present>	〈UR F15 (Rev.6 Feb 2021)UL〉 – P2.7.4.9
<hereafter omitted>	<hereafter same as the present>	

Present	Amendment	Reason
103. Valves and fitting [See Guidance] <omitted>	**103. Valves and fitting** [See Guidance] <omitted>	
104. Type of connections **1. to 4. <omitted>** **5. Mechanical joints** ***(2017)*** These requirements are applicable to pipe unions, compression couplings, slip-on joints as shown in **Fig 5.6.2.** Similar joints complying with these requirements may be acceptable. (1)to (8) <omitted> (9) Slip-on joints are not to be used in pipelines in cargo holds, tanks, and other spaces which are not easily accessible, unless approved by the Classification Society. Application of these joints inside tanks may be permitted only for the same media that is in the tanks. Usage of slip type slip-on joints as the main means of pipe connection is not permitted except for cases where compensation of axial pipe deformation is necessary. (10) <omitted> <hereafter omitted>	**104. Type of connections** **1. to 4. <same as the present>** **5. Mechanical joints** ***(2017)*** These requirements are applicable to pipe unions, compression couplings, slip-on joints as shown in **Fig 5.6.2.** Similar joints complying with these requirements may be acceptable. (1)to (8) <same as the present> (9) Slip-on joints are not to be used in pipelines in cargo holds, tanks and other spaces which are not easily accessible (refer to MSC/Circ.734), except that these joints may be permitted in tanks that contain the same media. Usage of slip type slip-on joints as the main means of pipe connection is not permitted except for cases where compensation of axial pipe deformation is necessary. (10) <same as the present> <hereafter same as the present>	〈UR P2.7.4 (Rev.10 Jan 2021)〉 – P2.7.4.9

Present

Table 5.6.10 Application of Mechanical Joints

	Systems	Kind of connections		
		Pipe Unions	Compression Couplings	Slip-on joints
Flammable fluids (Flash point ≤ 60 °C)				
1	Cargo oil lines(4)	○	○	○
2	Crude oil washing lines(4)	○	○	○
3	Vent lines(3)	○	○	○
Inert Gas				
4	Water seal effluent lines	○	○	○
5	Scrubber effluent lines	○	○	○
6	Main lines(2)(4)	○	○	○
7	Distributions lines(4)	○	○	○
Flammable fluids (Flash point 〉 60 °C)				
8	Cargo oil lines(4)	○	○	○
9	Fuel oil lines(3)(2)	○	○	○
10	Lubricating oil lines(2)(3)	○	○	○
11	Hydraulic oil(2)(3)	○	○	○
12	Thermal oil(2)(3)	○	○	○

Amendment

Table 5.6.10 Application of Mechanical Joints

	Systems	Kind of connections				
		Pipe Unions	Compression Couplings	Slip-on joints	Classification of pipe system	Fire endurance test condition(7)
Flammable fluids (Flash point ≤ 60 °C)						
1	Cargo oil lines(1)	○	○	○	dry	30 min dry (*)
2	Crude oil washing lines(1)	○	○	○	dry	
3	Vent lines(3)	○	○	○	dry	
Inert Gas						
4	Water seal effluent lines	○	○	○	wet	30 min wet (*)
5	Scrubber effluent lines	○	○	○	wet	30 min wet (*)
6	Main lines(1)(2)	○	○	○	dry	30 min dry (*)
7	Distributions lines(1)	○	○	○	dry	30 min dry (*)
Flammable fluids (Flash point 〉 60 °C)						
8	Cargo oil lines(1)	○	○	○		30 min dry (*)
9	Fuel oil lines(2)(3)	○	○	○	wet	30 min wet (*)
10	Lubricating oil lines(2)(3)	○	○	○	wet	
11	Hydraulic oil(2)(3)	○	○	○	wet	
12	Thermal oil(2)(3)	○	○	○	wet	

Reason

〈UR P2.7.4 (Rev.10 Jan 2021)〉 – Table 7

Present

Table 5.6.10 Application of Mechanical Joints (continued)

Systems		Kind of connections		
		Pipe Unions	Compression Couplings	Slip-on joints
Sea water				
13	Bilge lines(1)	○	○	○
14	Water filled fire extinguishing systems, e.g. sprinkler systems(3)	○	○	○
15	Non water filled fire extinguishing systems, e.g. foam, drencher systems(3)	○	○	○
16	Fire main (not permanently filled)(3)	○	○	○
17	Ballast system(1)	○	○	○
18	Cooling water system(1)	○	○	○
19	Tank cleaning services	○	○	○
20	Non-essential systems	○	○	○

Amendment

Table 5.6.10 Application of Mechanical Joints (continued)

Systems		Kind of connections				
		Pipe Unions	Compression Couplings	Slip-on joints	Classification of pipe system	Fire endurance test condition(7)
Sea water						
13	Bilge lines(4)	○	○	○	dry/wet	8 min dry + 22 min wet (*)
14	Permanent water filled fire extinguishing systems, e.g. fire main, sprinkler systems(3)	○	○	○	wet	30 min wet (*)
15	Non-permanent water filled fire extinguishing systems, e.g. foam, drencher systems and fire main(3)	○	○	○	dry/wet	8 min dry + 22 min wet (*) For foam systems FSS Code Chapter 6 to be observed
~~16~~	~~Fire main (not permanently filled)(3)~~	~~○~~	~~○~~	~~○~~		
16	Ballast system(4)	○	○	○	wet	30 min wet (*)
17	Cooling water system(4)	○	○	○	wet	30 min wet (*)
18	Tank cleaning services	○	○	○	dry	Fire endurance test not required
19	Non-essential systems	○	○	○	dry dry/wet wet	Fire endurance test not required

Reason

Present

Table 5.6.10 Application of Mechanical Joints (continued)

	Systems	Kind of connections		
		Pipe Unions	Compression Couplings[6]	Slip-on joints
	Fresh water			
21	Cooling water system[1]	○	○	○
22	Condensate return[1]	○	○	○
23	Non-essential system	○	○	○
	Sanitary/Drains/Scuppers			
24	Deck drains (internal)[6]	○	○	○[4]
25	Sanitary drains	○	○	○
26	Scuppers and discharge (overboard)	○	○	-
	Sounding/Vent			
27	Water tanks/Dry spaces	○	○	○
28	Oil tanks (f.p. 〉 60 °C)[2][3]	○	○	○

Amendment

Table 5.6.10 Application of Mechanical Joints (continued)

	Systems	Kind of connections				
		Pipe Unions	Compression Couplings~~6~~	Slip-on joints	Classification of pipe system	Fire endurance test condition[7]
	Fresh water					
20	Cooling water system[4]	○	○	○	wet	30 min wet (*)
21	Condensate return[4]	○	○	○	wet	30 min wet (*)
22	Non-essential system	○	○	○	dry dry/wet wet	Fire endurance test not required
	Sanitary/Drains/Scuppers					
23	Deck drains (internal)[5]	○	○	○~~4~~	dry	Fire endurance test not required
24	Sanitary drains	○	○	○	dry	
25	Scuppers and discharge (overboard)	○	○		dry	
	Sounding/Vent					
26	Water tanks/Dry spaces	○	○	○	dry, wet	Fire endurance test not required
27	Oil tanks (f.p. 〉 60 °C)[2][3]	○	○	○	dry	

Reason

Present

Table 5.6.10 Application of Mechanical Joints (continued)

Systems		Kind of connections		
		Pipe Unions	Compression Couplings[6]	Slip-on joints
Miscellaneous				
29	Starting/Control air[1]	○	○	-
30	Service air (non-essential)	○	○	○
31	Brine	○	○	○
32	CO_2 system[1]	○	○	-
33	Steam	○	○	○[5]

Amendment

Table 5.6.10 Application of Mechanical Joints (continued)

Systems		Kind of connections				
		Pipe Unions	Compression Couplings[6]	Slip-on joints	Classification of pipe system	Fire endurance test condition[7]
Miscellaneous						
28	Starting/Control air[4]	○	○	-	dry	30 min dry (*)
29	Service air (non-essential)	○	○	○	dry	Fire endurance test not required
30	Brine	○	○	○	wet	
31	CO2 system (outside protected space)	○	○	-	dry	30 min dry (*)
32	CO2 system (inside protected space)	○	○	-	dry	Mechanical joints shall be constructed of materials with melting point above 925°C. Ref. to FSS Code Chapter 5.
33	Steam	○	○	○[5]	wet	Fire endurance test not required

Reason

Present	Amendment	Reason
Table 5.6.10 Application of Mechanical Joints (continued) Abbreviations ○ : Application is allowed, - : Application is not allowed NOTES - Fire resistance capability If mechanical joints include any components which readily deteriorate in case of fire, the following footnotes are to be observed: 1) Inside machinery spaces of category A - approved fire resistant types. 2) Slip on joints are not accepted Not inside machinery spaces of category A or accommodation spaces. May be accepted in other machinery spaces provided the joints are located in easily visible and accessible positions. provided the joints are located in easily visible and accessible positions. 3) Approved fire resistant types except in cases where such mechanical joints are installed on open decks, as defined in SOLAS II-2/Reg. 9.2.3.3.2.2(10) and not used for fuel oil lines. 4) In pump rooms and open decks - approved fire resistant types. NOTES - General 5) Slip type slip-on joints as shown in Fig 5.6.2. May be used for pipes on deck with a design pressure of 10 bar or less. 6) Only above bulkhead deck of passenger ships and freeboard deck of cargo ships.	**Table 5.6.10 Application of Mechanical Joints (continued)** Abbreviations ○ : Application is allowed, - : Application is not allowed, * : Fire endurance test as specified in **Ch 3, Sec 18, Table 3.18.2, 6.** of the **"Guidance for Approval of Manufacturing Process and Type Approval, Etc."** NOTES - Fire resistance capability If mechanical joints include any components which readily deteriorate in case of fire, the following footnotes are to be observed: 1) Fire endurance test shall be applied when mechanical joints are installed in pump rooms and open decks. 2) Slip on joints are not accepted Not inside machinery spaces of category A or accommodation spaces. May be accepted in other machinery spaces provided the joints are located in easily visible and accessible positions(refer to MSC/Circ.734). 3) Approved fire resistant types except in cases where such mechanical joints are installed on open decks, as defined in SOLAS II-2/Reg. 9.2.3.3.2.2(10) and not used for fuel oil lines. 4) Fire endurance test shall be applied when mechanical joints are installed inside machinery spaces of category A. NOTES - General 5) Only above bulkhead deck of passenger ships and freeboard deck of cargo ships. 6) Slip type slip-on joints as shown in Fig 5.6.2. May be used for pipes on deck with a design pressure of 10 bar or less. 7) If a connection has passed the "30 min dry" test, it is considered suitable also for applications for which the "8 min dry+22 min wet" and/or "30 min wet " tests are required. If a connection has passed the "8 min dry+22 min wet" test, it is considered suitable also for applications for which the "30 min wet" test is required.	

Present	Amendment	Reason
105. to 106. <omitted>	**105. to 106. <omitted>**	
107. General requirements for piping arrangement	**107. General requirements for piping arrangement**	
1. Installation	**1. Installation**	
<omitted>	<omitted>	
2. Protection of pipes and fittings	**2. Protection of pipes and fittings**	
(1) to (3) <omitted>	(1) to (3) <same as the present>	
(4) Seawater pipes located in cargo holds and in other spaces where pipes may be subject to impacts (e.g. fish holds, chain lockers), are to be protected from mechanical damage. *(2020)*	(4) Seawater pipes in cargo holds for dry cargoes, including cargo spaces of container ships, ro-ro ships, are to be protected from impact of cargo where they are liable to be damaged.*(2022)*	P2.13.1
<hereafter omitted>	<hereafter same as the present>	

Present	Amendment	Reason
Section 4 Bilge and Ballast System	**Section 4 Bilge and Ballast System**	
401. to 404. <omitted>	**401. to 404. <same as the present>**	(TST4800-93-2021)
405. Bilge pumps [See Guidance] **1. Number of pumps** <omitted> **2. Capacity of pumps** (1) The capacity, Q, of each bilge pumping unit or bilge pump is not to be less than that required by the following formula. $Q = 5.66 d_m^2 10^{-3}$ (m^3/hr) where: d_m = Required internal diameter of main bilge line (mm) (2) <omitted> <hereafter omitted>	**405. Bilge pumps [See Guidance]** **1. Number of pumps** <same as the present> **2. Capacity of pumps** (1) The capacity, Q, of each bilge pumping unit or bilge pump is not to be less than that required by the following formula. $Q = 5.66 d_m^2 10^{-3}$ (m^3/hr) where: d_m = Required internal diameter of main bilge line in accordance with **404.1** or required internal diameter(d_{m0}) of main bilge line in accordance with **404.3** (mm) (2) <same as the present> <hereafter same as the present>	

- Main Amendments -

(1) Reflecting IACS URs <ships contracted for construction on or after 2021/07/01>

◉ UR P2.12 (Rev.3 Feb 2021)

Present	Amendment	Reason
CHAPTER 1 GENERAL **Section 1 General** **101. <omitted>** **102. Definitions** **1. to 22.** <omitted> **23. Flexible hose assembly** is the short length of metallic or non-metallic hose normally with pre fabricated end fittings ready for installation. <hereafter omitted>	**CHAPTER 1 GENERAL** **Section 1 General** **101. <omitted>** **102. Definitions** **1. to 22.** <omitted> **23. Flexible hose assembly** is the short length of metallic or non-metallic hose normally with pre fabricated end fittings ready for installation. Note: Flexible hose assemblies for essential services or containing either flammable or toxic media are not to exceed 1.5 m in length. <hereafter same as the present>	P2.12.1

GUIDANCE RELATING TO RULES FOR CLASSIFICATION OF STEEL SHIPS

(Development Review : External Opinion Inquiry)

Part 5 Machinery Installation

2021. 8.

Machinery Rule Development Team

- Main Amendments -

(1) Reflecting IACS URs <ships contracted for construction on or after 2021/07/01>

◉ UR P2.12 (Rev.3 Feb 2021)

Present	Amendment	Reason
Annex 5-9 Flexible Pipes	**Annex 5-9 Flexible Pipes**	
1. <omitted>	**1. <same as the present>**	
2. Design and construction (1) to (5) <omitted> (6) Flexible pipe assemblies constructed of non-metallic materials in tended for installation in piping systems for flammable media and sea water systems where failure may result in flooding, are to be of fire-resistant type except in cases where such pipes are installed on open decks, as defined in SOLAS II-2/Reg. 9.2.3.3.2.2(10) and not used for fuel oil lines. Fire resistance is to be demonstrated by testing to ISO 15540(or KS V 0820) and ISO 15541(or KS V 0821). (7) <omitted> <hereafter omitted>	**2. Design and construction** (1) to (5) <same as the present> (6) Flexible pipe assemblies constructed of non-metallic materials in tended for installation in piping systems for flammable media and sea water systems where failure may result in flooding, are to be of fire-resistant type except in cases where such pipes are installed on open decks, as defined in Regulation 9.2.3.3.2.2(10) of SOLAS Chapter II-2 as amended by IMO resolutions up to MSC.421(98) and not used for fuel oil lines. Fire resistance is to be demonstrated by testing to ISO 15540(or KS V 0820) and ISO 15541(or KS V 0821). (7) <same as the present> <hereafter same as the present>	P2.12.3

- Main Amendments -

(1) Reflecting Requests for revision of rules <ships contracted for construction on or after 2021/07/01>

◉ Air pipe installation (ENP4800-3819-2021)

Present	Amendment	Reason
CHAPTER 6 AUXILIARIES AND PIPING ARRANGEMENT **Section 1 General** <omitted> **Section 2 Air Pipes, Overflow Pipes and Sounding Devices** **201. Air pipes** **1. to 3. <omitted>** **4. Size of air pipes** 【See Rule】 In application to 201. 4 (1) of the Rules, the air pipes for the tank is provided with an overflow pipe are to comply with the following. (1) Where the aggregated sectional area of overflow pipes in the tank is greater than 1.25 times the effective area of the filling pipes, the air pipes may be omitted. In this time, the sectional area of air pipes in the overflow tank is not less than the aggregated sectional area of overflow pipes. (2) to (3) <omitted> <hereafter omitted>	**CHAPTER 6 AUXILIARIES AND PIPING ARRANGEMENT** **Section 1 General** <same as the present> **Section 2 Air Pipes, Overflow Pipes and Sounding Devices** **201. Air pipes** **1. to 3. <same as the present>** **4. Size of air pipes** 【See Rule】 In application to 201. 4 (1) of the Rules, the air pipes for the tank is provided with an overflow pipe are to comply with the following. (1) Where the aggregated sectional area of overflow pipes in the tank, which are not fitted with valves impeding air flow, is greater than 1.25 times the effective area of the filling pipes, the air pipes may be omitted. In this time, the sectional area of air pipes in the overflow tank is not less than the aggregated sectional area of overflow pipes. (2) to (3) <same as the present> <hereafter same as the present>	- to consider installation of check valve in the overflow lines

- Main Amendments -

(1) Reflecting IACS URs <ships contracted for construction on or after 2021/07/01>

◉ UR P4 (Rev.6 Feb 2021)

Present	Amendment	Reason
Annex 5-6 Plastic Piping System	**Annex 5-6 Plastic Piping System**	- UR P4 (Rev.6 Feb 2021)
1. to 3. <omitted>	**1. to 3.** <omitted>	
4. General requirements	**4. General requirements**	
The specification of piping is to be in accordance with a recognised national or international standard approved by the Society. In addition, the following requirements apply:	The specification of piping is to be in accordance with a recognised national or international standard approved by the Society. In addition, the following requirements apply:	
(1) Strength	(1) Strength	
(A) to (D) <omitted>	(A) to (D) <omitted>	
(E) External pressure(for any installation which may be subject to vacuum conditions inside the pipe or a head of liquid acting on the outside of the pipe; and for any pipe installation required to remain operational in case of flooding damage, as per Regulation II-1/8-1 of SOLAS 1974 Convention, as amended, or for any pipes that would allow progressive flooding to other compartments through damaged piping or through open ended pipes in the compartments). External pressure is to be determined by the following.	(E) External pressure(for any installation which may be subject to vacuum conditions inside the pipe or a head of liquid acting on the outside of the pipe; and for any pipe installation required to remain operational in case of flooding damage, as per Regulation 8-1 of SOLAS Chapter II-1, as amended by IMO resolutions up to MSC.436(99), or for any pipes that would allow progressive flooding to other compartments through damaged piping or through open ended pipes in the compartments). External pressure is to be determined by the following.	4.3.1.3 (ii)
<hereafter omitted>	<hereafter omitted>	
(2) to (3) <omitted>	(2) to (3) <omitted>	
(4) Temperature	(4) Temperature	
(A) The design temperature depending on the working pressure is to be in accordance with Manufacturer's recommendations, but in each case it is to be at least 20 ℃ lower than the minimum heat distortion/deflection temperature of the pipe material, determined according to *ISO 75* method A, or equivalent.	(A) The design temperature depending on the working pressure is to be in accordance with Manufacturer's recommendations, but in each case it is to be at least 20 ℃ lower than the minimum heat distortion/deflection temperature of the pipe material, determined according to *ISO 75-2:2013* method A, or equivalent e.g. *ASTM D648-18*.	4.3.4.1
(B) The minimum heat distortion/deflection temperature is to be not less than 80 ℃.	(B) The minimum heat distortion/deflection temperature is to be not less than 80 ℃.	
<hereafter omitted>	<hereafter omitted>	

