CCS Rule Change Notice For:

RULES FOR CLASSIFICATION OF SEA-GOING STEEL SHIPS

Version: Dec 2018.   RCN No.3

Effective date: 1 Jan 2019

Beijing

CHINA CLASSIFICATION SOCIETY

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PART ONE

Brief Introduction

According to IACS URZ18 (Rev.8 July 2018), UR Z 20 (Rev.1 July 2018), UR Z 27 (New July 2018), the relevant specifications are added or revised.

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CHAPTER 4 SURVEYS DURING CONSTRUCTION

Section 2 SURVEYS AND TESTS

4.2.1 General requirements

4.2.1.3 For ships contracted for construction on or after 1 January 2008 and for international voyages, the hull survey during construction is additionally to be in accordance with the requirements in Appendix 1 of this Chapter.

CHAPTER 5 SURVEYS AFTER CONSTRUCTION

Section 9 SURVEYS OF MACHINERY

5.9.1 General requirements

5.9.1.5 Surveys of machinery may be carried out on a Planned Maintenance Scheme (PMS) basis (Reference to the appendix 16 of this chapter).

5.9.1.6 Surveys of machinery may be carried out on a Condition Monitoring (CM) and Condition Based Maintenance (CBM) basis (Reference to the appendix 22 of this chapter).

Appendix 16 GUIDELINES FOR SURVEY OF PLANNED MAINTENANCE SCHEME（PMS）FOR MACHINERY[①]

1 General

1.3 Requirements for owner or ship management company

1.3.3 Maintenance intervals and examination items

~~(4) Unless otherwise specified, the maintenance of the equipment effectively controlled by the approved condition monitoring system may be carried out in accordance with the maintenance intervals indicated in the specifications of manufacturers, but not to exceed 5 years as maximum. Apparatus and sensors with condition monitoring techniques used by condition monitoring equipment are to be provided with certificates of metrological verification.~~

(~~5~~4) Items subject to confirmatory examination each year and items to be overhauled once within a five-year survey period are to be indicated by “F” and “H” respectively in Annex “Items for Survey of PMS” to this Appendix.

1.3.4 Requirements for PMS database system

(2) Function requirements

~~⑤ Condition monitoring equipment~~

~~a. where condition monitoring equipment is used by the ship, a matching interface is to be provided to deal with the data transmitted by condition monitoring equipment and to put forward recommendations;~~

~~⑥~~⑤ Correction/self-checking function

a. software is to be capable of identifying normal faulty operation and correcting automatically;

b. software is to be capable of testing normal mistakes in database;

1.4 Definitions

① Changes introduced in this revision are to be uniformly implemented from 1 July 2019.

~~1.4.4 Condition monitoring equipment means that the monitoring is to be carried out periodically for the equipment (the frequency of monitoring is to be in accordance with the specifications of manufacturers) by means of condition monitoring techniques, e.g. analyzing vibration signal, lubricating oil and impact impulses, measuring temperature and internal detection of cylinder. The monitored data are analyzed to determine whether repair or maintenance is necessary. Such equipment, the operation condition of which is analyzed and judged by applying condition monitoring techniques, is called condition monitoring equipment.~~

1.4.~~5~~4 Confirmatory audit means confirmation of validity of the class notation PMS. For the survey of PMS, an annual audit is to be made in accordance with the requirements of 3.2 of Section 3 when the annual/intermediate/special survey is carried out every year.

1.4.~~6~~5 Implementation survey means the first confirmatory survey of PMS for the ship which applies for survey of PMS within one year of its trial.

2 Procedural Requirements

2.2 Approval documentation

2.2.1 While the owner or ship management company applies to CCS for assignment of PMS notation, the following written documentation or electronic file are to be submitted for approval:

~~(7) List and specifications of condition monitoring equipment, if any;~~

~~(8) Baseline data for condition monitoring equipment, if any;~~

(~~9~~7) Type approval certificate of PMS computer management software approved by CCS.

2.3 Documentation to be kept on board

2.3.1 The following documentation are to be kept on board:

~~(3) All monitored data of the condition monitoring equipment since last overhaul, including initial baseline data of the equipment (if any);~~

(~~4~~3) Reference documents (trend analysis procedure, etc.);

(~~5~~4) Records of maintenance, including repairs and renewals carried out.

2.5 Assignment of class notation

2.5.3 For the ship which is assigned the class notation PMS for the first time, a class memorandum is to be given and Implementation Survey is to be carried out by CCS Surveyor within one year since the approval date of the PMS.

3 Survey Requirements

3.1 Implementation survey

3.1.1 For the ship which begins to carry out the PMS, trial is to be completed before implementation of the survey. After the trial is finished, the owner or ship management company is to apply to CCS for an implementation survey ~~and submit an trial implementation report at the same time~~.

3.1.3 When this survey is carried out and the implementation is found in order, a report describing the PMS shall be submitted to CCS survey unit by the owner or ship management company and the approved PMS may replace the CMS.

3.2 Annual Audit[①]

3.2.2 During the annual confirmatory audit, The surveyor shall review the annual report or verify that it has been reviewed by CCS. An annual report covering the year's service, including the information as required under the clauses (3) and (5) as well as the information on changes to other clauses in 2.2.1. the owner or ship management company is to submit the annual report of PMS implementation to CCS survey unit. The report is to include at least the updated contents of the items mentioned in 2.2.1(1) to (6) (if any), and:

(1) list of PMS equipment maintenance completed since the previous annual audit;

(2) general condition of all machineries operated since the previous annual audit;

(3) details of machinery breakdown/malfunction and cause analysis (if any);

(4) repair records and renewal of spare parts, the components or equipment which have been replaced are to be kept for inspection by the Surveyor (if any).

3.2.3 During the annual audit, the Surveyor is to examine the following items when reviewing the annual report submitted by the owner or ship management company.

(5) At the discretion of the Surveyor, function tests, confirmatory surveys and random check readings, where condition monitoring equipment is in use, are to be carried out as far as practicable and reasonable.

(65) When the Surveyor deems, in examining maintenance records, that the measured data are not correct or that the data exceed acceptable tolerances with no renewal being made and that the machinery malfunction is not properly handled, he may require the chief engineer to open the equipment for further survey.

(76) General examination is to be carried out for items indicated by "F" in Annex "Items for Survey of PMS" to this Appendix, and all items indicated by "H" which have been completed form the previous annual audit to this annual audit are to be verified and visual examination to be carried out.

(87) For the items indicated by "F" in Annex "Items for Survey of PMS" to this Appendix, when the overhaul time coincides with the time of annul audit, confirmatory examination is to be carried out under the surveyor's supervision; for the items indicated by "H" in Annex "Items for Survey of PMS" to this Appendix, when the overhaul and test time coincides with the time of annul audit, overhaul and test are to be carried out under the surveyor's supervision.

(98) According to the audit and examination results, the Surveyor is to issue an appropriate audit report and the class notation PMS is to be maintained.

Appendix 22 Condition Monitoring and Condition Based Maintenance[②]

1 General

1.1 Application

1.1.1 These requirements apply to the approved Condition Monitoring and Condition Based Maintenance schemes where the condition monitoring results are used to influence the scope and/or frequency of Class survey.

1.1.2 This scheme may be applied to components and systems covered by Continuous Machinery Survey (CMS), and other components and systems as requested by the owner. The extent of Condition Based Maintenance and associated monitoring equipment to be included in the maintenance scheme is decided by the Owner.

1.1.3 These requirements can be applied only to vessels operating on approved PMS survey scheme.

1.1.4 The scheme may be applied to any individual items and systems. Any items not covered by the scheme shall be surveyed and credited in accordance with the requirements of UR Z18 and / or UR Z20.