Present	Amendment	Reason
5. Requirements for pipes/piping systems depending on service and/or locations (1) Fire endurance (A) Pipes and their associated fittings whose integrity is essential to the safety of ships are required to meet the minimum fire endurance requirements of Appendix 1 or 2, as applicable, of IMO Res A.753 (18). (B) Depending on the capability of a piping system to maintain its strength and integrity, there exist three different levels of fire endurance for piping systems. (a) Level 1(L1) : Piping having passed the fire endurance test specified in Appendix 1 of IMO Res. A.753(18), as amended by IMO Res. MSC. 313(88) and IMO Res. MSC. 399(95) for a duration of a minimum of one hour without loss of integrity in the dry condition is considered to meet level 1 fire endurance standard (L1). Level 1W – Piping systems similar to Level 1 systems except these systems do not carry flammable fluid or any gas and a maximum 5% flow loss in the system after exposure is acceptable (L1W).	**5. Requirements for pipes/piping systems depending on service and/or locations** (1) Fire endurance (A) Pipes and their associated fittings whose integrity is essential to the safety of ships, including plastic piping required by Regulation 21.4 of SOLAS Chapter II-2 as amended by IMO Resolutions up to MSC.421(98) (hereinafter the same) to remain operational after a fire casualty, are required to meet the minimum fire endurance requirements of Appendix 1 or 2, as applicable, of IMO Resolution A.753(18), as amended by IMO Resolutions. MSC.313(88) and MSC.399(95). (B) Depending on the capability of a piping system to maintain its strength and integrity, there exist three different levels of fire endurance for piping systems. (a) Level 1(L1) : Piping having passed the fire endurance test specified in Appendix 1 of IMO Resolution A.753(18), as amended by IMO Resolutions MSC.313(88) and MSC.399(95) for a duration of a minimum of one hour without loss of integrity in the dry condition is considered to meet level 1 fire endurance standard (L1). Level 1W – Piping systems similar to Level 1 systems except these systems do not carry flammable fluid or any gas and a maximum 5% flow loss in the system after exposure is acceptable (L1W).	4.4.1

Present	Amendment	Reason
(b) Level 2(L2) : Piping having passed the fire endurance test specified in Appendix 1 of IMO Res. A.753(18), as amended by IMO Res. MSC. 313(88) and IMO Res. MSC. 399(95) for a duration of a minimum of 30 minutes in the dry condition is considered to meet level 2 fire endurance standard (L2). Level 2W – Piping systems similar to Level 2 systems except a maximum 5% flow loss in the system after exposure is acceptable (L2W). (c) Level 3(L3) : Piping having passed the fire endurance test specified in Appendix 2 of IMO Res. A .753 (18) for a duration of a minimum of 30 *minutes* in the wet condition is considered to meet level 3 fire endurance standard. (C) Permitted use of piping depending on fire endurance, location and piping system is given in **Table 1**. (D) For Safe Return to Port purposes (SOLAS II-2, Reg.21.4), plastic piping can be considered to remain operational after a fire casualty if the plastic pipes and fittings have been tested to L1 standard.	(b) Level 2(L2) : Piping having passed the fire endurance test specified in Appendix 1 of IMO Resolution A.753(18), as amended by IMO Resolution MSC. 313(88) and MSC. 399(95) for a duration of a minimum of 30 minutes in the dry condition is considered to meet level 2 fire endurance standard (L2). Level 2W – Piping systems similar to Level 2 systems except a maximum 5% flow loss in the system after exposure is acceptable (L2W). (c) Level 3(L3) : Piping having passed the fire endurance test specified in Appendix 2 of IMO Resolution A.753(18) as amended by IMO Resolutions MSC.313(88) and MSC.399(95) for a duration of a minimum of 30 minutes in the wet condition is considered to meet level 3 fire endurance standard. (C) Permitted use of piping depending on fire endurance, location and piping system is given in **Table 1**. (D) For Safe Return to Port purposes (Regulation. 21.4 of SOLAS Chapter II-2), plastic piping can be considered to remain operational after a fire casualty if the plastic pipes and fittings have been tested to L1 standard.	

Present	Amendment	Reason

Table 1 Fire Endurance Requirements Matrix

Piping system	Location[13]										
	A	B	C	D	E	F	G	H	I	J	K
	Machinery spaces of category A	Other machinery spaces & pump rooms	Cargo pump rooms	Ro/Ro cargo holds	Other dry cargo holds	Cargo tanks	Fuel oil tanks	Ballast water tanks	Coffer dams void spaces pipe tunnel & ducts	Accommodation service & control spaces	Open decks
Cargo (Flammable cargos, f.p ≤ 60 °C) <omitted> Inert gas <omitted> Flammable liquids (f.p > 60 °C) <omitted> Seawater[1] <omitted> Freshwater <omitted> Sanitary/Drain/Scuppers <omitted>											

Table 1 Fire Endurance Requirements Matrix

Piping system	Location[13]										
	A	B	C	D	E	F	G	H	I	J	K
	Machinery spaces of category A	Other machinery spaces & pump rooms	Cargo pump rooms	Ro/Ro cargo holds	Other dry cargo holds	Cargo tanks	Fuel oil tanks	Ballast water tanks	Coffer dams void spaces pipe tunnel & ducts	Accommodation service & control spaces	Open decks
Cargo (Flammable cargos, f.p ≤ 60 °C) <omitted> Inert gas <omitted> Flammable liquids (f.p > 60 °C) <omitted> Seawater[1] <omitted> Freshwater <omitted> Sanitary/Drain/Scuppers <omitted>											

Present	Amendment	Reason
Table 1 Fire Endurance Requirements Matrix (continued)	**Table 1 Fire Endurance Requirements Matrix (continued)**	

Abbreviations :

L1 Fire endurance test (IMO Resolution A.753(18), Appendix 1, as amended by IMO Res. MSC. 313(88) and IMO Res. MSC. 399(95)) in dry conditions, 60 min.

L1W Fire endurance test(5.(1))

L2 Fire endurance test (IMO Resolution A.753(18), Appendix 1, as amended by IMO Res. MSC. 313(88) and IMO Res. MSC. 399(95)) in dry conditions, 30 min.

L2W Fire endurance test(5.(1))

L3 Fire endurance test (IMO Resolution A.753(18), Appendix 2, as amended by IMO Res. MSC. 313(88) and IMO Res. MSC. 399(95)) in wet conditions, 30 min.

0 No fire endurance test required

NA Not applicable

X Metallic materials having a melting point greater than 925 °C

Footnotes :

1. Where non-metallic piping is used, remotely controlled valves to be provided at ship's side (valve is to be controlled from outside space).
2. Remote closing valves to be provided at the cargo tanks.
3. When cargo tanks contain flammable liquids with f.p. > 60 °C, "O may replace "NA or "X".
4. For drains serving only the space concerned, "O may replace "L1W"
5. When controlling functions are not required by statutory requirements or guidelines, "O may replace "L1"
6. For pipe between machinery space and deck water seal, "O may replace "L1"
7. For passenger vessels, "X is to replace "L1".

Abbreviations :

L1 Fire endurance test (appendix 1 of IMO Resolution A.753(18), as amended by IMO Resolution MSC. 313(88) and MSC. 399(95)) in dry conditions, 60 min.

L1W Fire endurance test(5.(1))

L2 Fire endurance test (appendix 1 of IMO Resolution A.753(18), as amended by IMO Resolution MSC. 313(88) and MSC. 399(95)) in dry conditions, 30 min.

L2W Fire endurance test(5.(1))

L3 Fire endurance test (IMO Resolution A.753(18), Appendix 2, as amended by IMO Resolution MSC. 313(88) and MSC. 399(95)) in wet conditions, 30 min.

0 No fire endurance test required

NA Not applicable

X Metallic materials having a melting point greater than 925 °C

Footnotes :

1. Where non-metallic piping is used, remotely controlled valves to be provided at ship's side (valve is to be controlled from outside space).
2. Remote closing valves to be provided at the cargo tanks.
3. When cargo tanks contain flammable liquids with f.p. > 60 °C, "O may replace "NA or "X".
4. For drains serving only the space concerned, "O may replace "L1W"
5. When controlling functions are not required by statutory requirements or guidelines, "O may replace "L1"
6. For pipe between machinery space and deck water seal, "O may replace "L1"
7. For passenger vessels, "X is to replace "L1".

Present	Amendment	Reason
Table 1 Fire Endurance Requirements Matrix (continued) 8. Scuppers serving open decks in positions 1 and 2, as defined in regulation 13 of the International Convention on Load Lines, 1966, are to be "X throughout unless fitted at the upper end with the means of closing capable of being operated from a position above the freeboard deck in order to prevent downflooding. 9. For essential services, such as fuel oil tank heating and ship's whistle, "X is to replace "O". 10. For tankers where compliance with paragraph 3.6 of regulation 19 of Annex I of MARPOL 73/78 as amended is required, "NA is to replace "O". 11. L3 in service spaces, NA in accommodation and control spaces. 12. Type Approved plastic piping without fire endurance test(0) is acceptable downstream of the tank valve, provided this valve is metal seated and arranged as fail-to-closed or with quick closing from a safe position outside the space in the event of fire. 13. For Passenger Ships subject to SOLAS II-2, Reg.21.4 (Safe return to Port), plastic pipes for services required to remain operative in the part of the ship not affected by the casualty thresholds, such as systems intended to support safe areas, are to be considered essential services. In accordance with MSC Circular MSC.1/Circ.1369, interpretation 12, for Safe Return to Port purposes, plastic piping can be considered to remain operational after a fire casualty if the plastic pipes and fittings have been tested to L1 standard.	**Table 1 Fire Endurance Requirements Matrix (continued)** 8. Scuppers serving open decks in positions 1 and 2, as defined in Regulation 13 of Protocol of 1988 relating to the International Convention on Load Lines, 1966, as amended by IMO Resolutions up to MSC.375(93), are to be "X throughout unless fitted at the upper end with the means of closing capable of being operated from a position above the freeboard deck in order to prevent downflooding. 9. For essential services, such as fuel oil tank heating and ship's whistle, "X is to replace "O". 10. For tankers where compliance with paragraph 3.6 of regulation 19 of MARPOL Annex I, as amended by IMO Resolutions up to MEPC.314(74) is required, "NA is to replace "O". 11. L3 in service spaces, NA in accommodation and control spaces. 12. Type Approved plastic piping without fire endurance test(0) is acceptable downstream of the tank valve, provided this valve is metal seated and arranged as fail-to-closed or with quick closing from a safe position outside the space in the event of fire. 13. For Passenger Ships subject to Regulation. 21.4 of SOLAS Chapter II-2 (Safe return to Port), plastic pipes for services required to remain operative in the part of the ship not affected by the casualty thresholds, such as systems intended to support safe areas, are to be considered essential services. In accordance with MSC.1/Circ.1369, interpretation 12, for Safe Return to Port purposes, plastic piping can be considered to remain operational after a fire casualty if the plastic pipes and fittings have been tested to L1 standard.	

Present	Amendment	Reason
Table 1 Fire Endurance Requirements Matrix (continued)	**Table 1 Fire Endurance Requirements Matrix (continued)**	
Location definitions - A (Machinery spaces of category A) : Machinery spaces of category A as defined in SOLAS* regulation II-2/3.31. - B (Other machinery spaces and pump rooms) : Spaces, other than category A machinery spaces and cargo pump rooms, containing propulsion machinery, boilers, fuel oil unit, steam and internal combustion engines, generators and major electrical machinery, oil filling stations, refrigerating, stabilizing, ventilation and air-conditioning machinery, and similar spaces, and trunks to such spaces. - C (Cargo pump rooms) : Spaces containing cargo pumps and entrances and trunks to such spaces. - D (Ro-ro cargo holds) : Ro-Ro cargo holds are Ro-Ro cargo spaces and special category spaces as defined in SOLAS* regulation II-2/3.41 and 3.46. - E (Other dry cargo holds) : All spaces other than Ro-Ro cargo holds used for non-liquid cargo and trunks to such spaces. - F (Cargo tanks) : All spaces used for liquid cargo and trunks to such spaces. - G (Fuel oil tanks) : All spaces used for fuel oil (excluding cargo tanks) and trunks to such spaces. - H (Ballast water tanks) : All spaces used for ballast water and trunks to such spaces. - I (Cofferdams, voids, etc.) : Cofferdams and voids are those empty spaces between two bulkheads separating two adjacent compartments. - J (Accommodation, service) : Accommodation spaces, service spaces and control stations as defined in SOLAS * regulation II-2/3.1, 3.45, 3.18 - K (Open decks) : Open deck spaces as defined in SOLAS* regulation II-2/9.2.2.3.2.(5). * SOLAS 1974 Convention, as amended.	Location definitions - A (Machinery spaces of category A) : Machinery spaces of category A as defined in SOLAS* regulation II-2/3.31. - B (Other machinery spaces and pump rooms) : Spaces, other than category A machinery spaces and cargo pump rooms, containing propulsion machinery, boilers, fuel oil unit, steam and internal combustion engines, generators and major electrical machinery, oil filling stations, refrigerating, stabilizing, ventilation and air-conditioning machinery, and similar spaces, and trunks to such spaces. - C (Cargo pump rooms) : Spaces containing cargo pumps and entrances and trunks to such spaces. - D (Ro-ro cargo holds) : Ro-Ro cargo holds are Ro-Ro cargo spaces and special category spaces as defined in SOLAS* regulation II-2/3.41 and 3.46. - E (Other dry cargo holds) : All spaces other than Ro-Ro cargo holds used for non-liquid cargo and trunks to such spaces. - F (Cargo tanks) : All spaces used for liquid cargo and trunks to such spaces. - G (Fuel oil tanks) : All spaces used for fuel oil (excluding cargo tanks) and trunks to such spaces. - H (Ballast water tanks) : All spaces used for ballast water and trunks to such spaces. - I (Cofferdams, voids, etc.) : Cofferdams and voids are those empty spaces between two bulkheads separating two adjacent compartments. - J (Accommodation, service) : Accommodation spaces, service spaces and control stations as defined in SOLAS * regulation II-2/3.1, 3.45, 3.18 - K (Open decks) : Open deck spaces as defined in SOLAS* regulation II-2/9.2.2.3.2.(5). * SOLAS Chapter II-2 as amended by IMO Resolutions up to MSC.421(98)	

Present	Amendment	Reason
(2) Flame spread (A) All pipes, except those fitted on open decks and within tanks, cofferdams, pipe tunnels and ducts if separated from accommodation, permanent manned areas and escape ways by means of an A class bulkhead are to have low surface flame spread characteristics not exceeding average values specified in **Ch 3, 2604. 3** of the **"Guidance for Approval of Manufacturing Process and Type Approval, etc.".** (B) Surface flame spread characteristics are to be determined using the procedure specified in **Ch 3, 2604. 3** of the **"Guidance for Approval of Manufacturing Process and Type Approval, etc."** with regard to the modifications due to the curvilinear pipe surfaces as listed in Appendix 3 of IMO Resolution A.753 (18). (C) Surface flame spread characteristics may also be determined using the text procedures given in national or international standards. (3) to (6) <omitted>	(2) Flame spread (A) All pipes, except those fitted on open decks and within tanks, cofferdams, pipe tunnels and ducts if separated from accommodation, permanent manned areas and escape ways by means of an A class bulkhead are to have low surface flame spread characteristics not exceeding average values specified in **Ch 3, 2604. 3** of the **"Guidance for Approval of Manufacturing Process and Type Approval, etc.".** (B) Surface flame spread characteristics are to be determined using the procedure specified in Ch 3, 2604. 3 of the "Guidance for Approval of Manufacturing Process and Type Approval, etc." with regard to the modifications due to the curvilinear pipe surfaces as listed in Appendix 3 of IMO Resolution A.753 (18), as amended by IMO Resolutions MSC.313(88) and MSC.399(95). (C) Surface flame spread characteristics may also be determined using the test procedures given in ASTM D635-18, or in other national or international equivalent standards. Under the procedure of ASTM D635-18 a maximum burning rate of 60 mm/min applies. In case of adoption of other national equivalent standards, the relevant acceptance criteria are to be defined. (3) to (6) <omitted>	- 4.2.2.1 - 4.4.2.2 - 4.4.2.3

RULES FOR CLASSIFICATION(STEEL SHIPS)

Part 5 MACHINERY INSTALLATIONS

2022. 02.

Machinery Rule Development Team

- Main Amendments -

(1) Effective date : 1 Jul. 2022 (Date of which contracts for construction are signed)

- ◉ Auxiliary related to the purpose of ships has been deleted from the definition of essential auxiliary boiler.
- ◉ Burning systems for boilers has been added in plans and documents to be submitted by the manufacturers of boilers.
- ◉ The regulation of prohibiting the keyway for propellers fixing in installations with a barred speed range has been deleted.
- ◉ It has been amended to apply the regulations of Chapter 4 with appropriate modifications to the shaft system of essential auxiliaries driven by reciprocating internal combustion engine.
- ◉ The design pressure limitation on the use of nodular graphite cast iron in the material of the body of the pressure vessel has been deleted.

Present	Amendment	Note
# CHAPTER 1 GENERAL ## Section 1 General **101. 〈omitted〉** **102. Definitions** **1. ~ 5. 〈omitted〉** **6. Boiler** is the plant which generates steam or hot water by means of flame, combustion gas or other hot gases, including the equipment subject to a boiler. **7. Main boiler** means the boiler used in moving the propulsion steam engines. **8. Essential auxiliary boiler** means the auxiliary boiler other than the main boiler, which is used in supplying steam need for operating generators, auxiliary machinery in relation to the propulsion of ships, safety of lives and ships or the purpose of ships. (hereafter, omitted)	# CHAPTER 1 GENERAL ## Section 1 General **101. 〈same as the present〉** **102. Definitions** **1. ~ 5. 〈same as the present〉** **6. Boiler** is the plant which generates steam or hot water by means of flame, combustion gas or other hot gases, including the equipment subject to a boiler. **7. Main boiler** means the boiler used in moving the propulsion steam engines. **8. Essential auxiliary boiler** means the auxiliary boiler other than the main boiler, which is used in supplying steam need for operating generators, auxiliary machinery in relation to the propulsion of ships, safety of lives and ships ~~or the purpose of ships~~. *(2022)* (hereafter, same as the present Rules)	(Amendment) Reflect Request for Establishment/Revision of Classification Technical Rules 'MAM4300-1943-2020' 〈application date: the date of contract for construction on or after 1 July 2022〉 - In line with the definition of essential auxiliaries, auxiliary related to the purpose of ships has been deleted from the definition of essential auxiliary boiler.

Present	Amendment	Note
CHAPTER 1 GENERAL	**CHAPTER 1 GENERAL**	
Section 2 Plans and Documents	**Section 2 Plans and Documents**	(Amendment) Reflect Request for Establishment/Revision of Classification Technical Rules 'MAM4300-1943-2020' 〈application date: the date of contract for construction on or after 1 July 2022〉
201. ~ 207. 〈omitted〉	**201. ~ 207. 〈same as the present〉**	
208. Plans and documents to be submitted by the manufacturers of boilers, Class 1 and 2 pressure vessels 【See Guidance】 **1. Plans for approval** (1) General arrangement of boiler and pressure vessel. (2) Details of boiler shells and headers. (3) Details of washers for mountings and nozzles. (4) Arrangement and details for boiler tubes, superheater, reheater, economizer and/or exhaust gas heater. (5) Arrangement or its diagrams for air preheater and boiler mountings. (6) Assembly of safety valve and assembly of relief valve. (7) Welding details of main component parts. (8) Detail of bursting disk (if installed) (9) 〈new〉	**208. Plans and documents to be submitted by the manufacturers of boilers, Class 1 and 2 pressure vessels 【See Guidance】** **1. Plans for approval** (1) General arrangement of boiler and pressure vessel. (2) Details of boiler shells and headers. (3) Details of washers for mountings and nozzles. (4) Arrangement and details for boiler tubes, superheater, reheater, economizer and/or exhaust gas heater. (5) Arrangement or its diagrams for air preheater and boiler mountings. (6) Assembly of safety valve and assembly of relief valve. (7) Welding details of main component parts. (8) Detail of bursting disk (if installed) (9) Burning systems for boilers *(2022)*	- Burning systems for boilers are essential auxiliary and there is a requirements for burning systems for boilers in Pt 5, Ch 6 902. of the Rules, but there are no requirements for drawings to be submitted.
(hereafter, omitted)	(hereafter, same as the present Rules)	

Present	Amendment	Note
CHAPTER 3 PROPULSION SHAFTING AND POWER TRANSMISSION SYSTEMS **Section 2 Shaftings** **201. ~ 203. 〈omitted〉** **204. Propeller shaft and stern tube shaft** **1. ~ 4. 〈omitted〉** **5. Key of propeller shaft fixing of propellers (2018)** (1) Keyways are not to be used in installations with a barred speed range. (2) Key and keyway Where a key is provided to the taper part of the propeller shaft, the key is to be tightly fitted in the keyway and to be secured by use of a set bolt. The fillet radius at the bottom of the keyway is to be not less than 1.25 % of the actual propeller shaft diameter at the large end of the cone. The forward end of the keyway is in general to be made a spoon shaped ending and the distance from the large end of the propeller shaft cone to the forward end of the key is to be not less than 20 % of the actual propeller shaft diameter in way of the large end of the cone. For fitting part of small ship's propeller, it may be complied with *KS V*4811. (3) ~ (4) 〈omitted〉 (hereafter, omitted)	**CHAPTER 3 PROPULSION SHAFTING AND POWER TRANSMISSION SYSTEMS** **Section 2 Shaftings** **201. ~ 203. 〈same as the present〉** **204. Propeller shaft and stern tube shaft** **1. ~ 4. 〈same as the present〉** **5. Key of propeller shaft fixing of propellers (2018)** ~~(1) Keyways are not to be used in installations with a barred speed range.~~ (1) Key and keyway Where a key is provided to the taper part of the propeller shaft, the key is to be tightly fitted in the keyway and to be secured by use of a set bolt. The fillet radius at the bottom of the keyway is to be not less than 1.25 % of the actual propeller shaft diameter at the large end of the cone. The forward end of the keyway is in general to be made a spoon shaped ending and the distance from the large end of the propeller shaft cone to the forward end of the key is to be not less than 20 % of the actual propeller shaft diameter in way of the large end of the cone. For fitting part of small ship's propeller, it may be complied with *KS V*4811. (2) ~ (3) 〈same as the present〉 (hereafter, same as the present Rules)	(Amendment) Reflect Request for Establishment/Revision of Classification Technical Rules 'MAM4300-681-2021' 〈application date: the date of contract for construction on or after 1 July 2022〉 - When a barred speed range is set, the use of the keyway is not allowed because the intermediate shaft becomes a node point of one node torsional vibration, but the propeller shaft fixing part is a node point of two node torsional vibration, and the stress level is lower than that of one node, so prohibiting the keyway is considered to be excessive.

Present	Amendment	Note
# CHAPTER 4 TORSIONAL VIBRATION OF SHAFTINGS ## Section 1 General **101. Application** **1.** The requirements of this Chapter apply to power transmission systems for propulsion and propulsion shafting systems, shafting systems to transmit power from main engines to generators, crankshafts of diesel engines used as main engines and shafting systems of generators driven by diesel engines. **2.** Where alternative calculation methods other than this section are used for calculating dimensions of allowable torsional vibration stresses, they are to be complied with the requirements in **Ch 3, 201.2.** (hereafter, omitted)	# CHAPTER 4 TORSIONAL VIBRATION OF SHAFTINGS ## Section 1 General **101. Application** **1.** The requirements of this Chapter apply to power transmission systems for propulsion and propulsion shafting systems, shafting systems to transmit power from main engines to generators, crankshafts of reciprocating internal combustion engines used as main engines and shafting systems of generators driven by reciprocating internal combustion engines. In addition, the requirements of this chapter apply with appropriate modifications to the shaft systems of the essential auxiliaries driven by reciprocating internal combustion engines. *(2022)* **2.** Where alternative calculation methods other than this section are used for calculating dimensions of allowable torsional vibration stresses, they are to be complied with the requirements in **Ch 3, 201.2.** (hereafter, same as the present Rules)	(Amendment) Reflect Request for Establishment/Revision of Classification Technical Rules 'MAM4300-682-2021' 〈application date: the date of contract for construction on or after 1 July 2022〉 - Shaft damage due to torsional vibration may cause loss of function of essential auxiliaries, so the provisions of this chapter should be applied with appropriate modifications to the shaft system of essential auxiliaries driven by reciprocating internal combustion engine. - Diesel engines were modified with reciprocating internal combustion engines as engines of various low flash point fuels appear.

Present	Amendment	Note
CHAPTER 5 BOILERS AND PRESSURE VESSELS **Section 1 Pressure Vessels** **301. ~ 302. 〈omitted〉** **303. Materials *(2017)* 【See Guidance】** **1. 〈omitted〉** **2.** Materials of cast steel and grey iron casting are to be used for the construction of pressure vessels, according to the following items. (1) Cast steel may be used in pressure vessels. (2) Grey iron castings may be used in the pressure vessels where the working temperature does not exceed 220 °C and the design pressure does not exceed 1 MPa. However, grey iron castings are not to be used for the pressure vessels which contain inflammable or toxic liquid or gas. (3) Special cast iron such as nodular graphite cast iron etc. may be used for the pressure vessels with the maximum working temperature not exceeding 350 °C and the design pressure not exceeding 1.8 MPa where approved by the Society. (hereafter, omitted)	**CHAPTER 5 BOILERS AND PRESSURE VESSELS** **Section 1 Pressure Vessels** **301. ~ 302. 〈same as the present〉** **303. Materials *(2017)* 【See Guidance】** **1. 〈same as the present〉** **2.** Materials of cast steel and grey iron casting are to be used for the construction of pressure vessels, according to the following items. (1) Cast steel may be used in pressure vessels. (2) Grey iron castings may be used in the pressure vessels where the working temperature does not exceed 220 °C and the design pressure does not exceed 1 MPa. However, grey iron castings are not to be used for the pressure vessels which contain inflammable or toxic liquid or gas. (3) Special cast iron such as nodular graphite cast iron etc. may be used for the pressure vessels with the maximum working temperature not exceeding 350 °C ~~and the design pressure not exceeding 1.8 MPa~~ where approved by the Society. *(2022)* (hereafter, same as the present Rules)	(Amendment) Reflect Request for Establishment/Revision of Classification Technical Rules 〈application date: the date of contract for construction on or after 1 July 2022〉 - To delete the requirement of design pressure limitation on use of nodular graphite cast iron in the material of the body of the pressure vessel.

GUIDANCE RELATING TO RULES FOR CLASSIFICATION OF STEEL SHIPS

(Development Review : External Opinion Inquiry)

Part 5 Machinery Installation

2021. 3.

Machinery Rule Development Team

- Main Amendments -

(1) Reflecting Q&A on Intranet from HMM Ocean Service <ships contracted for construction on or after 2021/07/01>

◉ to require devices to protect the supply lines from back flow of gas and flame passage

Present	Amendment	Reason
Annex 5-5 Requirements of Equipment for Gas welding	**Annex 5-5 Requirements of Equipment for Gas welding**	
1. to 3. <omitted>	**1. to 3.** <same as the present Guidance>	
4. In case where permanent piping is arranged between the gas bottles and working area, the following requirements are to be complied with :	**4.** In case where permanent piping is arranged between the gas bottles and working area, the following requirements are to be complied with :	
(1) to (2) <omitted>	(1) to (2) <same as the present Guidance>	
(3) The procedures of piping arrangement are to be as specified below :	(3) The procedures of piping arrangement are to be as specified below :	
(A) Acetylene gas piping and oxygen gas piping are not to be led through enclosed spaces which are susceptible to fire. But, in case where it can be led through enclosed space, the following comply; *(2017)*	(A) Acetylene gas piping and oxygen gas piping are not to be led through enclosed spaces which are susceptible to fire. But, in case where it can be led through enclosed space, the following comply; *(2017)*	
(a) Provision of effective mechanical exhaust ventilation.	(a) Provision of effective mechanical exhaust ventilation.	
(b) Pipe connection with butt-welding	(b) Pipe connection with butt-welding	
(c) Pipes are to be protected from mechanical damage where necessary.	(c) Pipes are to be protected from mechanical damage where necessary.	
(B) Stop valves are to be fitted on oxygen and acetylene gas piping at adequate locations of the penetrations through the casing of the store room and working area. Except when used in a working area, gas bottles are to be kept closed by stop valves which are fitted in a store room, and warning notices to this effect are to be placed in a store room and working area. *(2021)*	(B) Stop valves are to be fitted on oxygen and acetylene gas piping at adequate locations of the penetrations through the casing of the store room and working area. Except when used in a working area, gas bottles are to be kept closed by stop valves which are fitted in a store room, and warning notices to this effect are to be placed in a store room and working area. *(2021)*	
(C) Joints between pipes and pipe fittings are to be of welded joint or flange joint as far as practicable.	(C) Joints between pipes and pipe fittings are to be of welded joint or flange joint as far as practicable.	
(D) For clear distinction of the acetylene gas piping system and oxygen gas piping system, the piping systems are to be provided with adequate means of identification.	(D) For clear distinction of the acetylene gas piping system and oxygen gas piping system, the piping systems are to be provided with adequate means of identification.	
	(E) Supply lines are to include, at the distribution station as far as practicable, devices to protect the supply lines from back flow of gas or flame passage. *(2021)*	- to prevent backflow of gas and flame passage to gas bottle
<hereafter omitted>	<hereafter same as the present Guidance>	

Amendments of the Guidance Relating to the Rules for Classification of Steel Ships

(For External opinion inquiry)

Pt. 5 Machinery Installations - Chapter 6

2022.1.

Machinery Rule Development Team

- Main Amendments -

(1) Effective date : 1 July 2022 (based on contract date for construction)

- ◉ reflected of IACS SC154 Corr.1
- ◉ reflected of IACS REC.151 Rev.1

Present	Amendment	Note
# CHAPTER 6 AUXILIARIES AND PIPING ARRANGEMENT ## Section 4 Bilge and Ballast System **402. Drainage of compartment other than machinery spaces** 【See Rule】 1. **Omission of bilge suction pipes** For small compartment such as echo sounder recess, the provision of bilge suction pipes may be omitted under the approval of the Society. 2. **Bilge scuppers in special case** In case where hold or cabin bilges are drained to the engine room or shaft tunnel adjacent thereto through the watertight construction as specified in **Fig 5.6.8** of the guidance, the bilge drainage piping is to be led to spaces readily accessible and self-closing valve or cock is to be provided. Where such bilge is led to the watertight bilge tanks, the above mentioned valve or cock may be omitted, but where the hold is located under the load line, non-return valve is to be provided. In case where hold bilges are led to the shaft tunnel, no sounding pipe may be provided, but the diam-eter of the drainage pipe is not to be less than the value specified for bilge suction pipe. 3. **Bilge well high water level alarms** For ships being within the application limits of regulation XII/4.2 of SOLAS, which have been constructed with an insufficient number of transverse watertight bulkheads to satisfy the regulation, it is provided with bilge well high water level alarms in all cargo holds, or in cargo conveyor tunnels, as appropriate, giving an audible and visual alarm on the navigation bridge.	# CHAPTER 6 AUXILIARIES AND PIPING ARRANGEMENT ## Section 4 Bilge and Ballast System **402. Drainage of compartment other than machinery spaces** 【See Rule】 1. **Omission of bilge suction pipes** For small compartment such as echo sounder recess, the provision of bilge suction pipes may be omitted under the approval of the Society. 2. **Bilge scuppers in special case** In case where hold or cabin bilges are drained to the engine room or shaft tunnel adjacent thereto through the watertight construction as specified in **Fig 5.6.8** of the guidance, the bilge drainage piping is to be led to spaces readily accessible and self-closing valve or cock is to be provided. Where such bilge is led to the watertight bilge tanks, the above mentioned valve or cock may be omitted, but where the hold is located under the load line, non-return valve is to be provided. In case where hold bilges are led to the shaft tunnel, no sounding pipe may be provided, but the diam-eter of the drainage pipe is not to be less than the value specified for bilge suction pipe. 3. **Bilge well high water level alarms** For ships being within the application limits of regulation XII/4.~~2~~3 of SOLAS, which have been constructed with an insufficient number of transverse wa-tertight bulkheads to satisfy the regulation, it is provided with bilge well high water level alarms in all cargo holds, or in cargo conveyor tunnels, as appropriate, giving an audible and visual alarm on the navigation bridge.	- Referred desig nation of the r egulation (IACS UI SC154 Corr. 1)

Amendment	Note
Annex 5-13 Fuel oil treatment system *(2019)*	
1. General (1) Application (A) The aim of these Annex is to improve the operational safety of the vessel by improving reliability of the oil fuelled machinery. (B) These Annex cover the complete fuel oil treatment system, from the fuel bunker connection through to the interface with the oil fuelled machinery. (C) For items not specified in this Annex, the relevant requirements specified in **Pt 5** and **Pt 8** of the Rules apply. (D) Where Fuel oil treatment system is designed, constructed and tested in accordance with this Annex, the **FTS** notation may be assigned. (2) Definition The definitions of terms are to be followed to the Rules, unless otherwise specially specified sbelow. (A) **Fuel oil treatment system** means a system intended for cleaning of the fuel oil by removal of water, catalyst fines (cat fines), water bound ash constituents (e.g. sodium) and particulate matter, conditioning of the fuel oil to ensure efficient combustion. The "fuel oil treatment system" does not cover the use of additives. (B) **Fuel oil** means petroleum fuels for use in marine diesel engines and other machinery. (C) **Oil fuelled machinery** means all machinery combusting fuel oil, including main and auxiliary engines, boilers, gas turbines. (D) **A service tank** is a fuel oil tank ~~which~~ intended to contains only fuel of a quality ready for use, i.e. fuel ~~of a grade and quality~~ with properties that meet the specification ~~required~~ recommended by the equipment manufacturer. (3) Approval of plan and documents (A) The Society, where considered necessary, may require further plans and documents other than specified in this Annex. (a) Fuel oil storage/supply system diagram (b) Fuel oil purifying system diagram (c) The operation plan for fuel oil treatment etc. suitable for the fuel oil treatment system including elevant requirements specified in **2. System requirement** of the this annex. (B) Guidelines for uel oil usage are to be provided on measures and procedures to minimize mixing of newly bunkered fuel with fuel already on-board or incompatible fuel during bunkering or fuel oil change-over.	- reflected of IACS REC.151 Rev. 1
2. System ~~requirement~~ objectives (1) General (A) The capacity and arrangements of the fuel oil treatment system are to be suitable for ensuring availability of treated fuel oil for the Maximum Continuous Rating (MCR) of the propulsion plant and normal operating load at sea of the generator plant. (B) The capacity and arrangements of the fuel oil treatment system are to be determined on the basis of the requirements of the oil fuelled machinery manufacturer and the types of fuel: Residual Marine Fuel (RMF), Distillate Marine Fuel (DMF) to be bunkered to the ship. (C) Main bunker tanks are to be arranged to limit the need to mix newly bunkered fuel with fuel already on-board. When mixing of fuel oil is necessary, a compatibility test is to be performed prior to transfer. (D) The maximum amount of water reaching the engine is to be 0.3 % v/v or according to engine maker's recommendations. (E) The maximum amount of catalyst fines reaching the engine is to be 10 ppm Al+Si and in some instances this might rise to 15 ppm however every attempt must be made to reduce the catalyst to the lowest possible levels. (F) Bunkered fuels are to be meet ~~the requirements of~~ ISO 8217:2017 (~~latest revision~~) or may meet an oil-fuelled machinery consumer manufacturers' specification.	

Amendment	Note
3. Sampling (1) Sampling point (A) The fuel oil treatment system is to be provided with sampling points. (B) The sampling points are to be meet ~~the requirements of~~ MEPC.1/Circ.864/Rev.1 'Guidelines for on board sampling and verification of the sulphur content of the fuel oil used on board ships' and are to be located as follows: (a) After the transfer pump discharge (b) Before and after the fuel cleaning equipment (c) After the fuel oil service tank, before any fuel change over valve (d) Before fuel enters the oil fuelled machinery (e) Fuel oil bunker manifold (2) Sampling points are to be provided at locations within the fuel oil system that enable samples of fuel oil to be taken in a safe manner. (3) The position of a sampling point is to be such that the sample of the fuel oil is representative of the fuel oil quality passing that location within the system. (4) The sampling points are to be located in positions as far removed as possible from any heated surface or electrical equipment so as to preclude impingement of fuel oil onto such surfaces on equipment under all operating conditions. **4. System design** (1) Fuel oil tanks (A) Settling and service tanks for fuel oil are to be designed and constructed in such a way as to direct water and sludge towards a drainage outlet. (B) If settling tanks are not provided, the fuel oil bunker (storage) and daily service tanks are to be designed and constructed in such a way as to direct water and sludge towards a drainage outlet. (C) A self-closing type cock or valve is to be installed under the fuel oil tank and the drain cock can not be considered as a sampling point. (D) Fuel suction points are to be located at an appropriate distance above the tank drain point to prevent accumulated water and sludge being drawn into the fuel oil treatment system (e.g. a minimum 5% of the tank volume is below the suction of the high suction pipe). (E) It is recommended that at least one low suction point and one high suction point be provided on the settling and service tank. (F) The materials and/or their surface treatment used for the storage and distribution of fuel oil are to be selected such that they do not introduce contamination or modify the properties of the fuel. (G) A temperature controller of PID type is to be fitted to ensure that the fuel is maintained at the temperature required for optimum system performance. (H) The fuel oil storage tank is to be equipped with a monitoring device for the temperature and liquid level inside the tank.	- reflected of IACS REC.151 Rev. 1

Amendment	Note
(2) Fuel oil temperature management equipment and viscosity controller (A) Where heating or cooling of the fuel oil is required for the efficient functioning of the fuel oil treatment system, a minimum of two heating or cooling units are to be provided. Each heating or cooling unit should be of sufficient capacity to maintain the required temperature of the fuel oil for the required delivery flow rate. (B) Heaters and coolers are to be located to avoid oil spray or oil leakages onto hot surfaces or other sources of ignition, or onto rotating machinery parts. Where necessary, shielding is to be provided. (C) Heaters and coolers are to be located to allow easy access for routine maintenance. (D) Depending on the type of fuel oil to be used, a viscosity control device is to be provided to maintain the desired viscosity or a viscosity maintenance control means (eg, additive) is to be provided. (3) Fuel oil pump (A) Fuel pump capacity is to ensure that fuel flow rate through the fuel system is sufficient to maintain the installed oil-fuelled machinery's fuel consumption during normal operation, according to **SOLAS Regulation II-1/26.3**. (B) Pumps are to be located to allow easy access for routine inspection and maintenance. (4) Tests procedures to confirm the ability of RMF fuel oil pumps operation with marine fuels with low viscosity (A) ~~General~~ Application (a) Primary essential services fuel oil pumps (main and stand-by) used in all services that need to be maintained in continuous operation. These include: separator fuel oil supply pumps; booster pumps, feeder pumps, fuel valve cooling pumps, (in systems which use fuel oil for this service). ~~(b) Primary essential services fuel oil pumps (main and stand-by) used in all services that need to be maintained in continuous operation. These include: separator fuel oil supply pumps; booster pumps, feeder pumps, fuel valve cooling pumps, (in systems which use fuel oil for this service).~~ Fuel pumps that are not required to be in continuous operation, e.g. fuel oil transfer pumps. (c) The arrangement of the fuel oil pump is to be satisfied with UI SC255. (B) Running test (a) A running test is to be carried out with a minimum or lower viscosity fuel oil with a sulphur content of 0.10 % m/m or less specified in ISO 8217:2017 ~~(latest edition)~~ Specifications for Marine Fuels; recommended fuel oil viscosity value for the test should be 2,0 cSt at the fuel pump. (b) The lubricity of fuel oil for running test is to be less than 520 μm as determined by a high-frequency reciprocating rig test according to ISO 12156-1:2018. (c) The running test is to be conducted for a minimum of 250 hours for pumps for both continuous and non-continuous operation and at a discharge pressure equal to the nominal pump pressure rating. (d) During the running test the following data is to be verified. (i) volume rate of flow Q [m3/h] (ii) delivery head H [m] (iii) pump power input P [kW] (iv) speed of rotation n [min-1] (e) During the running test, the pump is to be checked for smooth running (for example ~~VDI Regulation 2056 "Criteria for the assessment vibration in machines"~~ ISO 10816 series and/or ISO 20816-1:2016 could be used as a basis for acceptance) and bearing temperature. The assessment is to be based on international standard or a ~~Classification~~ Society's requirements, if applicable. This may be based on the pump manufacturer's in-house testing procedures ~~in agreement with~~ acceptable to the Society.	- Deletion of editorial mistakes and replaced to the correct regulation.