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① The term audit, in this context, is not related to ISM audit, the implementation of surveys is to be completed prior to the commencement of the audit.

② Changes introduced in this revision are to be uniformly implemented from 1 Jan. 2020.

1.2 Definitions

1.2.1 The following standard terms are defined in ISO 13372:2012:

(1) Condition monitoring: acquisition and processing of information and data that indicate the state of a machine over time. The machine state deteriorates if faults or failures occur.

(2) Diagnostic: examination of symptoms and syndromes to determine the nature of faults or failures.

(3) Condition Based Maintenance: maintenance performed as governed by condition monitoring programmes.

1.3 Condition Monitoring (CM)

1.3.1 Where an approved condition monitoring system is fitted, credit for survey may be based on acceptable condition monitoring results. The condition monitoring results are to be reviewed during the annual audit.

1.3.2 Limiting parameters are to be based on the Original Equipment Manufacturers guidelines (OEM), or a recognised international standard.

1.3.3 The condition monitoring system is to provide an equivalent or greater degree of confidence in the condition of the machinery to traditional survey techniques.

1.3.4 The condition monitoring system shall be approved in accordance with CCS's procedures.

1.3.5 A condition monitoring system may be used to provide a greater understanding of equipment condition, and a condition based maintenance scheme may be used to obtain maintenance efficiency. Class approval is required where owners wish to change the survey cycle based on CM/CBM.

1.3.6 Software systems can use complex algorithms, machine learning and knowledge of global equipment populations/defect data in order to identify acceptability for continued service or the requirement for maintenance. These systems may be independent of the OEM recommended maintenance and condition monitoring suggested limits. Approval of this type of software is to be based on OEM recommendations, industry standards and CCS experience.

1.3.7 CCS retains the right to test or open-up the machinery, irrespective of the CM results, if deemed necessary.

1.4 Condition Based Maintenance

1.4.1 Where an owner wishes to base their equipment maintenance on a CBM approach, this is to meet the requirements of the ISM Code.

1.4.2 Where an agreed planned maintenance and CBM scheme is in operation, the CMS and other survey intervals may be extended based on OEM maintenance recommendations and acceptable condition monitoring results.

1.4.3 Limiting parameters (alarms and warnings) are to be based on the OEM guidelines, or a recognised international standard.

1.4.4 The CBM scheme is to provide an equivalent or greater degree of confidence in the condition of the machinery to traditional maintenance techniques.

1.4.5 The scheme shall be approved in accordance with CCS's procedures.

1.4.6 Software systems can use complex algorithms, machine learning and knowledge of global equipment populations/defect data in order to identify acceptability for continued service or the requirement for maintenance. These systems may be independent of the OEM recommended maintenance and condition monitoring suggested limits. Approval of this type of software is to be based on OEM recommendations, industry standards and CCS experience.

2 Procedures and Conditions for approval of Condition Monitoring and Condition Based Maintenance

2.1 Onboard Responsibility

2.1.1 The chief engineer shall be the responsible person on board in charge of the CM and CBM.

2.1.2 Documentation on the overhaul of items covered by CM and CBM schemes shall be reported by the chief engineer.

2.1.3 Access to computerized systems for updating of the maintenance documentation and maintenance program shall only be permitted by the chief engineer or other authorized person.

2.1.4 All personnel involved in CM and CBM shall be appropriately qualified.

Note: CM does not replace routine surveillance or the chief engineer's responsibility for taking decisions in accordance with his judgement.

2.2 Equipment and System Requirements
2.2.1 CM equipment and systems shall be approved in accordance with a procedure of CCS.
2.2.2 The CM/CBM scheme and its extent, are to be approved by CCS.
2.2.3 The CBM scheme is to be capable of producing a condition report, and maintenance recommendations.
2.2.4 A system is to be provided to identify where limiting parameters (alarms and warnings) are modified during the operation of the scheme.
2.2.5 Where CM and CBM schemes use remote monitoring and diagnosis (i.e. data is transferred from the vessel and analysed remotely), the system is to meet the applicable standards for Cyber Safety and Security. The system shall be capable of continued onboard operation in the event of loss of the communication function.
2.2.6 CBM schemes are to identify defects and unexpected failures that were not prevented by the CM system.
2.2.7 Systems shall include a method of backing up data at regular intervals.

2.3 Documentation and Information
2.3.1 The following documentation shall be made available to the Society for the approval of the scheme:
(1) Procedure for changes to software system and CM parameters
(2) Listing of equipment to be included in the scheme
(3) Listing of acceptable condition monitoring parameters
(4) Description of CBM scheme
(5) Listing, specifications and maintenance procedures for condition monitoring equipment
(6) Baseline data for equipment with condition monitoring
(7) Qualification of personnel and company responsible for analysing CM results
2.3.2 In addition to the above documentation the following information shall be available on board:
(1) All clauses in 2.3.1 in an up-to-date fashion
(2) Maintenance instructions (manufacturer's and shipyard's)
(3) Condition monitoring data including all data since last opening of the machine and the original base line data
(4) Reference documentation (trend investigation procedures etc.)
(5) Records of maintenance including repairs and renewals carried out
(6) Records of changes to software systems and parameters
(7) Sensors calibration records / certification / status

2.4 Approval validity
2.4.1 An Annual Audit shall be carried out to maintain the validity of the CM/CBM scheme.
2.4.2 The survey arrangement for machinery under CM/CBM can be cancelled by CCS if the scheme is not being satisfactorily carried out either from the maintenance records or the general condition of the machinery.
2.4.3 The case of sale or change of management of the ship or transfer of class shall cause the approval to be reconsidered.
2.4.4 The ship owner may, at any time, cancel the survey arrangement for machinery under the scheme by informing CCS in writing and for this case the items which have been inspected under the scheme since the last annual Audit can be credited for class at the discretion of the attending surveyor.

3 Surveys

3.1 Installation Survey
3.1.1 Condition monitoring equipment is to be installed and surveyed in accordance with CCS rules, and a set of base line readings is to be taken.

3.2 Implementation Survey
3.2.1 The Implementation Survey shall be carried out by CCS's surveyor no earlier than 6 months after installation survey and no later than the first Class annual survey.
3.2.2 During the Implementation survey the following shall be verified by a surveyor:
(1) the CM/CBM scheme is implemented according to the approval documentation, including a comparison with baseline data;

(2) the scheme is producing the documentation required for the Annual Audit and the requirements of surveys and testing for the maintenance of class are complied with;
(3) the onboard personnel are familiar with operating the scheme.
(4) records of any limiting parameters (alarms and warnings) that have been modified during the operation of the scheme.
(5) Records of any failures of monitored equipment are to be reviewed to ensure that the condition monitoring scheme is effective / sufficient.
3.2.3 When this survey is carried out and the implementation is found in order, a report describing the scheme shall be submitted to CCS and the scheme may be put into service.

3.3 Annual Survey
3.3.1 An annual audit of the CM and CBM scheme shall be carried out by a CCS's surveyor concurrently with the Class annual survey.
3.3.2 The purpose of this audit shall be to verify that the scheme is being correctly operated and that the machinery has been functioning satisfactorily since the previous audit. This is to include any limiting parameters (alarms and warnings) that have been modified since the last audit. A general examination of the items concerned shall be carried out.
3.3.3 The performance, condition monitoring and maintenance records shall be examined to verify that the machinery has functioned satisfactorily since the previous survey, or action has been taken in response to machinery operating parameters exceeding acceptable tolerances.
3.3.4 Written details of break-down or malfunction shall be made available.
3.3.5 At the discretion of the surveyor, function tests, confirmatory surveys and random check readings, where Condition Monitoring / Condition Based Maintenance equipment is in use, shall be carried out as far as practicable and reasonable.
3.3.6 The familiarity of the chief engineer and other personnel involved with the CM system shall be verified.
3.3.7 Calibration status of sensors and equipment shall be verified.
3.3.8 Verification that the suitability of the CM/CBM scheme has been reviewed following defects and failures shall be carried out.