Amendment	Note
(C) Pump suitability (a) All elastomeric components in the fuel oil system (e.g. diaphragms) is to be made of fluoro-rubber or other material suitable for use with marine fuels according to MSC.1/Circ.1321. (b) Displacement pumps are to be fitted with relief valves. The discharge from the relief valve is normally to be led back to suction side of the pump. (c) The maximum amount of catalyst fines reaching the engine is to be 10 ppm Al+Si and in some instances this might rise to 15 ppm however every attempt must be made to reduce the catalyst to the lowest possible levels. (d) Dedicated continuous monitoring of the quantity of catfines between the pump and the service tank outlet is to be considered. If continuous monitoring of catfines is not implemented, and the fuel type used is RMF, then weekly sampling and analysing of catfine level at service tank outlet is recommended to ensure that catfine level doesn't exceed maximum level. (e) Compatibility test kits, approved or recommended by the fuel oil manufacturer, are to be used when bunkering two or more different fuel types, e.g. a high sulphur and low 0,10 % m/m sulphur fuel. (f) An automated fuel oil changeover valve/system or manual valve/system that can provide for timed changeover of fuel oil from one type to another is to be provided and done in accordance with the engine manufacturers' recommendation. (g) Each vessel or installation is to have established procedures for fuel oil changeover and posted on-board. (D) Verification ~~requirements for~~ of pump design and test documentation (a) All types of fuel oil pumps used for operation with low-sulphur fuel oil installed onboard is to be tested and the evidence of test is to be kept on-board. (b) The scope of design documentation supplied by the pump manufacturer and kept on board is to include: (i) Pump(s) arrangement drawing, pump installation diagram with position and characteristics of sensors/monitoring system details (ii) List of components with characteristics of materials critical for reliable operation of pump (iii) Sealing arrangements (iv) Reliability and life cycle data (v) Operational manual with performance and life cycle guidance (vi) Test programme of the pump(s) for class survey (c) A certificate of the running test containing the following information is to be attached to the pump documentation. (i) Manufacturer details (ii) The test stand location and accreditation - approval details (iii) Pump type and serial number (iv) Duration of testing (v) Viscosity of used medium (vi) Parameters as mentioned in running test (vii) Minimum operating temperature (viii) Result of running test	- reflected of IACS REC.151 Rev. 1 - Editorial mistake corrected : order in the page of English version was modified as it should be. -Red Color : #1

Amendment	Note
(5) Filters (A) Filters are to be located to avoid oil spray or oil leakages onto hot surfaces or other sources of ignition, or onto rotating machinery parts. Where necessary, shielding is to be provided. (B) Filters are to be located to allow easy access for routine maintenance. (C) The arrangements of filters are to be such that any unit can be cleaned without interrupting the supply of filtered oil to the combustion system. (D) Filters are to be fitted in the fuel oil supply lines to each oil fuelled machinery ~~engine and gas turbine~~ to ensure that only suitably filtered oil is fed to the combustion system. (E) The filters installed at the inlet of oil fuelled machinery are to be selected considering the maximum amount of fuel oil catalyst particles reaching the oil fulled machinery. (65) Centrifugal separators (A) Centrifugal separators are to be located to avoid oil spray or oil leakages onto hot surfaces or other sources of ignition, oronto rotating machinery parts. Where necessary, shielding is to be provided. (B) Centrifugal separators are to be located to allow easy access for routine maintenance. **5. Test and Inspection** (1) Shop tests (A) Sampling equipment and fuel oil pumps used in low viscosity fuel oil are to be inspected by the Society. (B) Centrifugal separators are to be certified for a flow rating in accordance with a recognised standard~~, e.g. CEN Workshop Agreement (CWA) 15375 (latest revision).~~ (C) Centrifugal separators are to meet the safety requirements of a recognised standard, e.g. EN 12547:2014, Centrifuges. (2) Onboard tests (A) The main components of the fuel oil treatment system and their accessories are to be inspected for compliance with the approved drawings. (B) Piping systems are to be examined and tested in accordance with Pt 5, Ch 6, Sec. 14 of the Rules. (C) Electrical equipments are to be examined and tested in accordance with Pt 6, Ch 1 of the Rules. (D) Instrumentation is to be tested to confirm proper operation as per its predetermined set points. (E) Pressure relief and safety valves installed on the unit are to be tested.	- Editorial mistake corrected

Amendments of the Guidance Relating to the Rules for Classification of Steel Ships

(For External opinion inquiry)

Pt. 5 Machinery Installations - Chapter 6

2022.1.

Machinery Rule Development Team

- Main Amendments -

(1) Effective date : 1 July 2022 (based on contract date for construction)

◉ reflected of feedback from Domestic Business Development Team

Amendment	Note
Section 11 Compressed Air System **1101. Compressed air starting devices** 【See Rule】 **1. Number and total capacity of main air reservoirs** In **1101. 1** (5) of the Rules, ~~the total capacity of the starting air reservoirs is to be sufficient to provide, without replenishment, not less than the number of consecutive starts as specified in the following.~~ for multi-engine propulsion plants, the total capacity of the starting air receivers is to be sufficient to ensure at least 3 consecutive starts per engine, without replenishment. However, the total capacity is not to be less than 12 starts and need not exceed 18 starts. *(2022)* ~~(1) For direct reversible engines~~ ~~$N=12C$~~ ~~where;~~ ~~N : Total number of starts of each engine~~ ~~C : Constant determined by the arrangement of main propulsion engines and shafting system, where the following values are to be referred to as the standard.~~ ~~C = 1.0~~ ~~For single screw ships, where one engine is coupled with the shaft either directly or through reduction gears~~ ~~C = 1.5~~ ~~For twin screw ships, where two engines are coupled with the shafts either directly or through reduction gear, or for single screw ships, where two engines are coupled with the shaft through deductable coupling provided between engine and reduction gear~~ ~~C = 2.0~~ ~~For single screw ships, where two engines are coupled with the shaft without any declutchable coupling between engine and reduction gear~~ ~~C = 2.3~~ ~~For triple screw ships, where three engines are coupled with the shaft either directly or through reduction gear, or for single screw ships, where four engines are coupled with the shaft through declutchable coupling provided between engine and reduction gear, or for twin screw ships, where four engines are coupled with the shaft through declutchable coupling provided between engine and reduction gear~~ ~~C = 3.0~~ ~~For twin screw ships, where four engine are coupled with the reduction gear directly~~ ~~(2) For non-reversible type engines, 1/2 of the total number of starts specified in above may be accepted.~~ ~~(3) For electric propulsion ships~~ ~~$N = 6+3(k-1)$~~ ~~N : Total number of starts of engine~~ ~~k : Number of engines and it is not necessary for the value of k to exceed 3.~~	- Reflected of the feedback from the Domestic Business Development Team - Clarifiaction added in accordance with internal opinion

Amendments of the Guidance Relating to the Rules for Classification of Steel Ships

Pt. 5 Machinery Installations

2022.02.

Machinery Rule Development Team

- Main Amendments -

(1) Effective date : 1 Sep. 2021 (Date of which contracts for construction are signed)

◉ Test requirements of partial load in sea trials programme of internal combustion engine have been deleted.

◉ The requirement for an alternative source of power where the propulsion power does not exceed 2,500 kW have been deleted.

◉ Guidance for enhanced shaft alignment has been newly established.

〈Present〉 Guidance Pt 5, Ch 2, 211. 5

Table 5.2.3 Programme for Sea Trials (on-board tests) of Internal Combustion Engine

Use of engines / Test items		Propulsion engines driving propeller or impeller only(1)	Engines driving generators for electric propulsion and main power supply(2)	Propulsion engines also driving power take off (PTO) generator	Engines driving essential auxiliaries
110 % power run(3)		30 *minutes* at the speed of 1.032 times of the rated engine speed	10 *minutes* at the 110 % rated electrical power of generator	–	–
Approved intermittent overload (if applicable)		testing for duration as agreed with the manufacturer	–	–	testing for duration as agreed with the manufacturer
Load tests	100 % power run	4 *hours* at the rated engine speed	1 *hour* at the 100 % rated electrical power of generator	4 *hours* at the rated engine speed (4)	30 *minutes* at the rated engine speed
	90 % or Normal continuous cruise power run	2 *hours* at engine speed corresponding to nominal continuous cruise power	–	–	–
	75 % power run	reasonable hours at the rated engine speed for 1 or 2 kind of power run	–	–	–
	50 % power run		–	–	–
	25 % power run		–	–	–
Minimum engine speed test		○	–	–	–
Starting maneuvering test(5)		○	○	○	○
Reverse maneuvering test(6)		○	–	–	–
UMA test(7)		○	○	○	○
Alarms and safety devices test(8)		○	○	○	○
Test for fitness of fuel oil(9)		○	○	○	○

Table 5.2.3 Programme for Sea Trials (on-board tests) of Internal Combustion Engine (continued)

NOTES: (1) through (9) in this Table are subject to the following;

(1) For controllable pitch propellers, the tests are to be carried out at the maximum achievable power if 100 % cannot be reached, the tests are to be carried out at the various pitches. For controllable pitch propellers, the test at the speed of 1.032 × rated engine speed is not required. *(2021)*

(2) Each engine is to be tested 100 % electrical power for at least 60 min and 110 % of rated electrical power of the generator for at least 10 min. This may, if possible, be done during the electrical propulsion plant test, which is required to be tested with 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 stable operating temperatures of all rotating machines or for at least 4 hours. When some of the gen. 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. Demonstration of the generator prime movers' and governors' ability to handle load steps as described in **Pt 6, Ch 1, 202. 2 of the Rules.**

(3) The test is to be carried out in case that engine adjustment permit (See **Table 5.2.2** Note 2. (2)). However, the test may be dispensed with when deemed appropriate by the Society in consideration of the result of the shop trials. *(2021)*

(4) The test is to be carried out for 2 hours with 100 % propeller branch power at rated engine speed (unless already covered in the test at 100 % power run). In addition, the test is to be carried out for 1 hour with 100 % PTO branch power at rated engine speed. *(2021)*

(5) The direct reversible engines are to be carried out ahead and astern starting repeatedly without replenishment, and the other engines are to be carried out starting and stop repeatedly without replenishment.

(6) For controllable pitch propellers in reverse pitch, for the direct reversible engine in reverse rotational direction during stopping tests, passages through the barred speed range are to be demonstrated in accordance with **211. 6** (2) of the Guidance.

(7) The test is to be carried out for ships which are going to be registered as ships provided with unattended machinery automatic systems.

(8) The monitoring and alarm systems are to be checked to the full extent for all engines, except items already verified during the works trials.

(9) The test is to be carried out for the engines used residue oil or equivalent thereto. However, the test may be dispense with when deemed appropriate by the Society or in the case of that the fitness was certified at the shop trial.

〈Amendment〉 Guidance Pt 5, Ch 2, 211. 5

Table 5.2.3 Programme for Sea Trials (on-board tests) of Internal Combustion Engine

Use of engines / Test items	Propulsion engines driving propeller or impeller only(1)	Engines driving generators for electric propulsion and main power supply(2)	Propulsion engines also driving power take off (PTO) generator	Engines driving essential auxiliaries
110 % power run(3)	30 *minutes* at the speed of 1.032 times of the rated engine speed	10 *minutes* at the 110 % rated electrical power of generator	–	–
Approved intermittent overload (if applicable)	testing for duration as agreed with the manufacturer	–	–	testing for duration as agreed with the manufacturer
100 % power run	4 *hours* at the rated engine speed	1 *hour* at the 100 % rated electrical power of generator	4 *hours* at the rated engine speed (4)	30 *minutes* at the rated engine speed
Minimum engine speed test	○	–	–	–
Starting maneuvering test(5)	○	○	○	○
Reverse maneuvering test(6)	○	–	–	–
UMA test(7)	○	○	○	○
Alarms and safety devices test(8)	○	○	○	○
Test for fitness of fuel oil(9)	○	○	○	○

NOTES: (1) through (9) in this Table are subject to the following;

(1) For controllable pitch propellers, the tests are to be carried out at the maximum achievable power if 100 % cannot be reached, the tests are to be carried out at the various pitches. For controllable pitch propellers, the test at the speed of 1.032 × rated engine speed is not required. *(2021)*

(2) Each engine is to be tested 100 % electrical power for at least 60 min and 110 % of rated electrical power of the generator for at least 10 min. This may, if possible, be done during the electrical propulsion plant test, which is required to be tested with 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 stable operating temperatures of all rotating machines or for at least 4 hours. When some of the gen. 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. Demonstration of the generator prime movers' and governors' ability to handle load steps as described in **Pt 6, Ch 1, 202. 2 of the Rules.**

(3) The test is to be carried out in case that engine adjustment permit (See **Table 5.2.2** Note 2. (2)). However, the test may be dispensed with when deemed appropriate by the Society in consideration of the result of the shop trials. *(2021)*

(4) The test is to be carried out for 2 hours with 100 % propeller branch power at rated engine speed (unless already covered in the test at 100 % power run). In addition, the test is to be carried out for 1 hour with 100 % PTO branch power at rated engine speed. *(2021)*

(5) The direct reversible engines are to be carried out ahead and astern starting repeatedly without replenishment, and the other engines are to be carried out starting and stop repeatedly without replenishment.

(6) For controllable pitch propellers in reverse pitch, for the direct reversible engine in reverse rotational direction during stopping tests, passages through the barred speed range are to be demonstrated in accordance with **211. 6** (2) of the Guidance.

Table 5.2.3 Programme for Sea Trials (on-board tests) of Internal Combustion Engine (continued)

(7) The test is to be carried out for ships which are going to be registered as ships provided with unattended machinery automatic systems. (8) The monitoring and alarm systems are to be checked to the full extent for all engines, except items already verified during the works trials. (9) The test is to be carried out for the engines used residue oil or equivalent thereto. However, the test may be dispense with when deemed appropriate by the Society or in the case of that the fitness was certified at the shop trial.

Present	Amendment	Note
Annex 5-1 Requirements for the Water-jet Propulsion Systems and Azimuth or Rotatable Thrusters **1. Water-jet propulsion systems** (1) ~ (3) 〈omitted〉 (4) System design (A) ~ (E) 〈omitted〉 (F) Where the propulsion power exceeds 2,500 kW per thruster unit, an alternative source of power is to be provided in accordance with the following: (a) Any alternative source of power is to be capable of automatically supplying alternative power within 45 seconds to the deflector and its associated control system and its indication devices for deflector positions. (b) In every ship of 10,000 gross tonnage and upwards, the alternative power supply is to have a capacity for at least 30 min of continuous operation and in any other ship for at least 10 min. (c) The alternative source of power is to be either: (i) emergency source of electric power; or (ii) an independent source of power located in the steering gear compartment and used only for this purpose. (d) ~ (e) 〈omitted〉 (G) Electrical Installations for Steering and Reversing Systems Where hydraulic pumps for hydraulic power systems are driven by electric motors, electrical installations for steering and reversing systems are to comply with the following requirements : (a) ~ (g) 〈omitted〉 (h) Where the propulsion power does not exceed 2,500 kW per thruster unit and emergency generators are provided, one hydraulic power system for the steering system (including associated control systems) is to be served by exclusive circuits fed directly from emergency switchboards. In this cases, those exclusive circuits supplied through the emergency switchboards specified in above (a) may be used as this circuit. (hereafter, omitted)	**Annex 5-1 Requirements for the Water-jet Propulsion Systems and Azimuth or Rotatable Thrusters** **1. Water-jet propulsion systems** (1) ~ (3) 〈same as the present〉 (4) System design (A) ~ (E) 〈same as the present〉 (F) Where the propulsion power exceeds 2,500 kW per thruster unit, an alternative source of power is to be provided in accordance with the following: (a) Any alternative source of power is to be capable of automatically supplying alternative power within 45 seconds to the deflector and its associated control system and its indication devices for deflector positions. (b) In every ship of 10,000 gross tonnage and upwards, the alternative power supply is to have a capacity for at least 30 min of continuous operation and in any other ship for at least 10 min. (c) The alternative source of power is to be either: (i) emergency source of electric power; or (ii) an independent source of power located in the steering gear compartment and used only for this purpose. (d) ~ (e) 〈same as the present〉 (G) Electrical Installations for Steering and Reversing Systems Where hydraulic pumps for hydraulic power systems are driven by electric motors, electrical installations for steering and reversing systems are to comply with the following requirements : (a) ~ (g) 〈same as the present〉 ~~(h) Where the propulsion power does not exceed 2,500 kW per thruster unit and emergency generators are provided, one hydraulic power system for the steering system (including associated control systems) is to be served by exclusive circuits fed directly from emergency switchboards. In this cases, those exclusive circuits supplied through the emergency switchboards specified in above (a) may be used as this circuit.~~ (hereafter, same as the present Rules)	<Pt 5 Guidance> (Amendment) Deletion of the requirement for an alternative source of power where the propulsion power does not exceed 2,500 kW <application date: the date of contract for construction on or after 1 Sep. 2021>

Present	Amendment	Note
2. Azimuth or rotatable thrusters (1) ~ (3) 〈omitted〉 (4) System design (A) ~ (E) 〈omitted〉 (F) Where the propulsion power exceeds 2,500 kW per thruster unit, an alternative source of power is to be provided in accordance with the following: (a) Any alternative source of power is to be capable of automatically supplying alternative power within 45 seconds to the steering arrangement and its associated control system and its indication devices for azimuth angle. In every ship of 10,000 gross tonnage and upwards, the alternative power supply is to have a capacity for at least 30 min of continuous operation and in any other ship for at least 10 min. (b) The alternative source of power is to be either: (i) emergency source of electric power; or (ii) an independent source of power located in the steering gear compartment and used only for this purpose. (c) ~ (d) 〈omitted〉 (G) Electrical installations for azimuth steering gears Electrical installations for azimuth steering gears are to comply with the following requirements : (a) ~ (d) 〈omitted〉 (e) Where the propulsion power does not exceed 2,500kW per thruster unit and emergency generators are provided, one azimuth steering gear (including associated control systems) is to be served by exclusive circuits fed directly from emergency switchboards. In this cases, those exclusive circuits supplied through the emergency switchboards specified in (4) (E) (b) may be used as this circuit. (hereafter, omitted)	**2. Azimuth or rotatable thrusters** (1) ~ (3) 〈same as the present〉 (4) System design (A) ~ (E) 〈same as the present〉 (F) Where the propulsion power exceeds 2,500 kW per thruster unit, an alternative source of power is to be provided in accordance with the following: (a) Any alternative source of power is to be capable of automatically supplying alternative power within 45 seconds to the steering arrangement and its associated control system and its indication devices for azimuth angle. In every ship of 10,000 gross tonnage and upwards, the alternative power supply is to have a capacity for at least 30 min of continuous operation and in any other ship for at least 10 min. (b) The alternative source of power is to be either: (i) emergency source of electric power; or (ii) an independent source of power located in the steering gear compartment and used only for this purpose. (c) ~ (d) 〈same as the present〉 (G) Electrical installations for azimuth steering gears Electrical installations for azimuth steering gears are to comply with the following requirements : (a) ~ (d) 〈same as the present〉 ~~(e) Where the propulsion power does not exceed 2,500 kW per thruster unit and emergency generators are provided, one azimuth steering gear (including associated control systems) is to be served by exclusive circuits fed directly from emergency switchboards. In this cases, those exclusive circuits supplied through the emergency switchboards specified in (4) (E) (b) may be used as this circuit.~~ (hereafter, same as the present Rules)	<Pt 5 Guidance>

New	Note
Annex 5-12-1 Enhanced Shaft Alignment *(2021)*	<Pt 5 Guidance> (Amendment) Enhanced Shaft Alignment 〈application date: the date of contract for construction on or after 1 Sep. 2021〉
1. Application (1) This annex addresses the enhanced requirements of design, procedure and verification for shaft alignment in addition to the requirements in **Annex 5-12**. The sensitive installations to the shaft alignment (e.g. tankers, bulkers and twin screw vessels and shafting with no forward stern tube bearings, etc.) are the main targets of application, but can be extended if requested. (2) The requirements of this annex are optional, and ships satisfying the requirements of this annex may be assigned a notation specified in **2.** as additional special feature notations.	
2. Class notations Ships satisfying the requirements of this annex may be assigned the following notation as additional special feature notations. (1) Where the enhanced requirements of design for shaft alignment in **3.** are satisfied, the notation of ESA1 may be assigned. (2) Where the enhanced requirements of design, procedure and verification for shaft alignment in **3.** and **4.** are satisfied, the notation of ESA2 may be assigned.	- ESA(Enhanced Shaft Alignment)
3. The requirements for ships assigned ESA1 notation In order to register as ships with the ESA1 notation, the following requirements of the enhanced design for shaft alignment are to be satisfied. (1) Drawings and data to be submitted (A) Description of shafting system such as shaft diameter, shaft material, bearing length, bearing liner material, and bearing axial position, bearing clearance, propulsion system specifications (B) Stern tube lubricant specifications, (manufacturer, type and viscosity) (C) Propeller dimensional data, weight and buoyancy effect, including propeller cap and energy saving devices (D) Hydrodynamic propeller loads in running conditions including ship turning condition (E) For geared installations, gear forces and moments (F) External forces acting on crankshaft (G) Axial positions of the bearings points of support (H) Bearing Stiffness values for all bearings in the shaftline (I) Definition of a reference line (J) Bearing offsets from reference line (K) Thermal displacement of the bearings between cold static and hot static machinery conditions (L) Effect of predicted hull deflections over the range of the ship's operating drafts	

New	Note
(M) Calculated bearing loads for all considered conditions (N) Calculated shaftline deflection for all considered conditions (O) Bending moment and shear force curves along the shaftline for static and dynamic conditions (P) Misalignment angle between the shaft and the aft most bearing (aft stern tube bearing or aft most strut bearing) for all considered conditions or the alternative modelling techniques according to (5) (Q) Whirling Vibrations calculations (2) Hydrodynamic propeller loads (A) Transverse and vertical hydrodynamic propeller loads in the following ship conditions are to be used in the shaft alignment calculations. (a) Straight ahead condition at MCR at ballast draft (b) Straight ahead condition at MCR at full loaded draft (c) Full rudder turn to port and starboard at MCR at ballast draft (d) Full rudder turn to port and starboard at MCR at full loaded draft A turning condition is hereby defined as the condition in which the vessel is performing a steady state full rudder turn to port or starboard, commencing from a straight course at a ballast or full loaded draft at MCR condition. (B) Hydrodynamic propeller loads can be estimated by calculations (lifting surface method, boundary panel method, CFD, etc.) or based on empirical/database formulae duly justified. (C) Where hydrodynamic propeller loads as per (B) are not available, then empirical formulae for hydrodynamic propeller loads in **Table 1** are to be used for the dynamic condition calculations as shown in the following table. **Table 1 Empirical formulae for hydrodynamic propeller loads** Straight ahead condition: For single screw vessel: − 5% of Q / + 30% of Q; For twin screw vessel: +/− 20% of Q Turning condition: For single screw vessel: − 30% of Q; For twin screw vessel: − 40% of Q NOTES: Q : Torque at MCR + : Upward moment about the transverse axis − : Downward moment about the transverse axis	

New	Note
(3) Hull deflections (A) The hull deflections in the following ship conditions are to be used in the shaft alignment calculations. In addition, the hull deflections for the aft peak tank empty and full (or the maximum level in the ship loading manual) is to be evaluated. (a) Dry dock or aft launching draft (lightship condition or close to lightship condition with minimum ballast) (b) Ballast draft (c) Full loaded draft (B) Hull deflections can be estimated by finite element calculations or by measurements from similar vessels (same type, similar vessel size, similar double bottom height in the area of the engine room, similar stern tube and stern arrangement) or other recognized calculation methodologies. (4) Shaft alignment calculations (A) In order to determine the shaft alignment that satisfies the various operating conditions of the ship, the shaft alignment calculations in the following conditions are to be performed. (a) Cold, static, dry dock or aft launching draft (lightship condition or close to lightship condition with minimum ballast) with propeller partially immersed (b) Hot, static, ballast draft with propeller fully immersed (c) Hot, ballast draft with propeller fully immersed in dynamic condition including hydrodynamic propeller loads according to (2) (d) Hot, static, full loaded draft with propeller fully immersed (e) Hot, full loaded draft with propeller fully immersed in dynamic condition including hydrodynamic propeller loads according to (2) (5) Contact between the shaft and the aft most bearing (aft stern tube bearing or aft most strut bearing) The misalignment angle between the shaft and the aft most bearing is not to exceed 0.3×10^{-3} rad under all ship conditions which the shaft alignment calculations are performed. When alternative recognized modelling techniques are used, such as 3D Finite Element Modelling with Fluid Structure Interaction between the bearing oil film and the rotating shaft, the relevant assumptions and practices are to be detailed in the submitted calculation report. If a 3D Finite Element Modelling with Fluid Structure Interaction between the bearing oil film and the rotating shaft is used, the misalignment angle criterion can be replaced by an oil film thickness criterion so that the oil film thickness to be not below 30 μm under all ship conditions which the shaft alignment calculations are performed; other criteria may be considered acceptable by the Society on a case by case basis.	

New	Note
(6) Whirling vibrations (A) Calculations are to be submitted to ensure that whirling vibration frequencies are satisfactory throughout the speed range. The calculations are to take into account bearing and oil-film stiffness and gyroscopic effects. The calculations are to investigate the excitation frequencies giving rise to all critical speeds within the speed range. (B) The whirling critical speeds are not to be within the range of ±20% of MCR. (7) STCM notation Oil lubricated stern tube shaft that the approved condition monitoring scheme in accordance with **Pt 1, Ch 2, 701. 2** of the Guidance is applied, is to be installed and the notation of STCM is to be assigned.	

New	Note
4. The requirements for ships assigned ESA2 notation In order to register as ships with the ESA2 notation, in addition to the requirements of EAS1 in **3.**, the following requirements of the enhanced procedure and verification for shaft alignment are to be satisfied. (1) Data to be submitted (A) Shaft alignment procedure including final sighting and the followings (a) Bearing locations (including temporary supports), bearing offsets in respect of the reference line and bearing loads. (b) Bearing offset tolerances (c) Jack up positions and correction factors (d) Bearing load with tolerances (e) Bearing reaction influence coefficients (B) Bearing run-in procedure (C) Shaft alignment verification procedure during sea trials (2) Final sighting (A) After the stern structure is in place and heavy equipment such as engines, boilers, generators, etc. are installed and major welding works are completed at the aft part of ships, final sighting is to be carried out in the presence of the Surveyor. (B) The final sighting is to extend from the aft most bearing (aft stern tube bearing or aft most strut bearing), up to the engine or gearbox (if applicable) output flange, and is to be used to adjust the relative position of the engine and intermediate bearings in respect of the stern tube bearings. (C) Sufficient number of targets are to be utilized during the sighting-through, to ensure satisfactory accuracy in verification of bearings offsets. (D) The sighting procedure may be carried out by recognized methods, e.g. piano wire, optical sighting or laser sighting. (E) The bearings and engine/gearbox offsets (vertical and horizontal) in respect of the reference line are to correspond to those in the calculation with a tolerance of ± 0.1 mm. (F) When final sighting is carried out, shaft alignment by gap and sag method is not required.	

New	Note
(3) Bearing run-in procedure (A) Bearing run-in is to be carried out in the presence of the Surveyor. A bearing run-in procedure, to be agreed between the Surveyor and the yard, is to be conducted preferably with fully immersed propeller. If this is not possible due to shallow waters, then the lowest possible RPM for navigation and the lowest possible helm angles are to be used to avoid exposing the new bearings into high stresses and temperatures. (B) Bearing run-in procedure is to be carried out as soon as possible prior to commencing full operational sea trials. The procedure gradually exposes the stern tube bearing to increased loads and assists with bedding the stern tube shaft in a controlled manner to the stern tube bearing to create proper contact with the bearing bottom surface. It also prepares the stern tube bearings to withstand various service loads without sustaining damage. (C) During the bearing run-in, the aft stern tube bearing temperature is to be closely monitored. If bearing temperature rises at a rate faster than a previously agreed rate, such as 5℃/min, or exceeds expected temperature threshold then the rudder angle is to be immediately set to zero and the engine speed is to be immediately reduced to minimum, or shut down – until the bearing temperature lowers to an acceptable level and stabilizes accordingly. Temperatures exceeding the high temperature alarm settings and high temperatures increase rate to be reported to the Society. If previously agreed allowable limits, design criteria or alarm settings are exceeded, the shipyard may request to repeat the bearing run-in procedure. Repeating is subject to Society agreement; otherwise further investigation is to be carried out. (D) Once a bearing run-in procedure is completed satisfactorily, the parts of the sea trials addressing the propulsion system and shaftline may commence.	

New	Note
(4) Shaft alignment verification during sea trials (A) The sea trial is to be carried out in the presence of the Surveyor with stern tube lubricant according to specification in the shaft alignment calculation report. The aft stern tube bearing temperature is to be recorded during verification. (B) The following movements are to be included in the sea trial program after the vessel stabilizes at a full ahead condition, at a zero-rudder angle (straight ahead) and ballast condition. (a) Perform one 360 degree turn to the port by swiftly changing the rudder angle from 0 to full rudder angle and a full ahead setting. At the completion of the turn, return the rudder angle to zero (straight ahead). (b) Keep the rudder angle to zero for 5 minutes at a full ahead setting. (c) Perform one 360 degree turn to the starboard by swiftly changing the rudder angle from 0 to full rudder angle and a full ahead setting. At the completion of the turn, return the rudder angle to zero (straight ahead). (d) Keep the rudder angle to zero for 5 minutes and at a full ahead setting. (C) If the recorded bearing temperature rate of rise does not exceed a previously agreed rate, such as 5℃/min, or the high temperature alarm settings then the sea trial bearing performance for shaft alignment is regarded as satisfactory. If previously agreed allowable limits, design criteria or alarm settings are exceeded then the whole test in (B) may be repeated subject to the Society's acceptance and considered passed if satisfactory results are demonstrated twice. The results of the test (maximum rate of temperature rise and maximum bearing temperature, as well as alarm set point) are to be included in the sea trial report. A root cause analysis is to be initiated to reveal the possible cause of the damage, if bearing is deemed to be damaged. (D) In order to verify the bearing loads in various ship conditions, the bearing loads in the following conditions are to be additionally measured in the presence of the Surveyor during sea trials. (a) Ballast draft with the aft peak tank full (or the maximum level in the ship loading manual) at hot static condition, and the measured bearing loads are not to be exceeded bearing manufacturer's limits. (b) Full loaded draft at hot static condition, and the measured bearing loads are not to be exceeded the bearing manufacturer's limits. However if full loaded draft condition is not foreseen during sea trials, then the jack up test values at ballast draft hot static condition are to be performed and the bearing load values to be not above 80% of the bearing manufacturer's limits.	

- Main Amendments -

(1) Effective date : 1 Jul. 2022 (Date of which contracts for construction are signed)

- ◉ The performance of non-traditional steering gear has been revised according to IACS UI242 (rev.2).
- ◉ For ships not engaged in international voyages, the requirement for omission of engineers' alarm has been newly added.
- ◉ For small thrusts of less than 100 kW, the mitigation requirement has been newly added.
- ◉ Reflecting IACS UR M78 (Rev.1), the exemption clauses related to 110% load testing on the gas mode of dual fuel engines are also applied to on-board tests.

(2) Effective date : 1 Jul. 2022 (Date of the application for approval)

- ◉ Reflecting IACS UR M56 (Rev.4) and 56 (Rev.4 Corr.1), the formats for referencing ISO standards have been developed.

(3) Effective date : 1 Jul. 2022 (Date of the application for Type approval)

◉ Reflecting IACS UR M78 (Rev.1), the formats for referencing IMO and IEC have been modified.

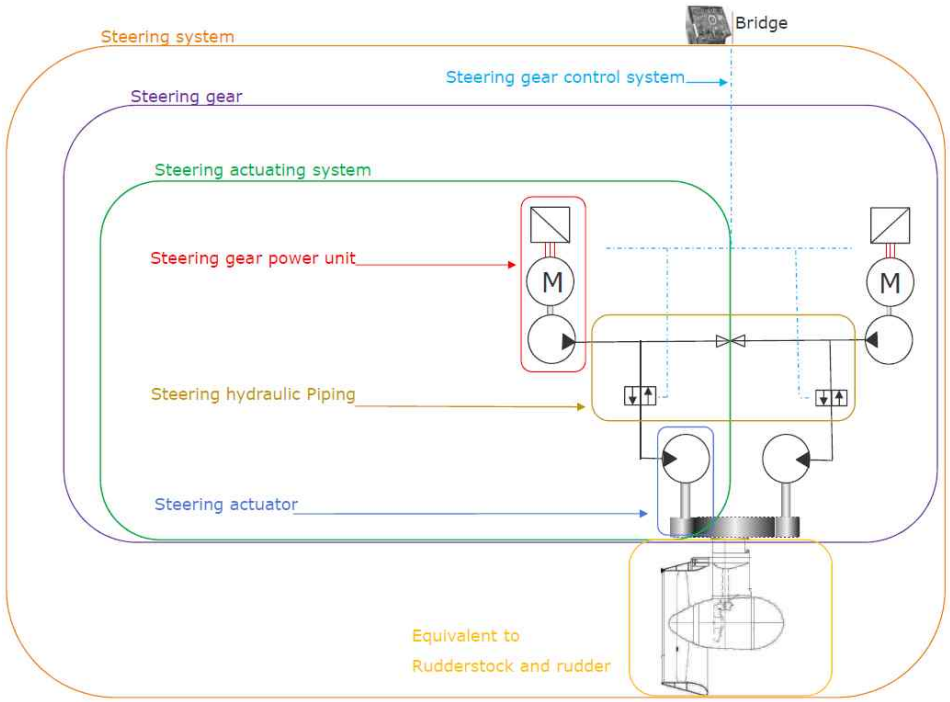
◉ Reflecting IACS UR M44 (Rev.10), the formats for referencing ISO standards and MSC Res. have been modified.

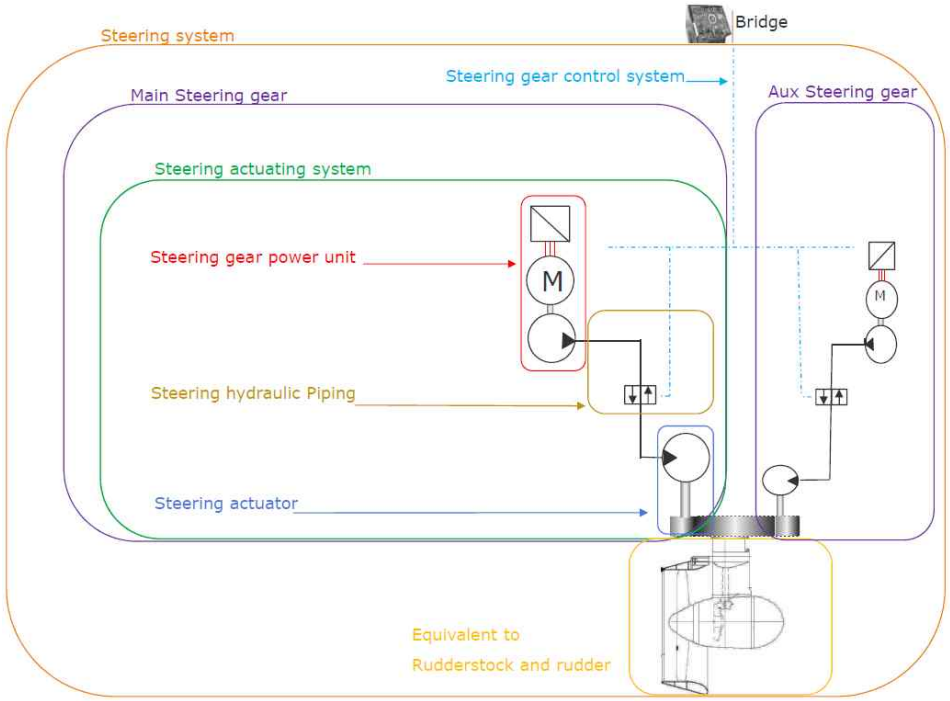
Present	Amendment	Note
# CHAPTER 1 GENERAL ## Section 1 General **101. ~ 103. 〈omitted〉** **106. Communication between Navigating Bridge and Machinery Space 【See Rule】** The telegraph is required in any case, even if the remote control of the engine is foreseen, irrespective of the fact that the engine room is attended or not. (hereafter, omitted)	# CHAPTER 1 GENERAL ## Section 1 General **101. ~ 103. 〈same as the present〉** **106. Communication between Navigating Bridge and Machinery Space 【See Rule】** The telegraph is required in any case, even if the remote control of the engine is foreseen, irrespective of the fact that the engine room is attended or not. **107. Engineers' alarm *(2022)* 【See Rule】** In application to **107.** of the Rules, for ships not engaged in international voyages, engineers' alarm may be omitted. (hereafter, same as the present)	〈Pt 5 Guidance〉 (Amendment) Reflect Request for Establishment/Revision of Classification Technical Rules 'EAT4400-1304-2021' 〈application date: the date of contract for construction on or after 1 July 2022〉 - to align with administration's regulations.