3.4 Damage and repairs
3.4.1 Damage to components or items of machinery is to be reported to CCS. The repairs of such damaged components or items of machinery are to be carried out to the satisfaction of the Surveyor.
3.4.2 Details of repairs and maintenance carried out shall be examined. Any machinery part, which has been replaced by a spare one, due to damage, is to be retained on board where possible until examined by CCS's Surveyor.
3.4.3 Defect and failure data is to be reviewed in order to ensure the system output is appropriate. Where necessary, following review of the failure data, there is to be a method of amending the CM and CBM scheme.

CCS Rule Change Notice For:

RULES FOR CLASSIFICATION OF SEA-GOING STEEL SHIPS

PART TWO　HULL

Brief Introduction

1. Incorporating the latest revision of UR S6, which will take effect on 1 July 2019.
2. Revising Selection of Welding Consumables in accordance with the latest revision of UR W17, which will take effect on 1 July 2019.
3. Updating the rules in accordance with the latest Finnish-Swedish Ice Class Rules, which will take effect on 1 January 2019.

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CHAPTER 1 GENERAL

Section 3 MATERIALS

1.3.4 ~~Requirements for hull structural steel~~ Ships exposed to low air temperatures[①]

1.3.4.1 For ships intended to operate in areas with low air temperatures (below -10℃~~and including -20℃~~), e.g. regular service during winter seasons to Arctic or Antarctic waters, the materials in exposed structures are to be selected based on the design temperature t_D.

1.3.4.2 Grades of hull structural steel above the lowest ballast waterline (BWL) exposed to low air temperatures (including the plating covered by Note ⑤ of Table 1.3.4.2) and materials of cargo tank boundary plating for which 1.3.4.7 is applicable are not to be lower than those as given in Table 1.3.4.2. For n~~N~~on-exposed hull structural steel above BWL (except for ⑤ as indicated in Table 1.3.4.2) and hull structural steel below BWL, ~~are to be in compliance with~~ the requirements in 1.3.2 of this Section apply.

Material Classes at Low Air Temperatures **Table 1.3.4.2**

Structural member category	Structural member	Material class	
		Within 0.4*L* amidships	Outside 0.4*L* amidships
Secondary	Deck plating exposed to weather in general, side plating above BWL, transverse bulkheads above BWL[⑤], Cargo tank boundary plating exposed to cold cargo[⑥]	I	I
Primary	Strength deck plating[①] Continuous longitudinal members above strength deck, excluding longitudinal hatch coamings Longitudinal bulkhead above BWL[⑤] Top wing tank bulkhead above BWL[⑤]	II	I
Special	Sheer strake at strength deck, including rounded gunwale[②] Stringer plate in strength deck[②] Deck strake at longitudinal bulkhead[③] Continuous longitudinal hatch coamings[④]	III	II

Notes: ① Plating at corners of large hatch openings to be specially considered. Class III or grade E/EH to be applied in positions where high local stresses may occur.

② Not to be less than grade E/EH within 0.4 *L* amidships in ships with length exceeding 250 m.

③ In ships with breadth exceeding 70 m at least three deck strakes to be class III.

④ Not to be less than grade D/DH.

⑤ Applicable to plating attached to hull envelope plating exposed to low air temperature. At least one strake is to be considered in the same way as exposed plating and the strake width is to be at least 600 mm

⑥ For cargo tank boundary plating exposed to cold cargo for ships other than liquefied gas carriers, the requirements of 1.3.4.7 are to be satisfied.

Material Grade Requirements for Classes I, II and III at Low Temperatures **Table 1.3.4.3**

Class I										
Plate thickness(mm)	-11～-15℃		~~-20~~ -16～-25℃		-26～-35℃		-36～-45℃		-46～-55℃	
	Mild steel	Higher tensile steel	Mild steel	Higher tensile steel	Mild steel	Higher tensile steel	Mild steel	Higher tensile steel	Mild steel	Higher tensile steel
t≤10	A	AH	A	AH	B	AH	D	DH	D	DH
10＜t≤15	A	AH	B	AH	D	DH	D	DH	D	DH
15＜t≤20	A	AH	B	AH	D	DH	D	DH	E	EH
20＜t≤25	B	AH	D	DH	D	DH	D	DH	E	EH
25＜t≤30	B	AH	D	DH	D	DH	E	EH	E	EH
30＜t≤35	D	DH	D	DH	D	DH	E	EH	E	EH
35＜t≤45	D	DH	D	DH	E	EH	E	EH	–	FH
45＜t≤50	D	DH	E	EH	E	EH	–	FH	–	FH

Class II										
Plate thickness(mm)	-11～-15℃		~~-20~~ -16～-25℃		-26～-35℃		-36～-45℃		-46～-55℃	
	Mild steel	Higher tensile steel	Mild steel	Higher tensile steel	Mild steel	Higher tensile steel	Mild steel	Higher tensile steel	Mild steel	Higher tensile steel
t≤10	A	AH	B	AH	D	DH	D	DH	E	EH
10＜t≤20	B	AH	D	DH	D	DH	E	EH	E	EH
20＜t≤30	D	DH	D	DH	E	EH	E	EH	–	FH

[①] Changes introduced in this revision are to be uniformly implemented from 1 July 2019.

30＜t≤40	D	DH	E	EH	E	EH	–	FH	–	FH
40＜t≤45	E	EH	E	EH	–	FH	–	FH	–	–
45＜t≤50	E	EH	E	EH	–	FH	–	FH	–	–
Class III										
Plate thickness(mm)	-11～-15℃		~~-20~~ -16～-25℃		-26～-35℃		-36～-45℃		-46～-55℃	
	Mild steel	Higher tensile steel	Mild steel	Higher tensile steel	Mild steel	Higher tensile steel	Mild steel	Higher tensile steel	Mild steel	Higher tensile steel
t≤10	B	AH	D	DH	D	DH	E	EH	E	EH
10＜t≤20	D	DH	D	DH	E	EH	E	EH	–	FH
20＜t≤25	D	DH	E	EH	E	EH	E	FH	–	FH
25＜t≤30	D	DH	E	EH	E	EH	–	FH	–	FH
30＜t≤35	E	EH	E	EH	–	FH	–	FH	–	–
35＜t≤40	E	EH	E	EH	–	FH	–	FH	–	–
40＜t≤50	E	EH	–	FH	–	FH	–	–	–	–

Note: "–" in the Table = Not applicable.

1.3.4.7 Cold cargo for ships other than liquefied gas carriers

For ships other than liquefied gas carriers, intended to be loaded with liquid cargo having a temperature below -10℃, e.g. loading from cold onshore storage tanks during winter conditions, the material grade of cargo tank boundary plating is defined in Table 1.3.4.3 based on the following:

(1) t_c design minimum cargo temperature in ℃;

(2) steel grade corresponding to Class I as given in Table 1.3.4.2.

The design minimum cargo temperature, t_c is to be specified in the loading manual.

Section 4 WELD DESIGN FOR HULL STRUCTURES

1.4.2 Welding consumables①

1.4.2.1 Welding consumables used for hull structures are to comply with the requirements of CCS Rules for Materials and Welding. The grade of welding consumables selected is to be suitable for the grade of hull structural steel, and is to comply with the requirements of Table 1.4.2.1.

Selection of Welding Consumables **Table 1.4.2.1**

Hull structural steel grade / Grade of welding consumables	A	B	D	E	AH32 AH36	DH32 DH36	EH32 EH36	FH32 FH36	AH40	DH40	EH40	FH40
1	×											
2	×	×	×									
3	×	×	×	×								
1Y	×				×②							
2Y	×	×	×		×	×						
3Y	×	×	×	×	×	×	×					
4Y	×	×	×	×	×	×	×	×				
2Y40	①	①	①		×	×			×	×		
3Y40	①	①	①	①	×	×	×		×	×	×	
4Y40	①	①	①	①	×	×	×	×	×	×	×	×
5Y40	①	①	①	①	×	×	×	×	×	×	×	×

Notes: "×" means applicable;

① When joining structural steels of normal strength, it is not recommended to use a much higher grade of welding consumable.

② When using Grade 1Y welding consumables, the material thicknesses should not exceed 25 mm.

① Changes introduced in this revision are to be uniformly implemented from 1 July 2019.

CHAPTER 4 STRENGTHENING FOR NAVIGATION IN ICE

Section 1 GENERAL PROVISIONS

4.1.1 General requirements

4.1.1.4 The equivalence between ice strengthening requirements for B1*, B1, B2, B3 and B of CCS and the ice classes of Finnish-Swedish Ice Class Rules ~~2010~~2017 (FSICR) is given in Table 4.1.1.4.

Section 2 ICE STRENGTHENING FOR CLASSES B1*, B1, B2 AND B3

4.2.1 General requirements

4.2.1.1 The provisions of this Section ~~entered into force on 1 December 2010 and~~ apply to strengthening requirements for hull structures of merchant ships ~~contracted for construction on and after 1 January 2012~~ navigating in the Baltic or other sea areas with similar ice conditions in winter. ~~The provisions of this Section may also be applied to ships contracted for construction on and after 1 December 2010. In addition, the provisions of 4.2.1.2 and 4.2.2 of this Section apply to all ships irrespective of their year of build.~~

4.2.4 Hull structural design

4.2.4.1 General

4.2.4.2 Ice load

(2) Ice pressure

The design ice pressure p is not to be less than that obtained from the following formula:

$$p = c_d c_p c_a p_0 \quad \text{MPa}$$

where: c_d — factor which takes account of the influence of the size and engine output of the ship. This factor is taken as maximum $c_d = 1$, to be calculated by the formula:

$$c_d = \frac{ak + b}{1000}$$

where: $k = \frac{\sqrt{\Delta P}}{1000}$;

a, b — see Table 4.2.4.2(2);

Δ — see 4.2.2.2 of this Section;

P — actual continuous engine output of the ship when sailing in ice in accordance with Chapter 14, PART THREE of the Rules, in kW; If additional power sources are available for propulsion power (e.g. shaft motors) in addition to the power of the main engine(s), they are also to be included in the total engine output used as the basis for hull scantling calculations. The engine output used for the calculation of the hull scantlings is to be clearly stated on the shell expansion drawing.

Table 4.2.4.2(2)

	Region			
	Bow		Midbody & Stern	
	$k \leq 12$	$k > 12$	$k \leq 12$	$k > 12$
a	30	6	8	2
b	230	518	214	286

c_p — ~~factor which takes account of the probability that the design ice pressure occurs in a certain region of the hull for the ice class in question~~ factor that reflects the magnitude of the load expected in the hull area in question relative to the bow area, see Table 4.2.4.2(3);

Table 4.2.4.2(3)

Ice class	Region		
	Bow	Midbody	Stern
B1*	1.0	1.0	0.75
B1	1.0	0.85	0.65
B2	1.0	0.70	0.45

B3	1.0	0.50	0.25

4.2.4.4 Side framing

(1) Vertical extension of the ice strengthening of the side framing

Where the ice-strengthening would go beyond a deck or ~~a tank top (or tank bottom)~~ the top or bottom plating of a tank or tank top by no more than 250 mm, it can be terminated at that deck or top or bottom plating of the tank or tank top~~tank top (or tank bottom)~~.

(b) Requirements for upper end of transverse framing

The upper end of the strengthened part of a main frame and of an intermediate ice frame is to be attached to a deck, ~~tank top (or tank bottom)~~ top or bottom plating of a tank or an ice stringer.

Where an intermediate frame terminates above a deck or a stringer which is situated at or above the upper limit of the ice belt, the part above the deck or stringer may have the scantlings required in this PART for an non ice-strengthened ship and the upper end of an intermediate frame may be connected to the adjacent frames by a horizontal member having the same scantlings as the main frame.

(c) Requirements for lower end of transverse framing

The lower end of the strengthened part of a main frame and of an intermediate ice frame is to be attached to a deck, ~~tank top (or tank bottom)~~ top or bottom plating of a tank or an ice stringer.

Where an intermediate frame terminates below a deck, tank top (or tank bottom) or ice stringer which is situated at or below the lower limit of the ice belt, the lower end may be connected to the adjacent main frames by a horizontal member of the same scantlings as the main frames. Note that the main frames below the lower edge of ice belt must be ice strengthened, see 4.2.4.4(1).

(3) Longitudinal frames

The following requirements are intended for longitudinal frames with all end conditions:

(a) Frames with ~~and without~~ brackets

The section modulus W of a longitudinal frame is not to be less than that obtained from the following formula:

$$W=\frac{f_4 phl^2}{mR_{eH}}\times 10^6 \quad \text{cm}^3$$

and effective shear area A of a longitudinal frame is not to be less than that obtained from the following formula:

$$A=\frac{\sqrt{3}\, f_4\, f_5\, phl}{2R_{eH}}\times 10^4 \quad \text{cm}^2$$

(In calculation of the actual shear area of the frames, the shear area of the brackets is not to be taken into account.)

where:

- P — see 4.2.4.2(2);
- L — total span of frame, in m;
- m — boundary condition factor; m = 13.3 for a continuous beam with brackets; where the boundary conditions deviate significantly from those of a continuous beam, e.g. in an end field, a smaller boundary factor may be required. ~~For frames without brackets a value m = 11.0 is to be used.~~
- S — spacing of longitudinals, in m;
- f_4 — factor which takes account of the load distribution to adjacent frames, f_4 = $(1\text{-}0.2\frac{h}{s})$, where h is design ice thickness as given in Table 4.2.4.2(1);
- f_5 — factor which takes into account the maximum shear force versus load location and the shear stress distribution, f_5 = 2.16;
- R_{eH} — yield stress of the material, in N/mm^2.

(4) General requirements for side framing

(a) The attachment of frames to supporting structures: within the ice-strengthened area all frames are to be effectively attached to all the supporting structures. A longitudinal frame is to be attached by brackets to all the supporting web frames and bulkheads~~ by brackets~~. When a transversal frame terminates at a stringer or deck, a bracket or similar construction is to be fitted. When a frame is running through the supporting structure, both sides of the web plate of the frame are to be connected to the structure (by direct welding, collar plate or lug).

When a bracket is installed, it has to have at least the same thickness as the web plate of the frame and the edge has to be appropriately stiffened against buckling.

(b) ~~Support of frames against tripping for ice class B1*, for ice class B1 in the bow and midbody regions and for ice classes B2 and B3 in the bow region of the ice-strengthened area~~ Support of frames against instability, in particular tripping:

The frames are to be attached to the shell by double continuous weld. No scalloping is allowed (except when crossing shell plate butts).

The web thickness of the frames is to be at least the maximum of the following:

- $\frac{h_w\sqrt{R_{eH}}}{C}$, h_w is the web height and C = 805 for profiles and C = 282 for flat bars;
- ~~2.5 % of the frame spacing for transverse frames;~~
- half of the net thickness of the shell plating, $t - t_c$. For the purpose of calculating the minimum web thickness of frames, the required thickness of the shell plating is to be calculated according to 4.2.4.3 using the yield strength R_{eH} of the frames;
- 9 mm.