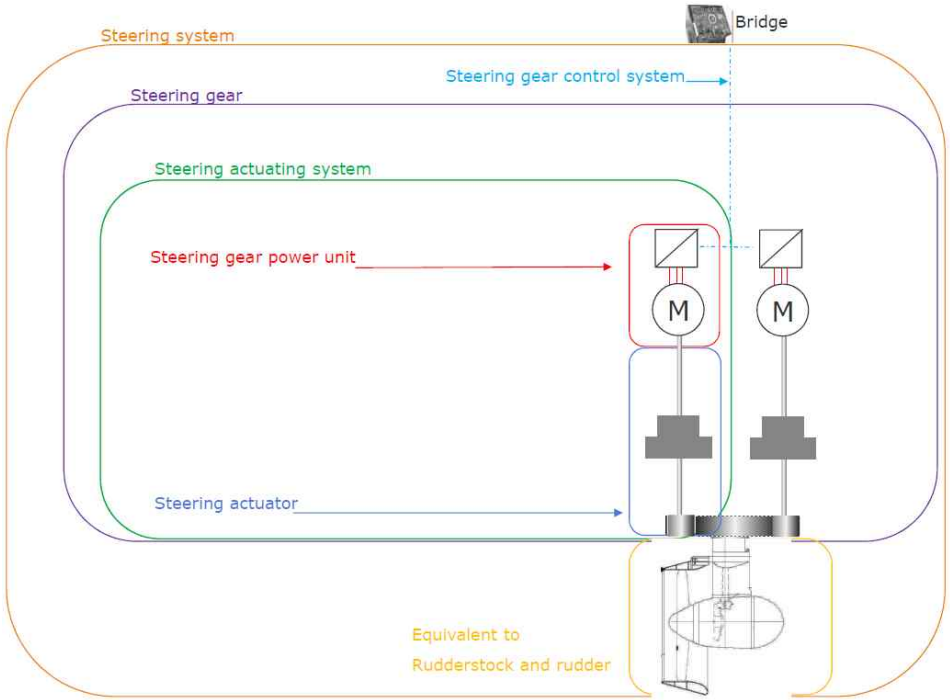
Present	Amendment	Note
CHAPTER 3 PROPULSION SHAFTING AND POWER TRANSMISSION SYSTEMS **Section 1 General** **102. Other propulsion and maneuvering machinery 【See Rule】** In application to **102.** of the Rules, it may be complied with the following; **1. 〈omitted〉** **2.** Bow or side thrusters and their control units (hereinafter called **"thrusters"**) are to comply with the followings. *(2019)* (1) Plans and documents Before the work is commenced, the manufacturers are to submit the following plans and documents in triplicate to the Society for approval. (A) ~ (I) 〈omitted〉 (2) Materials The materials used in the principal component, in principle, are to be complied with the requirements of **Pt 2, Ch 1** of the Rules. However, the Society may accept to be used of the materials which comply with *Korean Industrial Standard* or standard considered as equivalent thereto. (3) Design *(2020)* The construction and strength of propeller blades is to comply with the requirements in **Ch 3, 303.** of the Rules. However, where the manufacturer submits a detailed calculation and deemed as appropriate by the Society, it may be complied with.	**CHAPTER 3 PROPULSION SHAFTING AND POWER TRANSMISSION SYSTEMS** **Section 1 General** **102. Other propulsion and maneuvering machinery 【See Rule】** In application to **102.** of the Rules, it may be complied with the following; **1. 〈same as the present〉** **2.** Bow or side thrusters and their control units (hereinafter called **"thrusters"**) are to comply with the followings. However, in the case of small thrusters with less than 100kW of driving power, the requirements of (1), (2), (3), and (4) (A) below may be omitted. *(2019) (2022)* (1) Plans and documents Before the work is commenced, the manufacturers are to submit the following plans and documents in triplicate to the Society for approval. (A) ~ (I) 〈same as the present〉 (2) Materials The materials used in the principal component, in principle, are to be complied with the requirements of **Pt 2, Ch 1** of the Rules. However, the Society may accept to be used of the materials which comply with *Korean Industrial Standard* or standard considered as equivalent thereto. (3) Design *(2020)* The construction and strength of propeller blades is to comply with the requirements in **Ch 3, 303.** of the Rules. However, where the manufacturer submits a detailed calculation and deemed as appropriate by the Society, it may be complied with.	〈Pt 5 Guidance〉 (Amendment) Reflect Request for Establishment/Revision of Classification Technical Rules 'MAM4800-2093-2021' 〈application date: the date of contract for construction on or after 1 July 2022〉 -Comparing the requirements of Classification Society and other classifications, the 100kW application for pumps, shaft systems, gears, etc. of essential auxiliary is also applied to bow or side thrusters.

Present	Amendment	Note
(4) Shop tests (A) The test requirements of shafting, propellers and power transmission gears are to be applied appropriate modifications respectively such as follows; For shafting, **Ch 3, Sec 2** of the Rules; For propellers, **Ch 3, Sec 3** of the Rules; For power transmission gears **Ch 3, Sec 4** of the Rules. (B) The hydraulic tests for hydraulically pressurised parts of equipment and piping systems are to be in accordance with the requirements of **Ch 6** of the Rules. However, theses shop tests may be substituted for the tests carried out by the manufacturer. (C) The test requirements of piping system are to be applied appropriate modifications of **Ch 6** of the Rules. (D) The requirements of electrical installations are to be applied appropriate modifications of **Pt 6, Ch 1** of the Rules. (5) On board tests The performance test and the safety device test for thruster are to be carried out. (hereafter, omitted)	(4) Shop tests (A) The test requirements of shafting, propellers and power transmission gears are to be applied appropriate modifications respectively such as follows; For shafting, **Ch 3, Sec 2** of the Rules; For propellers, **Ch 3, Sec 3** of the Rules; For power transmission gears **Ch 3, Sec 4** of the Rules. (B) The hydraulic tests for hydraulically pressurised parts of equipment and piping systems are to be in accordance with the requirements of **Ch 6** of the Rules. However, theses shop tests may be substituted for the tests carried out by the manufacturer. (C) The test requirements of piping system are to be applied appropriate modifications of **Ch 6** of the Rules. (D) The requirements of electrical installations are to be applied appropriate modifications of **Pt 6, Ch 1** of the Rules. (5) On board tests The performance test and the safety device test for thruster are to be carried out. (hereafter, same as the present)	

Present	Amendment	Note
CHAPTER 7 STEERING GEARS **Section 1 General** **101. 〈omitted〉** **102. Terminology 【See Rule】** In **102. 1** (3) (A) of the Rules, the motor for electric steering gears is to be considered as part of power unit and actuator.	**CHAPTER 7 STEERING GEARS** **Section 1 General** **101. 〈same as the present〉** **102. Terminology 【See Rule】** **1.** In **102. 1** (3) (A) of the Rules, the motor for electric steering gears is to be considered as part of power unit and actuator. **2.** In addition to **102. 1** of the Rules, the definition of non-traditional steering systems, such as but not limited to, azimuthing propulsors or water jet propulsion systems, is as follows. (See **Fig. 5.7.1 ~ Fig. 5.7.3**) *(2022)* (1) **Steering system** is a ship's directional control system, including steering gear, steering gear control system and rudder (including the rudder stock) if any, or any equivalent system for applying force on the ship hull to cause a change of heading or course. (2) **Steering-propulsion unit** is a unit intended for both propulsion and steering of the ship (for example, an azimuth thruster or a rotating podded electrical thruster). (3) **Steering gear** is the machinery, actuators, power units, and auxiliary equipment applied to turn the rudder or thruster or equivalent about the axis of rotation in both directions for the purpose of steering the ship. (4) **Steering actuating system** consists of a steering gear power unit, a steering actuator and, for hydraulic or electrohydraulic steering gears, the hydraulic piping. (5) **Steering actuator** is a steering gear component which converts power into mechanical action to control the rotation of the rudder or thruster or equivalent. (A) In case of electric steering: electric motor and driving pinion (B) In case of electro hydraulic steering: hydraulic motor and driving pinion (6) **Declared steering angle limits** are the operational limits in terms of maximum steering angle, or equivalent, according to manufacturers' guidelines for safe operation, also taking into account the ship's speed or propeller torque/speed or other limitation; the "declared steering angle limits" are to be declared by the steering system manufacturer for each ship specific non-traditional steering means. ship manoeuvrability tests, such as those in the Standards for ship manoeuvrability (IMO Res. MSC.137(76)) are to be carried out with steering angles not exceeding the declared steering angle limits.	〈Pt 5 Guidance〉 (Amendment) The performance of non-traditional steering gear has been revised according to IACS UI242 (rev.2). 〈application date: the date of contract for construction on or after 01.07.2022〉 - Added definition for non-traditional steering system

Present	Amendment	Note
	 Fig 5.7.1 Definition of non-traditional steering system - where equiped with two identical steering actuating systems	

Present	Amendment	Note
	 Fig 5.7.2 Definition of non-traditional steering system - where equipped with a main steering gear and an auxiliary steering gear	

Present	Amendment	Note
	 Fig 5.7.3 Definition of non-traditional steering system - in case of electric steering system	
103. ~ 104. 〈omitted〉	103. ~ 104. 〈same as the present〉	

Present	Amendment	Note
Section 2 Performance and Arrangement	**Section 2 Performance and Arrangement**	
201. Number of steering gears 【See Rule】	**201. Number of steering gears 【See Rule】**	
1. In case where ships whose required upper stock diameter is not more than 120 mm according to **Pt 4, Ch 1** of the Rules and engaged in the service in smooth water area, or ships with a gross tonnage less than 50 tons, provide that spare parts liable to wear down such as packings, bearings are provided where the main steering gear is operated by power, the auxiliary steering gear required by **201.** of the Rules may be omitted.	**1.** In case where ships whose required upper stock diameter is not more than 120 mm according to **Pt 4, Ch 1** of the Rules and engaged in the service in smooth water area, or ships with a gross tonnage less than 50 tons, provide that spare parts liable to wear down such as packings, bearings are provided where the main steering gear is operated by power, the auxiliary steering gear required by **201.** of the Rules may be omitted.	
2. In case where the auxiliary steering gear as specified in **201. 1** of the Rules is of hydraulic type, the rudder actuator can serve in common with that for the main steering gear. Further, part of the hydraulic piping of the rudder actuator of the main steering gear may be used in common with that for the auxiliary steering gear. In this case, but the pipe length of the part of common use is to be as short as practicable.	**2.** In case where the auxiliary steering gear as specified in **201. 1** of the Rules is of hydraulic type, the rudder actuator can serve in common with that for the main steering gear. Further, part of the hydraulic piping of the rudder actuator of the main steering gear may be used in common with that for the auxiliary steering gear. In this case, but the pipe length of the part of common use is to be as short as practicable.	
3. In application to **201. 1** of Rules, for a ship fitted with alternative propulsion and steering systems, such as but not limited to azimuthing propulsors or water jet propulsion systems, the main steering arrangement and the auxiliary steering arrangement shall be so arranged that the failure of one of them will not render the other one inoperative. For a ship fitted with multiple steering systems, such as but not limited to azimuthing propulsors or water jet propulsion systems, each of the steering systems is to be equipped with its own dedicated steering gear satisfied the following. *(2017)* (1) Each of the steering systems is fulfilling the requirements for main steering gear (as given in **202. 2**). (2) Each of the steering systems is provided with an additional possibility of positioning and locking the failed steering system in a neutral position after a failure of its own power unit and actuator.	**3.** In application to **201. 1** of Rules, ships with non-traditional steering systems, such as but not limited to, azimuthing propulsors or water jet propulsion systems are to comply with the following. *(2022)* (1) For a ship fitted with multiple steering propulsion units, such as but not limited to azimuthing propulsors or water jet propulsion systems each of the steering-propulsion units shall be provided with a main steering gear and an auxiliary steering gear or with two or more identical steering actuating systems in compliance with **201. 4**. The main steering gear and the auxiliary steering gear shall be so arranged that the failure of one of them will not render the other one inoperative. (2) For a ship fitted with a single steering-propulsion unit, the requirement in **201. 1** of Rules is considered satisfied if the steering gear is provided with two or more steering actuating systems and is in compliance with **201. 4**. A detailed risk assessment is to be submitted in order to demonstrate that in the case of any single failure in the steering gear, control system and power supply the ship steering is maintained.	

Present	Amendment	Note
4. In application to **201. 2** of Rules, for a ship fitted with multiple steering systems, such as but not limited to azimuthing propulsors or water jet propulsion systems, an auxiliary steering gear need not be fitted in case that satisfied with the following. *(2017)* (1) In a passenger ship, each of the steering systems is capable of satisfying the requirements in **202. 2** of the Guidance while any one of the power units is out of operation. (2) In a cargo ship, each of the steering systems is capable of satisfying the requirements in **202. 2** of the Guidance while operating with all power units. The above capacity requirements apply regardless whether the steering systems are arranged with common or dedicated power units. (3) Each of the steering systems is to be arranged so that after a single failure in its piping or in one of the power units, ship steering capability (but not individual steering system operation) can be maintained or speedily regained (e.g. by the possibility of positioning the failed steering system in a neutral position in an emergency, if needed).	**4.** In application to **201. 2** of Rules, ships with non-traditional steering systems, such as but not limited to, azimuthing propulsors or water jet propulsion systems are to comply with the following. *(2022)* (1) For a ship fitted with a single steering-propulsion unit where the main steering gear comprises two or more identical power units and two or more identical steering actuators, an auxiliary steering gear need not be fitted provided that the steering gear: (A) in a passenger ship is capable of satisfying the requirements in **202. 2** while any one of the power units is out of operation; in a cargo ship, is capable of satisfying the requirements in **202. 2** while operating with all power units; and (B) is arranged so that after a single failure in its piping system or in one of the power units' steering capability can be maintained or speedily regained. (2) For a ship fitted with multiple steering propulsion units, where each main steering system comprises two or more identical steering actuating systems, an auxiliary steering gear need not be fitted provided that each steering gear: (A) in a passenger ship, is capable of satisfying the requirements in **202. 2** while any one of the steering actuating systems is out of operation; in a cargo ship, is capable of satisfying the requirements in **202. 2** while operating with all steering actuating systems; and (B) is arranged so that after a single failure in its piping system or in one of the steering actuating systems, steering capability can be maintained or speedily regained. The above capacity requirements apply regardless whether the steering systems are arranged with common or dedicated power units.	

Present	Amendment	Note
202. Performances of main steering gear 【See Rule】 **1.** In application to **202. 2** of the Rules, the diameter specified in **Pt 4, Ch 1** of the Rules is to be taken as having been calculated for upper rudder stock of mild steel with a yield strength of 235 N/mm^2 (i.e. with a material factor K_s = 1). **2.** For ships fitted with non-traditional steering arrangements, such as but not limited to azimuthing propulsors or water jet propulsion systems, the main steering arrangements are to be: (1) of adequate strength and capable of steering the ship at maximum ahead service speed which is to be demonstrated; (2) capable of changing direction of the ship"s directional control system from one side to the other at declared steering angle limits at an average rotational speed of not less than 2.3 °/s with the ship running ahead at maximum ahead service speed; (3) for all ships, operated by power; (4) so designed that they will not be damaged at maximum astern speed.	**202. Performances of main steering gear 【See Rule】** **1.** In application to **202. 2** of the Rules, the diameter specified in **Pt 4, Ch 1** of the Rules is to be taken as having been calculated for upper rudder stock of mild steel with a yield strength of 235 N/mm^2 (i.e. with a material factor K_s = 1). **2.** For ships fitted with non-traditional steering arrangements, such as but not limited to azimuthing propulsors or water jet propulsion systems, the main steering arrangements are to be: (1) of adequate strength and capable of steering the ship at maximum ahead service speed which is to be demonstrated; (2) capable of changing direction of the steering-propulsion unit from one side to the other at declared steering angle limits at an average turning speed of not less than 2.3 °/s with the ship running ahead at maximum ahead service speed; (3) for all ships, operated by power; and (4) so designed that they will not be damaged at maximum astern speed. This design requirement need not be proved by trials at maximum astern speed and declared steering angle limits.	
203. Performances of auxiliary steering gear 【See Rule】 **1.** In application to **203. 2** of the Rules, the diameter specified in **Pt 4, Ch 1** of the Rules is to be taken as having been calculated for upper rudder stock of mild steel with a yield strength of 235 N/mm^2 (i.e. with a material factor K_s = 1). **2.** For ships fitted with non-traditional steering arrangements, such as but not limited to azimuthing propulsors or water jet propulsion systems, the auxiliary steering arrangements are to be : (1) of adequate strength and capable of steering the ship at navigable speed and of being brought speedily in to action in an emergency; (2) capable of changing direction of the ship"s directional control system from one side to the other at declared steering angle limits at an average rotational speed, of not less than 0.5 °/s with the ship running ahead at one half of the maximum ahead service speed or 7 knots, whichever is the greater; (3) operated by power where necessary to meet the requirements of (2) and in any ship having power of more than 2,500 kW propulsion power per thruster unit.	**203. Performances of auxiliary steering gear 【See Rule】** **1.** In application to **203. 2** of the Rules, the diameter specified in **Pt 4, Ch 1** of the Rules is to be taken as having been calculated for upper rudder stock of mild steel with a yield strength of 235 N/mm^2 (i.e. with a material factor K_s = 1). **2.** For ships fitted with non-traditional steering arrangements, such as but not limited to azimuthing propulsors or water jet propulsion systems, the auxiliary steering arrangements are to be: (1) of adequate strength and capable of steering the ship at navigable speed and of being brought speedily in to action in an emergency; (2) capable of changing direction of the steering-propulsion unit from one side to the other at declared steering angle limits at an average turning speed, of not less than 0.5 °/s with the ship running ahead at one half of the maximum ahead service speed or 7 knots, whichever is the greater; and (3) operated by power where necessary to meet the requirements of (2) and in any ship having power of more than 2,500 kW propulsion power per steering-propulsion unit.	