Where there is a deck, ~~tank top (or tank bottom)~~ top or bottom plating of a tank, tank top or bulkhead in lieu of a frame, the plate thickness of this is to be calculated as above, to a depth corresponding to the height of the adjacent frames ~~as above, to a depth corresponding to the height of the adjacent frames~~. In such a case, the material properties of the deck, top or bottom plating of the tank, tank top or bulkhead and the frame height h_w of the adjacent frames are to be used in the calculations, and the constant C is to be 805.

Asymmetrical frames and ~~F~~frames which are not at right angles to the shell (web less than 90 degrees to the shell) ~~that are not normal to the plating or the profile is unsymmetrical~~, ~~and the span exceeds 4.0 m,~~ are to be supported against tripping by brackets, intercostals, stringers or similar at a distance not exceeding 1.3 m. For frames with spans greater than 4 m, the extent of antitripping supports is to be applied to all regions and for all ice classes. If the span is less than or equal to 4.0 m, the supports against tripping are required ~~for unsymmetrical profiles and stiffeners the web of which is not normal to plating~~ in the following regions:

B1*	All hull regions
B1	Bow and midbody regions
B2 and B3	Bow region.

Direct calculation methods may be applied to demonstrate the equivalent level of support provided by alternative arrangements.

4.2.4.8 Stern

The introduction of new propulsion arrangements with azimuthing thrusters ~~or "podded" propellers~~, which provide ~~an~~ improved manoeuvrability, will result in increased ice loading of the stern region and the stern area. This fact is to be considered in the design of the aft/stern structure.

In order to avoid very high loads on propeller blade tips, the minimum distance between propeller(s) and hull (including stern frame) is at least to satisfy the requirements of 2.14.4.1 of Section 14, Chapter 2 of this PART.

On twin and triple screw ships the ice strengthening of the shell and framing is to be extended to the ~~double bottom~~ tank top for 1.5 m forward and aft of the side propellers.

Shafting and stern tubes of side propellers are normally to be enclosed within plated bossings. If detached struts are used, due consideration is to be taken of their design, strength and attachments to the hull ~~are to be specially considered~~.

CCS Rule Change Notice For:

RULES FOR CLASSIFICATION OF SEA-GOING STEEL SHIPS

PART THREE
MACHINERY INSTALLATIONS

Brief Introduction

1. Revising relevant requirements for location of fuel tanks in cargo area on oil and chemical tankers in paragraph 4.2.5.9 of Chapter 4 in accordance with URM76 (Rev.1 June 2018).
2. Adding Appendix 9 Safety of Low Pressure Gas Fuel Engines in Chapter 9, which incorporates the requirements of URM 78.

CONTENTS

CHAPTER 4 **MACHINERY PIPING SYSTEMS**
Section 2 OIL FUEL SYSTEMS

CHAPTER 9 **DIESEL ENGINES**
Section 1 GENERAL PROVISIONS
Appendix 9 SAFETY OF LOW PRESSURE GAS FUEL ENGINES

CHAPTER 4 MACHINERY PIPING SYSTEMS

Section 2 OIL FUEL SYSTEMS

4.2.5 Oil fuel arrangements and fuel oil tanks

4.2.5.9 Location of fuel tanks in cargo area on oil and chemical tankers[1]

On oil and chemical tankers, carrying liquid cargoes having a flashpoint not exceeding 60℃ and/or toxic liquid cargoes[2], fuel tanks located with a common boundary to cargo or slop tanks are not to be situated within nor extend partly into the cargo tank block. Such tanks may, however, be situated ~~at the forward and aft ends~~ aft and/or forward of the cargo tank block ~~instead of cofferdams~~.

~~Fuel tanks are to extend neither fully nor partly into cargo or slop tanks.~~ They may ~~however~~ be accepted when located as independent tanks on open deck in the cargo area subject to spill and fire safety considerations.

~~Fuel tanks are not permitted to extend into the protective area of cargo tanks required by MARPOL Annex I and the IBC code. For chemical tankers due attention is to be paid to restrictions on cargoes that can be located adjacent to fuel tanks.~~ The arrangement of independent fuel tanks and associated fuel piping systems, including the pumps, can be as for fuel tanks and associated fuel piping systems located in the machinery spaces. For electrical equipment, requirements to hazardous area classification must however be met ~~taken into account~~.

Cargo tank block is the part of the ship extending from the aft bulkhead of the aftmost cargo or slop tank to the forward bulkhead of the forward most cargo or slop tank, extending to the full depth and beam of the ship, but not including the area above the deck of the cargo or slop tank as shown in Figure 4.2.5.9.

[1] Changes introduced in this revision are to be uniformly implemented from 1 July 2019.

[2] Toxic liquid cargoes include those for which toxic vapour detection is specified in column “k” of the table of chapter 17 of the IBC Code.

CHAPTER 9 DIESEL ENGINES

Section 1 GENERAL PROVISIONS

9.1.9 Gas fuel engines

9.1.9.1 In addition to the relevant provisions of this Chapter, gas fuel engines are to comply with the applicable requirements of Appendix 1 and 9 of this Chapter, the Rules for Natural Gas Fuelled Ships and CCS Guidelines for Design and Installation of Gas Fuel Engine Systems of Liquefied Gas Carriers.

Notes:

(1) Appendix 9 applies to gas fuel engines for which the date of an application for type approval certification is dated on or after 1 July 2019.

(2) The "date of an application for type approval" is the date of documents accepted by CCS as request for type approval certification of a new engine type or of an engine type that has undergone substantive modifications in respect of the one previously type approved, or for renewal of an expired type approval certificate.

(3) Engines with an existing type approval on 1 July 2019 are not required to be re-type approved in accordance with the new requirements until the current Type Approval becomes invalid. For the purpose of certification of these engines, the current type approval and related submitted documentation will be accepted.

Appendix 9 SAFETY OF LOW PRESSURE GAS FUEL ENGINES

1 General requirements

1.1 Application and scope

1.1.1 This Appendix applies to trunk piston low pressure gas fuel engines supplied with natural gas as fuel. This Appendix only specifies relevant requirements for the use of gas fuel. Gas fuel engines are also to satisfy relevant provisions of this Chapter.

1.1.2 This Appendix is only supplementary to the rules. Gas fuel engines intended for gas carriers are also to comply with the relevant provisions of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk. Gas fuel engines intended for ships other than gas carriers are also to comply with the relevant provisions of CCS Rules for Natural Gas Fuelled Ships.

1.1.3 Specific requirements of CCS Rules for Natural Gas Fuelled Ships as referenced in this Appendix are to be applied to engine types installed on any ship, regardless of type, size and trading area, as long as CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk is not referenced or explicitly specified otherwise.

1.1.4 Engines can be either dual fuel engines or gas fuel only engines. Gas can be introduced as follows:

(1) into the air inlet manifold, scavenge space, or cylinder air inlet channel port; or

(2) mixed with air before the turbo-charger (“pre-mixed engines”).

The gas / air mixture in the cylinder can be ignited by the combustion of a certain amount of fuel (pilot injection) or by extraneous ignition (sparking plug).

1.1.5 This Appendix covers the following applications of gas fuel engines, but is not limited to:

(1) mechanical propulsion;

(2) generating sets intended for main propulsion and auxiliary applications;

(3) single engine or multi-engine installations.

1.2 Definitions

(1) Certified safe type means electrical equipment that is certified in accordance with the recommendation published by the International Electrotechnical Commission (IEC), in particular publication IEC 60092-502:1999, or with recognized standards at least equivalent. The certification of electrical equipment is to correspond to the category and group for methane gas.

(2) Double block and bleed valves means the set of valves referred to in 16.4.5 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk and 1.1.2.10, 6.2.1.5 of CCS Rules for Natural Gas Fuelled Ships.

(3) Dual fuel engine (“DF engine”) means an engine that can burn natural gas as fuel simultaneously with liquid fuel, either as pilot oil or bigger amount of liquid fuel (gas mode), and also has the capability of running on liquid diesel fuel oil only (Diesel mode).

(4) Engine room is a machinery space or enclosure containing gas fuelled engine(s).

(5) Gas means a fluid having a vapour pressure exceeding 2.8 bar absolute at a temperature of 37.8℃.

(6) Gas fuel injection (admission) valve is a valve or injector on the engine, which controls gas supply to the cylinder(s) according to the cylinder(s) actual gas demand.

(7) Gas fuel engine means either a gas fuel only engine or a dual fuel engine.

(8) Gas fuel only engine (“GF engine”) means an engine capable of operating on gas fuel only and not able to switch over to oil fuel operation.

(9) Gas piping means piping containing gas or air / gas mixtures, including venting pipes.

(10) Gas Valve Unit (GVU) is a set of manual shutoff valves, actuated shut-off and venting valves, gas pressure sensors and transmitters, gas temperature sensors and transmitters, gas pressure control valve and gas filter used to control the gas supply to each gas consumer. It also includes a connection for inert gas purging.

(11) 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)).

(12) IMO means the International Maritime Organisation.

(13) IGF Code means the International Code of Safety for Ships Using Gases or other Low-Flashpoint Fuels (IMO Resolution MSC.391(95)).

(14) Low pressure gas means gas with a pressure up to 10 bar.

(15) Lower Heating Value (“LHV”) means the amount of heat produced from the complete combustion of a

specific amount of fuel, excluding latent heat of vaporization of water.
(16) Methane Number is a measure of resistance of a gas fuel to knock, which is assigned to a test fuel based upon operation in knock testing unit at the same standard knock intensity.
Note: Pure methane is used as the knock resistant reference fuel, that is, methane number of pure methane is 100, and pure hydrogen is used as the knock sensitive reference fuel, methane number of pure hydrogen is 0.
(17) Pilot fuel means the fuel oil that is injected into the cylinder to ignite the main gas-air mixture on DF engines.
(18) Pre-mixed engine means an engine where gas is supplied in a mixture with air before the turbocharger.
(19) Recognized standards means applicable international or national standards acceptable to CCS or standards laid down and maintained by an organisation which complies with the standards adopted by IMO and which are recognized by CCS.
(20) Safety Concept is a document describing the safety philosophy with regard to gas as fuel. It describes how risks associated with this type of fuel are controlled under reasonably foreseeable abnormal conditions as well as possible failure scenarios and their control measures.
Note: A detailed evaluation regarding the hazard potential of injury from a possible explosion is to be carried out and reflected in the safety concept of the engine.

1.3 Plans and documents

1.3.1 The following plans and documents are to be submitted for approval with regard to the approval of gas fuel engines, in addition to those required in 9.1.12.1, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships:

No.	Plans and documents
(1)	Schematic layout or other equivalent documents of gas system on the engine
(2)	Gas piping system (including double-walled arrangement where applicable)
(3)	Parts for gas admission system②
(4)	Arrangement and relevant calculations of explosion relief valves (crankcase①, charge air manifold, exhaust gas manifold) as applicable
(5)	List of certified safe equipment and evidence of relevant certification
(6)	Schematic layout or other equivalent documents of engine control and safety related to gas fuel combustion
(7)	Schematic layout or other equivalent documents of fuel oil system (main and pilot fuel systems) on the engine (only for DF engine)
(8)	Shielding of high pressure fuel pipes for pilot fuel system, assembly (only for DF engine)
(9)	High pressure parts for pilot fuel oil injection system②(only for DF engine)
(10)	Ignition system (only for GF engine)
Notes: ① If required by 9.1.12, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships. ② The documentation to contain specification of pressures, pipe dimensions and materials.	

1.3.2 The following plans and documents are to be submitted for information with regard to the approval of gas fuel engines, in addition to those required in 9.1.12.2, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships:

No.	Plans and documents
(1)	Safety concept
(2)	Report of the risk analysis①
(3)	Gas specification
(4)	Other plans and documents as deemed necessary by CCS
Note: ① See 1.4 of this Appendix.	

1.4 Risk analysis

1.4.1 The risk analysis is at least to consider the following scope:
(1) a failure or malfunction of any system or component involved in the gas operation of the engine;
(2) a gas leakage downstream of the gas valve unit;
(3) the safety of the engine in case of emergency shutdown or blackout, when running on gas;
(4) the inter-actions between the gas fuel system and the engine.
Note: With regard to the scope of the risk analysis it is to be noted that failures in systems external to the engine, such as fuel

storage or fuel gas supply systems, may require action from the engine control and monitoring system in the event of an alarm or fault condition. Conversely failures in these external systems may, from the vessel perspective, require additional safety actions from those required by the engine limited risk analysis.

1.4.2 The risk analysis is to be carried out in accordance with international standard ISO 31010: Risk management - Risk assessment techniques, or other recognized standards.

The required analysis is to be based on the single failure concept, which means that only one failure needs to be considered at the same time. Both detectable and non-detectable failures are to be considered. Consequences failures, i.e. failures of any component directly caused by a single failure of another component, are also to be considered.

1.4.3 The risk analysis is carried out in accordance with the procedures below:

(1) Identify all the possible failures in the concerned equipment and systems which could lead:

① to the presence of gas in components or locations not designed for such purpose; or

② to ignition, fire or explosion.

(2) Evaluate the consequences.

(3) Where necessary, identify the failure detection method.

(4) Where the risk cannot be eliminated, identify the corrective measures, e.g. in the system design, such as: redundancies, safety devices, monitoring or alarm provisions which permit restricted operation of the system; in the system operation, such as: initiation of the redundancy or activation of an alternative mode of operation.

The results of the risk analysis are to be documented.

1.4.4 The risk analysis is at least to include the following equipment and systems:

(1) failure of the gas-related systems or components, in particular gas piping and its enclosure, where provided, and cylinder gas supply valves. Failures of the gas supply components not located directly on the engine, such as block-and-bleed valves and other components of the Gas Valve Unit (GVU), are not to be considered in the analysis;

(2) failure of the ignition system (oil fuel pilot injection for DF engine or sparking plugs for GF engine);

(3) failure of the air to fuel ratio control system (charge air by-pass, gas pressure control valve, etc.);

(4) for engines where gas is injected upstream of the turbocharger compressor, failure of a component likely to result in a source of ignition (hot spots);

(5) failure of the gas combustion or abnormal combustion (misfiring, knocking);

(6) failure of the engine monitoring, control and safety systems;

Note: Where engines incorporate electronic control systems, a failure mode and effects analysis (FMEA) is to be carried out in accordance with 9.1.12.2(13) and Note 5, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

(7) abnormal presence of gas in engine components (e.g. air inlet manifold and exhaust manifold of DF or GF engines) and in the external systems connected to the engines (e.g. exhaust duct);

(8) changes of operating modes for DF engines, including changes between oil fuel mode, gas fuel mode or other working mode;

(9) hazard potential for crankcase fuel gas accumulation, for engines where the space below the piston is in direct communication with the crankcase, refer to 7.2.1.6 of CCS Rules for Natural Gas Fuelled Ships.

2 Design requirements

2.1 General principles

2.1.1 The manufacturer is to declare the allowable gas composition limits for the engine and the minimum and (if applicable) maximum methane number.

2.1.2 Components containing or likely to contain gas are to be designed to:

(1) minimise the risk of fire and explosion so as to demonstrate an appropriate level of safety commensurate with that of an oil-fuelled engine;

(2) mitigate the consequences of a possible explosion to a level providing a tolerable degree of residual risk, due to the strength of the component(s) or the fitting of suitable pressure relief devices of an approved type.