Present	Amendment	Note
204. 〈omitted〉	**204. 〈same as the present〉**	<Pt 5 Guidance>
206. Alternative source of power 【See Rule】 **1.** In case of steering gears complied with the following, the requirements of **206.** of the Rules may not be applied. (1) Steering gears equipped in ships with a gross tonnage less than 500 tons, or (2) Steering gears equipped in ships engaged in domestic coastal or smooth water service area **2.** For ships fitted with non-traditional steering arrangements, such as but not limited to azimuthing propulsors or water jet propulsion systems, alternative source of power is to be met the following : (1) Where the propulsion power exceeds 2,500 kW per thruster unit, an alternative power supply, sufficient at least to supply the steering arrangements which complies with the requirements in **203. 2** of the Guidance and also its associated control system and the steering system response indicator, is to be provided automatically within 45s. (2) In every ship of 10,000 gross tonnage and upwards, the alternative power supply is to have a capacity for at least 30 min of continuous operation and in any other ship for at least 10 min. (3) The alternative source of power is to be either: (A) emergency source of electric power; or (B) an independent source of power located in the steering gear compartment and used only for this purpose. (hereafter, omitted)	**206. Alternative source of power 【See Rule】** **1.** In case of steering gears complied with the following, the requirements of **206.** of the Rules may not be applied. (1) Steering gears equipped in ships with a gross tonnage less than 500 tons, or (2) Steering gears equipped in ships engaged in domestic coastal or smooth water service area **2.** For ships fitted with non-traditional steering arrangements, such as but not limited to azimuthing propulsors or water jet propulsion systems, alternative source of power is to be met the following : (1) Where the propulsion power exceeds 2,500 kW per steering-propulsion unit, an alternative power supply, sufficient at least to supply the steering arrangements which complies with the requirements in **203. 2** of the Guidance and also its associated control system and the steering system response indicator, is to be provided automatically within 45s. (2) In every ship of 10,000 gross tonnage and upwards, the alternative power supply is to have a capacity for at least 30 min of continuous operation and in any other ship for at least 10 min. (3) The alternative source of power is to be either: (A) emergency source of electric power; or (B) an independent source of power located in the steering gear compartment and used only for this purpose. (hereafter, same as the present)	

Present	Amendment	Note
Section 5 Testing	**Section 5 Testing**	<Pt 5 Guidance>
503. Sea trials	**503. Sea trials**	
1. ~ 3. 〈omitted〉	**1. ~ 3. 〈same as the present〉**	
4. 〈new〉	**4.** For ships with non-traditional steering systems, such as but not limited to, azimuthing propulsors or water jet propulsion systems are to comply with the following. Ship manoeuvrability tests, such as according to Resolution MSC.137(76) on Standards for ship manoeuvrability, are to be carried out with steering angles not exceeding the declared steering angle limits. *(2022)*	
(hereafter, omitted)	(hereafter, same as the present)	

Present	Amendment	Note
Annex 5-4 Strength Calculation for Gears of Power Transmission Systems **1. ~ 4. 〈omitted〉** **5. General influence factors** (1) ~ (2) 〈omitted〉 (3) Internal Dynamic factor, K_V The dynamic factor which accounts for internally generated dynamic loads due to vibrations of pinion and wheel against each other, is defined as the ratio between the maximum load which dynamically acts on the tooth flanks and the maximum externally applied load ($F_tK_AK_\gamma$). The factor mainly depends on followings. - transmission errors (depending on pitch and profile errors) - masses of pinion and wheel - gear mesh stiffness variation as the gear teeth pass through the meshing cycle - transmitted load including application factor - pitch line velocity - dynamic unbalance of gears and shaft - shaft and bearing stiffness - damping characteristics of the gear system (A) Application (a) ~ (b) 〈omitted〉 (c) For gears other than (a), (b), reference is to be made to Method B outlined in the reference standard ISO 6336-1.	**Annex 5-4 Strength Calculation for Gears of Power Transmission Systems** **1. ~ 4. 〈same as the present〉** **5. General influence factors** (1) ~ (2) 〈same as the present〉 (3) Internal Dynamic factor, K_V The dynamic factor which accounts for internally generated dynamic loads due to vibrations of pinion and wheel against each other, is defined as the ratio between the maximum load which dynamically acts on the tooth flanks and the maximum externally applied load ($F_tK_AK_\gamma$). The factor mainly depends on followings. - transmission errors (depending on pitch and profile errors) - masses of pinion and wheel - gear mesh stiffness variation as the gear teeth pass through the meshing cycle - transmitted load including application factor - pitch line velocity - dynamic unbalance of gears and shaft - shaft and bearing stiffness - damping characteristics of the gear system (A) Application (a) ~ (b) 〈same as the present〉 (c) For gears other than (a), (b), reference is to be made to Method B outlined in the reference standard ISO 6336-1:2019.	〈Pt 5 Guidance〉 (Amendment) Reflecting IACS UR M56 (Rev.4) and 56 (Rev.4 Corr.1), the format for referencing ISO standards has been developed. 〈application date: the date of application for approval on or after 1 July 2022〉

Present	Amendment	Note
(B) Calculation formula (a) For spur gears and for helical gears with overlap ratio $\varepsilon_\beta \geq 1$ $$K_V = 1 + \left(\frac{K_1}{K_A \frac{F_t}{b}} + K_2 \right) \cdot \frac{v \cdot z_1}{100} K_3 \sqrt{\frac{u^2}{1+u^2}}$$ If $K_A \frac{F_t}{b} < 100$ (N/mm), this value is assumed to $K_A \frac{F_t}{b} = 100$ (N/mm). Numerical values for the factor K_1 are to be as specified in the **Table 3**.	(B) Calculation formula (a) For spur gears and for helical gears with overlap ratio $\varepsilon_\beta \geq 1$ $$K_V = 1 + \left(\frac{K_1}{K_A \frac{F_t}{b}} + K_2 \right) \cdot \frac{v \cdot z_1}{100} K_3 \sqrt{\frac{u^2}{1+u^2}}$$ If $K_A \frac{F_t}{b} < 100$ (N/mm), this value is assumed to $K_A \frac{F_t}{b} = 100$ (N/mm). Numerical values for the factor K_1 are to be as specified in the **Table 3**.	

Table 3 Values of K_1

Kind of gear	K_1 (ISO 1328 grades of accuracy)					
	3*	4*	5*	6*	7*	8*
Spur gear	2.1	3.9	7.5	14.9	26.8	39.1
Helical gear	1.9	3.5	6.7	13.3	23.9	34.8

NOTE
* ISO grades of accuracy according to ISO 1328. In case of mating gears with different grades of accuracy the grade corresponding to the lower accuracy is to be used.

Table 3 Values of K_1

Kind of gear	K_1 (ISO grades of accuracy*)					
	3	4	5	6	7	8
Spur gear	2.1	3.9	7.5	14.9	26.8	39.1
Helical gear	1.9	3.5	6.7	13.3	23.9	34.8

NOTE
* ISO grades of accuracy according to ISO 1328-2:2020. In case of mating gears with different grades of accuracy the grade corresponding to the lower accuracy is to be used.

- Reflecting IACS UR M56 (Rev.4 Corr.1)

(hereafter, omitted)

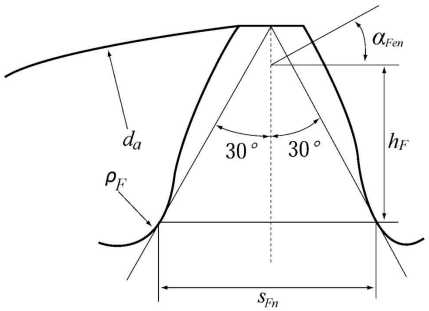
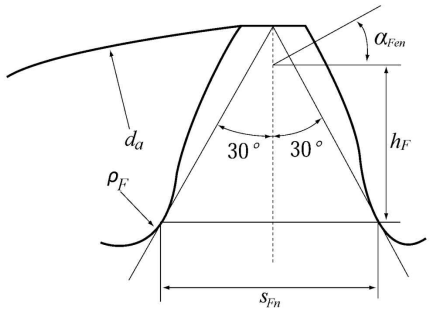
(hereafter, same as the present)

Present	Amendment	Note
(4) Face load distribution factors $K_{H\beta}$, $K_{F\beta}$ The face load distribution factors, $K_{H\beta}$, for contact stress, $K_{F\beta}$, for tooth root bending stress, account for the effect of non-uniform distribution of load across the facewidth. $K_{H\beta}$ and $K_{F\beta}$ are defined as follows: $$K_{H\beta} = \frac{Maximum\ load\ per\ unit\ face\ width}{Mean\ load\ per\ unit\ face\ width}$$ $$K_{F\beta} = \frac{Maximum\ bending\ stress\ at\ tooth\ root\ per\ unit\ face\ width}{Mean\ bending\ stress\ at\ tooth\ root\ per\ unit\ face\ width}$$ The mean bending stress at tooth root relates to the considered face width. $K_{F\beta}$ can be expressed as a function of the factor $K_{H\beta}$. The factors $K_{H\beta}$ and $K_{F\beta}$ mainly depend on: - gear tooth manufacturing accuracy - errors in mounting due to bore errors - bearing clearances - wheel and pinion shaft alignment errors - elastic deflections of gear elements, shafts, bearings, housing and foundations which support the gear elements - thermal expansion and distortion due to operating temperature - compensating design elements (tooth crowning, end relief, etc.) The face load distribution factors, $K_{H\beta}$, for contact stress, and $K_{F\beta}$ for tooth root bending stress, are to be determined according to the Method *C* outlined in the ISO 6336-1 standard. However, where the calculation sheets or data are submitted or the factors are measured actually, the values may be applied according to the discretion of the Society. (A) ~ (B) 〈omitted〉	(4) Face load distribution factors $K_{H\beta}$, $K_{F\beta}$ The face load distribution factors, $K_{H\beta}$, for contact stress, $K_{F\beta}$, for tooth root bending stress, account for the effect of non-uniform distribution of load across the facewidth. $K_{H\beta}$ and $K_{F\beta}$ are defined as follows: $$K_{H\beta} = \frac{Maximum\ load\ per\ unit\ face\ width}{Mean\ load\ per\ unit\ face\ width}$$ $$K_{F\beta} = \frac{Maximum\ bending\ stress\ at\ tooth\ root\ per\ unit\ face\ width}{Mean\ bending\ stress\ at\ tooth\ root\ per\ unit\ face\ width}$$ The mean bending stress at tooth root relates to the considered face width. $K_{F\beta}$ can be expressed as a function of the factor $K_{H\beta}$. The factors $K_{H\beta}$ and $K_{F\beta}$ mainly depend on: - gear tooth manufacturing accuracy - errors in mounting due to bore errors - bearing clearances - wheel and pinion shaft alignment errors - elastic deflections of gear elements, shafts, bearings, housing and foundations which support the gear elements - thermal expansion and distortion due to operating temperature - compensating design elements (tooth crowning, end relief, etc.) The face load distribution factors, $K_{H\beta}$, for contact stress, and $K_{F\beta}$ for tooth root bending stress, are to be determined according to the Method *C* outlined in the ISO 6336-1:2019 standard. However, where the calculation sheets or data are submitted or the factors are measured actually, the values may be applied according to the discretion of the Society. (A) ~ (B) 〈same as the present〉	

Present	Amendment	Note
(5) Transverse load distribution factors for surface durability and bending strength, $K_{H\alpha}$, $K_{F\alpha}$ The transverse load distribution factors, $K_{H\alpha}$ for contact stress and $K_{F\alpha}$ for tooth root bending stress, account for the effects of pitch and profile errors on the transversal load distribution between two or more pairs of teeth in mesh, and are to be determined according to Method B outlined in ISO 6336-1. However, where the calculation sheets or data are submitted or the factors are measured actually, the values may be applied according to the discretion of the Society. The factors $K_{H\alpha}$ and $K_{F\alpha}$ mainly depend on followings. - total mesh stiffness - total tangential load F_t, K_A, K_γ, K_V, $K_{H\beta}$ - base pitch error - tip relief - running-in allowances	(5) Transverse load distribution factors for surface durability and bending strength, $K_{H\alpha}$, $K_{F\alpha}$ The transverse load distribution factors, $K_{H\alpha}$ for contact stress and $K_{F\alpha}$ for tooth root bending stress, account for the effects of pitch and profile errors on the transversal load distribution between two or more pairs of teeth in mesh, and are to be determined according to Method B outlined in ISO 6336-1:2019. However, where the calculation sheets or data are submitted or the factors are measured actually, the values may be applied according to the discretion of the Society. The factors $K_{H\alpha}$ and $K_{F\alpha}$ mainly depend on followings. - total mesh stiffness - total tangential load F_t, K_A, K_γ, K_V, $K_{H\beta}$ - base pitch error - tip relief - running-in allowances	
6. Surface durability The criterion for surface durability is based on the Hertz pressure on the operating pitch point or at the inner point of single pair contact. The contact stress σ_H is to be equal to or less than the permissible contact stress σ_{HP}. (1) ~ (3) 〈omitted〉 (4) Elasticity factor, Z_E The elasticity factor is the value haven relevance with the material properties affected contact stress, and is to be determined as follows. (A) For steel pinions and wheels (E = 206,000 $\mathrm{N/mm^2}$, ν = 0.3) $Z_E = 189.8(\sqrt{\mathrm{N/mm^2}})$ E : Modulus of elasticity ($\mathrm{N/mm^2}$) ν : Poisson's ratio (B) In other cases, reference is to be made to the reference standard ISO 6336-2.	**6. Surface durability** The criterion for surface durability is based on the Hertz pressure on the operating pitch point or at the inner point of single pair contact. The contact stress σ_H is to be equal to or less than the permissible contact stress σ_{HP}. (1) ~ (3) 〈same as the present〉 (4) Elasticity factor, Z_E The elasticity factor is the value haven relevance with the material properties affected contact stress, and is to be determined as follows. (A) For steel pinions and wheels (E = 206,000 $\mathrm{N/mm^2}$, ν = 0.3) $Z_E = 189.8(\sqrt{\mathrm{N/mm^2}})$ E : Modulus of elasticity ($\mathrm{N/mm^2}$) ν : Poisson's ratio (B) In other cases, reference is to be made to the reference standard ISO 6336-2:2019.	

Present	Amendment	Note
(5) ~ (6) 〈omitted〉 (7) Endurance limit for contact stress, σ_{Hlim} For a given material, σ_{Hlim} is the limit of repeated contact stress which can be permanently endured. The value of σ_{Hlim} can be regarded as the level of contact stress which the material will endure without pitting for at least 5×10^7 load cycles. The endurance limit mainly depends on followings. - material composition, cleanliness and defects - mechanical properties - residual stresses - hardening process, depth of hardened zone, hardness gradient - material structure (forged, rolled bar, cast) The endurance limit for contact stress σ_{Hlim}, is to be determined, in general, making reference to values indicated in the standard ISO 6336-5, for material quality MQ. (A) ~ (B) 〈omitted〉 (8) Life factor, Z_N The life factor Z_N, accounts for the higher permissible contact stress in case a limited life (number of cycles) is required. The factor mainly depends on followings. - material and heat treatment - number of cycles - influence factors (Z_R, Z_V, Z_L, Z_W, Z_X) The life factor, Z_n, can is to be determined according to Method B outlined in the reference standard ISO 6336-2.	(5) ~ (6) 〈same as the present〉 (7) Endurance limit for contact stress, σ_{Hlim} For a given material, σ_{Hlim} is the limit of repeated contact stress which can be permanently endured. The value of σ_{Hlim} can be regarded as the level of contact stress which the material will endure without pitting for at least 5×10^7 load cycles. The endurance limit mainly depends on followings. - material composition, cleanliness and defects - mechanical properties - residual stresses - hardening process, depth of hardened zone, hardness gradient - material structure (forged, rolled bar, cast) The endurance limit for contact stress σ_{Hlim}, is to be determined, in general, making reference to values indicated in the standard ISO 6336-5:2016, for material quality MQ. (A) ~ (B) 〈same as the present〉 (8) Life factor, Z_N The life factor Z_N, accounts for the higher permissible contact stress in case a limited life (number of cycles) is required. The factor mainly depends on followings. - material and heat treatment - number of cycles - influence factors (Z_R, Z_V, Z_L, Z_W, Z_X) The life factor, Z_n, can is to be determined according to Method B outlined in the reference standard ISO 6336-2:2019.	

Present	Amendment	Note
(9) Influence factor of lubrication film on contact stress, Z_L, Z_V, Z_R The lubricant factor, Z_L, accounts for the influence of the type of lubricant and its viscosity. The velocity factor, Z_V, accounts for the influence of the pitch line velocity. The roughness factor, Z_R, accounts for the influence of the surface roughness on the surface endurance capacity. The factors may be determined for the softer material where gear pairs are of different hardness. The factors mainly depend on followings. - viscosity of lubricant in the contact zone - the sum of the instantaneous velocities of the tooth surfaces - load - relative radius of curvature at the pitch point - surface roughness of teeth flanks - hardness of pinion and gear (A) ~ (B) 〈omitted〉 (C) Roughness factor, Z_R The roughness facto, Z_R, is to be calculated from the following equations; $$Z_R = \left(\frac{3}{R_{z10}}\right)^{C_{ZR}}$$ Where, $$R_{z10} = R_z \sqrt[3]{\frac{10}{\rho_{red}}}$$ The peak-to-valley roughness determined for the pinion R_{z1} and for the wheel R_{z2} are mean values for the peak-to-valley roughness R_z measured on several tooth flanks (R_z as defined in the reference standard ISO 6336-2) (hereafter, omitted)	(9) Influence factor of lubrication film on contact stress, Z_L, Z_V, Z_R The lubricant factor, Z_L, accounts for the influence of the type of lubricant and its viscosity. The velocity factor, Z_V, accounts for the influence of the pitch line velocity. The roughness factor, Z_R, accounts for the influence of the surface roughness on the surface endurance capacity. The factors may be determined for the softer material where gear pairs are of different hardness. The factors mainly depend on followings. - viscosity of lubricant in the contact zone - the sum of the instantaneous velocities of the tooth surfaces - load - relative radius of curvature at the pitch point - surface roughness of teeth flanks - hardness of pinion and gear (A) ~ (B) 〈same as the present〉 (C) Roughness factor, Z_R The roughness facto, Z_R, is to be calculated from the following equations; $$Z_R = \left(\frac{3}{R_{z10}}\right)^{C_{ZR}}$$ Where, $$R_{z10} = R_z \sqrt[3]{\frac{10}{\rho_{red}}}$$ The peak-to-valley roughness determined for the pinion R_{z1} and for the wheel R_{z2} are mean values for the peak-to-valley roughness R_z measured on several tooth flanks (R_z as defined in the reference standard ISO 6336-2:2019) (hereafter, same as the present)	

Present	Amendment	Note
7. Bending strength The criterion for tooth root bending strength is the permissible limit of local tensile strength in the root fillet. The root stress, σ_F and the permissible root stress, σ_{FP} is to be calculated separately for the pinion and the wheel. σ_F must not exceed σ_{FP}. The following formulae and definitions apply to gears having rim thickness greater than 3.5 m_n. The result of rating calculations made by following this method are acceptable for normal pressure angles up to 25 ° and reference helix angles up to 30°. For larger pressure angles and large helix angles, the calculated results should be confirmed by experience as by Method A of the reference standard ISO 6336-3. (1) 〈omitted〉 (2) Tooth form factor, Y_F The tooth form factor, Y_F, is the values calculated by the following formula. (refer to **Fig 1**) $$Y_F = \frac{6\frac{h_F}{m_n}cos\,\alpha_{Fen}}{\left(\frac{s_{Fn}}{m_n}\right)^2 \cos\alpha_n}$$  **Fig 1 For the Calculation of h_F, s_{Fn} and α_{Fen}** For the calculation of h_F, s_{Fn} and α_{Fen}, the procedure outlined in the reference standard ISO 6336-3 (Method B) is to be used. (3) ~ (6) 〈omitted〉	**7. Bending strength** The criterion for tooth root bending strength is the permissible limit of local tensile strength in the root fillet. The root stress, σ_F and the permissible root stress, σ_{FP} is to be calculated separately for the pinion and the wheel. σ_F must not exceed σ_{FP}. The following formulae and definitions apply to gears having rim thickness greater than 3.5 m_n. The result of rating calculations made by following this method are acceptable for normal pressure angles up to 25 ° and reference helix angles up to 30°. For larger pressure angles and large helix angles, the calculated results should be confirmed by experience as by Method A of the reference standard ISO 6336-3:2019. (1) 〈same as the present〉 (2) Tooth form factor, Y_F The tooth form factor, Y_F, is the values calculated by the following formula. (refer to **Fig 1**) $$Y_F = \frac{6\frac{h_F}{m_n}cos\,\alpha_{Fen}}{\left(\frac{s_{Fn}}{m_n}\right)^2 \cos\alpha_n}$$  **Fig 1 For the Calculation of h_F, s_{Fn} and α_{Fen}** For the calculation of h_F, s_{Fn} and α_{Fen}, the procedure outlined in the reference standard ISO 6336-3:2019 (Method B) is to be used. (3) ~ (6) 〈same as the present〉	