Also refer to 7.1.2, Section 2 of CCS Rules for Natural Gas Fuelled Ships.

Note:

① Discharge from pressure relief devices is to prevent the passage of flame to the machinery space and be arranged such that the discharge does not endanger personnel or damage other engine components or systems.

② Relief devices are to be fitted with a flame arrester.

2.2 Design requirements

2.2.1 For gas carriers, engine-mounted gas piping is to be designed and manufactured in accordance with 5.1 to 5.9 of Chapter 5, Chapter 16 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk. For ships other than gas carriers, the piping is to be designed in accordance with the criteria for gas piping (design pressure, wall thickness, materials, piping fabrication and joining details etc.) as given in Chapter 3 of CCS Rules for Natural Gas Fuelled Ships.

2.2.2 Arrangement of the gas piping system on the engine is to satisfy the following requirements:

(1) Pipes and equipment containing fuel gas are defined as hazardous area Zone 0 (refer to 9.2.2.1 of CCS Rules for Natural Gas Fuelled Ships).

(2) The space between the gas fuel piping and the wall of the outer pipe or duct is defined as hazardous area Zone 1(refer to 9.2.2.2(6) of CCS Rules for Natural Gas Fuelled Ships).

(3) For gas carriers, the gas piping system on the engine is to be arranged in accordance with the provisions of 16.4.3 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk. For ships other than gas carriers, it is to be arranged in accordance with the principles and requirements of 6.4.1.1 and 6.4.1.2 of CCS Rules for Natural Gas Fuelled Ships.

The design criteria for the double pipe or duct are given in 3.3.1.4, 6.4.1.3 and 6.4.1.4 of CCS Rules for Natural Gas Fuelled Ships.

In case of a ventilated double wall, for gas carriers, the ventilation inlet is to be located in accordance with the provisions of 16.4.3.2 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk; for ships other than gas carriers, it is to be located in accordance with the provisions of 10.6.1.3 of CCS Rules for Natural Gas Fuelled Ships.

The pipe or duct is to be pressure tested in accordance with 2.7.1, Chapter 2, PART THREE of CCS Rules for Classification of Sea-going Steel Ships to ensure gas tight integrity and to show that it can withstand the expected maximum pressure at gas pipe rupture.

(4) Single walled gas piping is only acceptable:

① for engines installed in ESD protected machinery spaces, as defined in 2.3.1.1(2) of CCS Rules for Natural Gas Fuelled Ships and in compliance with other relevant parts of CCS Rules for Natural Gas Fuelled Ships (e.g. 2.3.3);

② in the case as per 6.4.1.2(1) of CCS Rules for Natural Gas Fuelled Ships.

For gas carriers, CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk apply.

In case of gas leakage in an ESD-protected machinery space, which would result in the shutdown of the engine(s) in that space, a sufficient propulsion and manoeuvring capability including essential and safety systems is to be maintained. Therefore the safety concept of the engine is to clearly indicate application of the “double wall” or “alternative” arrangement.

Note: The minimum power to be maintained is to be assessed on a case-by-case basis from the operational characteristics of the ship.

2.2.3 Charge air system on the engine is to satisfy the following requirements:

(1) The charge air system on the engine is to be designed in accordance with 2.1.2 above.

(2) In case of a single engine installation, the engine is to be capable of operating at sufficient load to maintain power to essential consumers after opening of the pressure relief devices caused by an explosion event. Sufficient power for propulsion capability is to be maintained.

Note: Load reduction is to be considered on a case by case basis, depending on engine configuration (single or multiple) and relief mechanism (self-closing valve or bursting disk).

2.2.4 Exhaust system on the engine is to satisfy the following requirements:

(1) The exhaust gas system on the engine is to be designed in accordance with 2.1.2 above.

(2) In case of a single engine installation, the engine is to be capable of operating at sufficient load to maintain power to essential consumers after opening of the pressure relief devices caused by an explosion event. Sufficient power for propulsion capability is to be maintained. Continuous relief of exhaust gas (through open rupture disc) into the engine room or other enclosed spaces is not acceptable.

2.2.5 The protection of crankcase is to satisfy the following requirements:

(1) Crankcase explosion relief valves are to be installed in accordance with 9.7.4, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships, refer to 7.2.1.6 of CCS Rules for Natural Gas Fuelled Ships.

(2) For maintenance purposes, a connection, or other means, are to be provided for crankcase inerting and ventilating and gas concentration measuring.

2.2.6 With regard to gas ignition in the cylinder, for gas carriers, the requirements of 16.7 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk are to be satisfied; for ships other than gas carriers, the requirements of Section 2 of CCS Rules for Natural Gas Fuelled Ships are to be satisfied.

2.2.7 Control, monitoring, alarm and safety systems are to satisfy the following requirements:

(1) The engine control system is to be independent and separate from the safety system.

(2) The gas supply valves are to be controlled by the engine control system or by the engine gas demand.

(3) Combustion is to be monitored on an individual cylinder basis.

(4) In the event that poor combustion is detected on an individual cylinder, gas operation may be allowed in the conditions specified in 7.2.1.13 of CCS Rules for Natural Gas Fuelled Ships.

(5) If monitoring of combustion for each individual cylinder is not practicable due to engine size and design, common combustion monitoring may be accepted.

(6) Unless the risk analysis required by 1.4 of this Appendix proves otherwise, the monitoring and safety system functions for DF or GF engines are to be provided in accordance with Table 1 of this Appendix in addition to the general monitoring and safety system functions given by the Rules for Classification of Sea-going Steel Ships.

Note: For DF engines, Table 1 applies only to the gas mode.

Monitoring and Safety Protection of Gas Fuel Engines **Table 1**

Parameter	Alarm	Automatic activation of the double block and bleed valves	Automatic switching over to oil fuel mode①	Engine shutdown
Abnormal pressures in the gas fuel supply line	×	×	×	× ⑤
Gas fuel supply systems - malfunction	×	×	×	× ⑤
Pilot fuel injection or spark ignition systems - malfunction	×	× ②	×	× ②⑤
Exhaust gas temperature after each cylinder - high	×	× ②	×	× ②⑤
Exhaust gas temperature after each cylinder, deviation from average –low③	×	× ②	×	× ②⑤
Cylinder pressure or ignition - failure, including misfiring, knocking and unstable combustion	×	× ②④	× ④	× ②④⑤
Oil mist concentration in crankcase or bearing temperature⑥ - high	×	×		×
Pressure in the crankcase – high④	×	×	×	
Engine stops - any cause	×	×		
Failure of the control-actuating medium of the block and bleed valves	×	×	×	

Note for the symbol: × Applicable

Notes:

① DF engine only, when running in gas mode.

② For GF engines, the double block-and-bleed valves and the engine shutdown may not be activated in case of specific failures affecting only one cylinder, provided that the concerned cylinder can be individually shutoff and the safe operation of the engine in such conditions is demonstrated by the risk analysis.

③ Required only if necessary for the detection of misfiring.

④ In the case where the failure can be corrected by an automatic mitigation action, only the alarm may be activated. If the failure persists after a given time, the safety actions are to be activated.

⑤ GF engine only.

⑥ Where required by 9.7.6, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

2.2.8 Gas admission valves are to be certified safe as follows:

(1) The inside of the valve contains gas and is therefore to be certified for Zone 0.

(2) When the valve is located within a pipe or duct in accordance with 2.2.2(2), the outside of the valve is to be certified for Zone 1.

(3) When the valve is arranged without enclosure in accordance with the "ESD-protected machinery space" (see 2.2.2(4)) concept, no certification is required for the outside of the valve, provided that the valve is de-energized upon gas detection in the space.
However, if they are not rated for the zone they are intended for, it is to be documented that they are suitable for that zone. Documentation and analysis are to be based on IEC 60079-10-1 or IEC 60092-502.