Present	Amendment	Note
(7) Bending endurance limit, σ_{FE} For a given material, σ_{FE} is the local tooth root stress which can be permanently endured. According to the reference standard ISO 6336-5 the number of 3×10^6 cycles is regarded as the beginning of the endurance limit. σ_{FE} is defined as the unidirectional pulsating stress with a minimum stress of zero(disregarding residual stresses due to heat treatment). Other conditions such as alternating stress or prestressing etc. are covered by the design factor Y_d. The σ_{FE} values are to correspond to a failure probability 1% or less. The endurance limit mainly depends on followings. - material composition, cleanliness and defects - mechanical properties - residual stresses - hardening process, depth of hardened zone, hardness gradient - material structure (forged, rolled bar, cast) The bending endurance limit, σ_{FE} is to be determined, in general, making reference to values indicated in the reference standard ISO 6336-5, for material quality MQ. (8) 〈omitted〉 (9) Life factor, Y_N The life factor, Y_N, accounts for the higher tooth root bending stress permissible in case a limited life (number of cycles) is required. The factor mainly depends on followings. - material and heat treatment - number of load cycles (service life) - influence factors ($Y_{\delta rel T}$, $Y_{R rel T}$, Y_X) The life factor, Y_N, is to be determined according to Method B outlined in the reference standard ISO 6336-3. (hereafter, omitted)	(7) Bending endurance limit, σ_{FE} For a given material, σ_{FE} is the local tooth root stress which can be permanently endured. According to the reference standard ISO 6336-5:2016 the number of 3×10^6 cycles is regarded as the beginning of the endurance limit. σ_{FE} is defined as the unidirectional pulsating stress with a minimum stress of zero(disregarding residual stresses due to heat treatment). Other conditions such as alternating stress or prestressing etc. are covered by the design factor Y_d. The σ_{FE} values are to correspond to a failure probability 1% or less. The endurance limit mainly depends on followings. - material composition, cleanliness and defects - mechanical properties - residual stresses - hardening process, depth of hardened zone, hardness gradient - material structure (forged, rolled bar, cast) The bending endurance limit, σ_{FE} is to be determined, in general, making reference to values indicated in the reference standard ISO 6336-5:2016, for material quality MQ. (8) 〈same as the present〉 (9) Life factor, Y_N The life factor, Y_N, accounts for the higher tooth root bending stress permissible in case a limited life (number of cycles) is required. The factor mainly depends on followings. - material and heat treatment - number of load cycles (service life) - influence factors ($Y_{\delta rel T}$, $Y_{R rel T}$, Y_X) The life factor, Y_N, is to be determined according to Method B outlined in the reference standard ISO 6336-3:2019. (hereafter, same as the present)	

Present	Amendment	Note
Annex 5-7 Internal Combustion Engines Supplied with Low Pressure Gas *(2019)*	**Annex 5-7 Internal Combustion Engines Supplied with Low Pressure Gas *(2019)***	〈Pt 5 Guidance〉
1. General	**1. General**	(Amendment) Reflecting IACS UR M78 (Rev.1), the format for referencing standards has been developed. 〈application date: the date of application for type approval on or after 1 July 2022〉
(1) 〈omitted〉 (2) Definitions (A) ~ (J) 〈omitted〉 (K) **IGC Code** means the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (as amended by IMO Resolution MSC.370(93)). (L) **IMO** means the International Maritime Organization. (M) **IGF Code** means the International Code of Safety for Ships Using Gases or other Low-Flashpoint Fuels (IMO Resolution MSC.391(95)).	(1) 〈same as the present〉 (2) Definitions (A) ~ (J) 〈same as the present〉 (K) **IGC Code** means the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (as amended by IMO Resolutions MSC.370(93), MSC.411(97) and MSC.441(99)). (L) **IMO** means the International Maritime Organization. (M) **IGF Code** means the International Code of Safety for Ships Using Gases or other Low-Flashpoint Fuels (IMO Resolution MSC.391(95), as amended by Resolution MSC.422(98)).	
(hereafter, omitted)	(hereafter, same as the present)	
4. Design	**4. Design**	
(1) ~ (7) 〈omitted〉 (8) Gas admission valves (A) Gas admission valves shall be certified safe as follows. (a) ~ (c) 〈omitted〉 (d) However, if they are not rated for the zone they are intended for, it shall be documented that they are suitable for that zone. Documentation and analysis is to be based on IEC 60079-10-1 or IEC 60092-502.	(1) ~ (7) 〈same as the present〉 (8) Gas admission valves (A) Gas admission valves shall be certified safe as follows. (a) ~ (c) 〈same as the present〉 (d) However, if they are not rated for the zone they are intended for, it shall be documented that they are suitable for that zone. Documentation and analysis is to be based on IEC 60079-10-1:2015 or IEC 60092-502:1999.	
(hereafter, omitted)	(hereafter, same as the present)	

Present	Amendment	Note
8. On-board tests (1) Shipboard trials are to be carried out in accordance with the provisions of **Ch 2, 211. 5** of the Rules. (2) For DF engines, the test loads required in **Ch 2, 211. 6 Table 5.2.3** of the Guidance are to be carried out in all operating modes (gas mode, diesel mode, etc.). (hereafter, omitted)	**8. On-board tests** (1) Shipboard trials are to be carried out in accordance with the provisions of **Ch 2, 211. 5** of the Rules. (2) For DF engines, the test loads required in **Ch 2, 211. 6 Table 5.2.3** of the Guidance are to be carried out in all operating modes (gas mode, diesel mode, etc.). The load tests are to be carried out in gas mode at the different percentages of the maximum power available in gas mode (see **5** (1) (A)). The 110% load tests are not required in the gas mode for DF engines. *(2022)* (hereafter, same as the present)	(Amendment) Reflecting IACS UR M78 (Rev.1) 〈application date: the date of contract for construction on or after 1 July 2022〉 - The exemption clauses related to 110% load testing on the gas mode of dual fuel engines are also applied to on-board tests.

Present	Amendment	Note
Annex 5-11 Documents for the Approval of Diesel Engines **1. General** (1) ~ (2) 〈omitted〉 **2. Document flow for obtaining a type approval certificate** (1) For the initial engine type, the engine designer prepares the documentation in accordance with **Table 5.1.4** and **Table 5.1.5** of the Rules including data sheet with general engine information in Table 1 and forwards to the Society according to the agreed procedure for review and approval. *(2019)* (hereafter, omitted)	**Annex 5-11 Documents for the Approval of Diesel Engines** **1. General** (1) ~ (2) 〈same as the present〉 **2. Document flow for obtaining a type approval certificate** (1) For the initial engine type, the engine designer prepares the documentation in accordance with **Table 5.1.4** and **Table 5.1.5** of the Rules including data sheet with general engine information in Table 1 and forwards to the Society according to the agreed procedure for review and approval. *(2019)* (hereafter, same as the present)	<Pt 5 Guidance> (Amendment) Reflecting IACS UR M44 (Rev.10), the format for referencing standards has been developed. <application date: the date of application for type approval on or after 1 July 2022> - ISO 9001 -> ISO 9001:2015 - ISO 8216 -> ISO 8216-1:2017 - MSC.81(70) -> MSC.81(70), as amended by IMO resolutions up to MSC.472(101)

〈Present〉

Table 1 Data Sheet with General Engine Information

Class Application number (if applicable): Engine Manufacturer's Application Identification Number:

General Data	
Engine Designer: Contact Person: Address:	Engine Manufacturer(s), Licensee(s) and/or Manufacturing Sites*Name Country

1. Document purpose *(select options from either 1a or 1b)*	
1a. Type Approval Application	
Service Requested ☐ New Type Approval ☐ Renew Type Approval ☐ Amend Type Approval ☐ Design Evaluation ☐ Update TA Supplement ☐ Other	*Required activities*† • *DA, TT, CoP* • *CoP, if design change then amended or new certificate process to be followed* • *DA & CoP, Further TT if previously approved engine has been substantively modified (as required by UR M71)* • *DA, TT, applicable where designer does not have production facilities, Type Approval to be granted to specific production facility once associated CoP has been completed* • *Update to Supplement, only for minor changes not affecting the Type Approval Certificate* • *e.g. National/Statutory Administration requirements i.e. MSC.81(70) for emergency engines*
For TA Cert amendments or Supplement updates, details of what is to be changed:	
For 'Other', Details of the requirements to be considered:	
1b. Addendum for Individual Engine FAT and Certification	
☐ Individual engine requiring FAT and Certification, only where the performance data for the engine being certified differs from the details provided on the original Type Approval Application. Only section 3b requires completion. Where changes to other sections are necessary, a new Type Approval Application may be required.	
Reference number of *Internal Combustion Engine Approval Application Form* previously submitted and reference number of the Type Approval Certificate.	*(Copy of original application form to be attached to this document)*

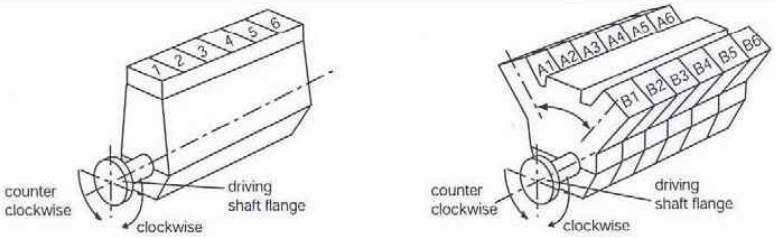
2. Existing documentation			
Previous Class Type Approval Certificate No. or related Design Approval No. *(if applicable)*			
Formerly issued documentation for engine *(E.g. previous type test reports, in-service experience justification reports, etc.)*	Issuing Body:	Document Type:	Document No.:
Existing Certification *(E.g. Manufacturer's quality certification ISO 9001 etc.)*	Issuing Body:	Document Type:	Document No.:

3. Design *(mark all that apply)*				
3a. Engine Particulars:				
Engine Type Manufactured Since‡:		Number of delivered marine engines‡:		
Application	☐ Direct drive Propulsion (☐ Single engine / ☐ Multi-engine installation)		☐ Auxiliary (☐ Aux. Services / ☐ Electric Propulsion)	☐ Emergency
Mechanical Design	☐ 2-stroke ☐ 4-stroke ☐ In-line ☐ Vee (V-angle °) ☐ Other ( ) ☐ Cross-head ☐ Trunk-piston ☐ Reversible ☐ Non-reversible Cylinder bore(mm)		Length of piston stroke (mm)	
Supercharging	☐ Without supercharging ☐ With supercharging ☐ Without charge air cooling ☐ Constant-pressure charging system		☐ With charge air cooling ☐ Pulsating pressure charging system	
Valve operation	☐ Cam control	☐ Electronic control		
Fuel Injection	☐ Direct injection	☐ Indirect injection	☐ Cam controlled injection	☐ Electronically controlled injection

〈Present〉

Table 1 Data Sheet with General Engine Information (continued)

Fuel Types[8] (Classification according to ISO 8216)	☐ Marine residual fuel		cSt (Max. kinematic viscosity at 50°C)
	☐ Marine distillate fuel		DMA, DMB, DMC
	☐ Marine distillate fuel		DMX
	☐ Low flashpoint liquid fuel (specify fuel type)		
	☐ Gas (specify gas type)		
	☐ Other (specify)		
	☐ Dual Fuel (specify combinations of fuels to be used simultaneously)		
3b. Performance Data *(Related to: Barometric pressure 1,000 mbar; Air temperature 45°C; Relative humidity 60%; Seawater temperature 32°C)*			
Model reference No. (if applicable)			
Max. continuous rating	kW/cyl		
Rated speed	1/min		
Mean indicated pressure	MPa		
Mean effective pressure	MPa		
Max. firing pressure	MPa		
Charge air pressure	MPa		
Compression ratio	-		
Mean piston speed	m/s		
3c. Crankshaft			
Design	☐ Solid	☐ Semi-built	☐ Built
Method of Manufacture	☐ Cast	☐ Forged	
		☐ Slab forged	☐ Approved die forged ☐ Continuous grain flow process
State approved forge/works name:			
Is the crankshaft hardened by an approved process which includes the fillet radii of crankpins and journals? ☐ Yes ☐ No If yes, state process:			
Crankshaft material specification: U.T.S. (N/mm²) Yield strength (N/mm²) Hardness value (Brinell/Vickers) Elongation (%)			
Dimensional Data			
If shrunk on webs, state shrinkage allowance (mm)		Yield strength of crankweb material (N/mm²)	
Centre of gravity of connecting rod from large end centre (mm)		Radius of gyration of connecting rod (mm)	
Mass of each crankweb (kg)		Centre of gravity of web from journal axis (mm)	
Mass of each counterweight (kg)		Centre of gravity of each counterweight from journal axis (mm)	
Axial length of main bearing (mm)		Main bearing working clearance (mm)	
Mass of flywheel at driving end (kg)		Mass of flywheel at opposite end (kg)	
Nominal alternating torsional stress in crankpin (N/mm²)		Nominal alternating torsional stress in crank journal (N/mm²)	
Length between centres (Total length)(mm)			
3d. Firing order			



State numbering system of cylinders from left to right as per above diagrams (as applicable)

Number of cylinders	Clockwise firing order	Counter-clockwise firing order

〈Amendment〉

Table 1 Data Sheet with General Engine Information

Class Application number (if applicable): Engine Manufacturer's Application Identification Number:

General Data	
Engine Designer: Contact Person: Address:	Engine Manufacturer(s), Licensee(s) and/or Manufacturing Sites' Name Country

1. Document purpose *(select options from either 1a or 1b)*	
1a. Type Approval Application	
Service Requested ☐ New Type Approval ☐ Renew Type Approval ☐ Amend Type Approval ☐ Design Evaluation ☐ Update TA Supplement ☐ Other	*Required activities*† • *DA, TT, CoP* • *CoP, if design change then amended or new certificate process to be followed* • *DA & CoP, Further TT if previously approved engine has been substantively modified (as required by UR M71)* • *DA, TT, applicable where designer does not have production facilities, Type Approval to be granted to specific production facility once associated CoP has been completed* • *Update to Supplement, only for minor changes not affecting the Type Approval Certificate* • *e.g. National/Statutory Administration requirements i.e. MSC.81(70), as amended by IMO resolutions up to MSC.472(101), for emergency engines*
For TA Cert amendments or Supplement updates, details of what is to be changed:	
For 'Other', Details of the requirements to be considered:	
1b. Addendum for Individual Engine FAT and Certification	
☐ Individual engine requiring FAT and Certification, only where the performance data for the engine being certified differs from the details provided on the original Type Approval Application. Only section 3b requires completion. Where changes to other sections are necessary, a new Type Approval Application may be required.	
Reference number of *Internal Combustion Engine Approval Application Form* previously submitted and reference number of the Type Approval Certificate.	*(Copy of original application form to be attached to this document)*

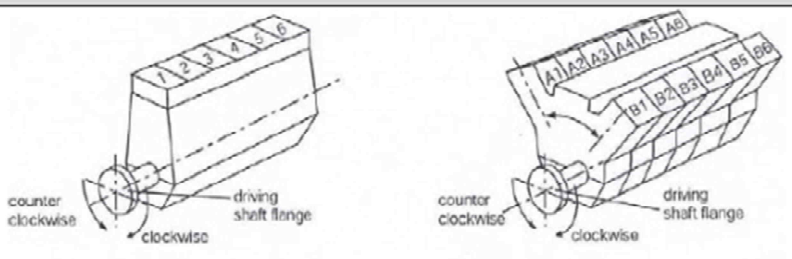
2. Existing documentation			
Previous Class Type Approval Certificate No. or related Design Approval No. *(if applicable)*			
Formerly issued documentation for engine *(E.g. previous type test reports, in-service experience justification reports, etc.)*	Issuing Body:	Document Type:	Document No.:
Existing Certification *(E.g. Manufacturer's quality certification ISO 9001:2015 etc.)*	Issuing Body:	Document Type:	Document No.:

3. Design *(mark all that apply)*				
3a. Engine Particulars:				
Engine Type Manufactured Since‡:			Number of delivered marine engines‡:	
Application	☐ Direct drive Propulsion (☐ Single engine / ☐ Multi-engine installation)		☐ Auxiliary (☐ Aux. Services / ☐ Electric Propulsion)	☐ Emergency
Mechanical Design	☐ 2-stroke ☐ 4-stroke ☐ Cross-head ☐ Trunk-piston Cylinder bore(mm)		☐ In-line ☐ Vee (V-angle °) ☐ Other ( ) ☐ Reversible ☐ Non-reversible Length of piston stroke (mm)	
Supercharging	☐ Without supercharging	☐ With supercharging ☐ Without charge air cooling ☐ Constant-pressure charging system		☐ With charge air cooling ☐ Pulsating pressure charging system
Valve operation	☐ Cam control	☐ Electronic control		
Fuel Injection	☐ Direct injection	☐ Indirect injection	☐ Cam controlled injection	☐ Electronically controlled injection

〈Amendment〉

Table 1 Data Sheet with General Engine Information (continued)

Fuel Types[§] (Classification according to ISO 8216-1:2017)	☐ Marine residual fuel		cSt (Max. kinematic viscosity at 50°C)
	☐ Marine distillate fuel		DMA, DMB, DMC
	☐ Marine distillate fuel		DMX
	☐ Low flashpoint liquid fuel (specify fuel type)		
	☐ Gas (specify gas type)		
	☐ Other (specify)		
	☐ Dual Fuel (specify combinations of fuels to be used simultaneously)		
3b. Performance Data *(Related to: Barometric pressure 1,000 mbar; Air temperature 45°C; Relative humidity 60%; Seawater temperature 32°C)*			
Model reference No. (if applicable)			
Max. continuous rating	kW/cyl		
Rated speed	1/min		
Mean indicated pressure	MPa		
Mean effective pressure	MPa		
Max. firing pressure	MPa		
Charge air pressure	MPa		
Compression ratio	-		
Mean piston speed	m/s		
3c. Crankshaft			
Design	☐ Solid	☐ Semi-built	☐ Built
Method of Manufacture	☐ Cast	☐ Forged	
		☐ Slab forged	☐ Approved die forged ☐ Continuous grain flow process
State approved forge/works name:			
Is the crankshaft hardened by an approved process which includes the fillet radii of crankpins and journals? ☐ Yes ☐ No If yes, state process:			
Crankshaft material specification: U.T.S. (N/mm²) Yield strength (N/mm²) Hardness value (Brinell/Vickers) Elongation (%)			
Dimensional Data			
If shrunk on webs, state shrinkage allowance (mm)		Yield strength of crankweb material (N/mm²)	
Centre of gravity of connecting rod from large end centre (mm)		Radius of gyration of connecting rod (mm)	
Mass of each crankweb (kg)		Centre of gravity of web from journal axis (mm)	
Mass of each counterweight (kg)		Centre of gravity of each counterweight from journal axis (mm)	
Axial length of main bearing (mm)		Main bearing working clearance (mm)	
Mass of flywheel at driving end (kg)		Mass of flywheel at opposite end (kg)	
Nominal alternating torsional stress in crankpin (N/mm²)		Nominal alternating torsional stress in crank journal (N/mm²)	
Length between centres (Total length)(mm)			
3d. Firing order			



State numbering system of cylinders from left to right as per above diagrams (as applicable)

Number of cylinders	Clockwise firing order	Counter-clockwise firing order