3 Specific design requirements

3.1 DF engines

3.1.1 The maximum continuous power that a DF engine can develop in gas mode may be lower than the approved MCR of the engine (i.e. in oil fuel mode), depending in particular on the gas quality. This maximum power available in gas mode and the corresponding conditions are to be stated by the engine manufacturer and demonstrated during the type test.
3.1.2 DF engines are to be arranged to use either oil fuel or gas fuel for the main fuel charge and with pilot oil fuel for ignition. The engines are to be arranged for rapid changeover from gas use to fuel oil use. In the case of changeover to either fuel supply, the engines are to be capable of continuous operation using the alternative fuel supply without interruption to the power supply.
Changeover to gas fuel operation is to be only possible at a power level and under conditions where it can be done with acceptable reliability and safety as demonstrated through testing.
Changeover from gas fuel operation mode to oil fuel operation mode is to be possible at all situations and power levels.
The changeover process itself from and to gas operation is to be automatic but manual interruption is to be possible in all cases.
In case of shut-off of the gas supply, the engines are to be capable of continuous operation by oil fuel only.
3.1.3 Gas supply to the combustion chamber is not to be possible without operation of the pilot oil injection.
Note: Pilot injection is to be monitored for example by fuel oil pressure and combustion parameters.

3.2 GF engines

3.2.1 In case of failure of the spark ignition, the engine is to be shut down except if this failure is limited to one cylinder, subject to immediate shut off of the cylinder gas supply and provided that the safe operation of the engine is substantiated by the risk analysis and by tests.

3.3 Pre-mixed engines

3.3.1 Inlet manifold, turbo-charger, charge air cooler, etc. are to be regarded as parts of the fuel gas supply system. Failures of those components likely to result in a gas leakage are to be considered in the risk analysis (see 1.4 of this Appendix).
3.3.2 Flame arresters are to be installed before each cylinder head, unless otherwise justified in the risk analysis, considering design parameters of the engine such as the gas concentration in the charge air system, the path length of the gas-air mixture in the charge air system, etc.

4 Type testing, factory acceptance tests and shipboard trials

4.1 Type testing

4.1.1 Type approval of DF and GF engines is to be carried out in accordance with the requirements of 9.10.1 and 9.10.2, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships, taking into account the additional requirements below.
4.1.2 In addition to the criteria given in 9.1.2.1(1), Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships, the type of engine is defined by the following:
(1) gas admission method (direct cylinder injection, charge air space or pre-mixed);
(2) gas supply valve operation (mechanical or electronically controlled);
(3) ignition system (pilot injection, spark ignition, glow plug or gas self-ignition);
(4) ignition system (mechanical or electronically controlled).
4.1.3 In addition to the safety precautions mentioned in 1.2, Appendix 4, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships, measures to verify that gas fuel piping on engine is gas tight are to be carried out prior to start-up of the engine.

4.1.4 The type testing of the engine is to be carried out in accordance with the procedure in 1.3, Appendix 4, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

For DF engines, the load tests are to be carried out in gas mode at the different percentages of the maximum power available in gas mode (see 3.1.1 of this Appendix).

The 110% load tests are not required in the gas mode.

The influence of the methane number and LHV of the fuel gas is not required to be verified during the Stage B type tests. It is however to be justified by the engine designer through internal tests or calculations and documented in the type approval test report.

4.1.5 In addition to the measurements and records required in 1.4, Appendix 4, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships, the following engine data are to be measured and recorded:

(1) each fuel index for gas and diesel as applicable (or equivalent reading);

(2) gas pressure and temperature at the inlet of the gas manifold;

(3) gas concentration in the crankcase.

Additional measurements may be required in connection with the design assessment.

4.1.6 Internal tests are to be carried out in accordance with 2.1, Appendix 4, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships, and the following conditions are to be tested:

(1) DF engines are to run the load points in both gas and diesel modes (with and without pilot injection in service) as found applicable for the engine type.

(2) For DF engines with variable liquid / gas ratio, the load tests are to be carried out at different ratios between the minimum and the maximum allowable values.

(3) For DF engines, switch over between gas and diesel modes are to be tested at different loads.

4.1.7 Witnessed tests are to be carried out in accordance with 2.2, Appendix 4, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships, taking into account the following requirements:

(1) For load tests, the following testing conditions are to be considered for DF engines:

① All load points must be run in both gas and diesel modes that apply for the engine type. This also applies to the overspeed test.

② In case of DF engines with variable liquid / gas ratio, the load tests are to be carried out at different ratios between the minimum and the maximum allowable values.

(2) For functional tests, the following tests are to be carried out:

① For DF engines, the lowest specified speed is to be verified in diesel mode and gas mode.

② For DF engines, switch over between gas and diesel modes are to be tested at different loads.

③ The efficiency of the ventilation arrangement of the double walled gas piping system is to be verified.

④ Simulation of a gas leakage in way of a cylinder gas supply valve.

Engines intended to produce electrical power are to be tested as follows:

① Capability to take sudden load and loss of load in accordance with the provisions of 9.7.10.1, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

② For GF and premixed engines, the influences of LHV, methane number and ambient conditions on the dynamic load response test results are to be theoretically determined and specified in the test report. Referring to the limitations as specified in 2.1.1, the margin for satisfying dynamic load response is to be determined.

Note:

1. For DF engines, switchover to oil fuel during the test is acceptable.

2. Application of electrical load in more than 2 load steps can be permitted in the conditions stated in 9.7.10.1, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships.

(3) GF and DF engines are to undergo integration tests to verify that the response of the complete mechanical, hydraulic and electronic engine system is as predicted for all intended operational modes. The scope of these tests is to be agreed with CCS for selected cases based on the risk analysis, and is at least to include the following incidents:

① Failure of ignition (spark ignition or pilot injection systems), both for one cylinder unit and common system failure.

② Failure of a cylinder gas supply valve.

③ Failure of the combustion (to be detected by e.g. misfiring, knocking, exhaust temperature deviation, etc.).

④ Abnormal gas pressure.

⑤ Abnormal gas temperature.

Note: This test may be carried out using a simulation signal of the temperature.

4.1.8 Stage C – Component inspection

Component inspection is to be carried out in accordance with the provisions of 2.3, Appendix 4, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships. The components to be inspected after the test run are to include also:

(1) gas supply valve including pre-chamber as found applicable;

(2) spark igniter (for GF engines);

(3) pilot fuel injection valve (for DF engines).

4.2 Factory acceptance test

4.2.1 Factory acceptance tests of DF and GF engines are to be carried out in accordance with Appendix 6, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships, taking into account the additional requirements below.

For DF engines, the load tests referred to in 2.3, Appendix 6, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships are to be carried out in gas mode at the different percentages of the maximum power available in gas mode (see 3.1.1 of this Appendix). The 110% load test is not required in the gas mode.

4.2.2 In addition to the safety precautions mentioned in 1.1, Appendix 6, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships, measures to verify that gas fuel piping on engine is gas tight are to be carried out prior to start-up of the engine.

4.2.3 In addition to the records required in 2.2, Appendix 6, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships, the following engine data are to be recorded:

(1) fuel index, both gas and diesel as applicable (or equivalent reading);

(2) gas pressure and temperature.

4.2.4 Test loads for various engine applications are given in 2.3, Appendix 6, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships. DF engines are to be tested in both diesel and gas mode as found applicable. In addition the scope of the trials may be expanded depending on the engine application, service experience, or other relevant reasons.

4.2.5 GF and DF engines are to undergo integration tests to verify that the response of the complete mechanical, hydraulic and electronic system is as predicted for all intended operational modes.

The scope of these tests is to be agreed with CCS for selected cases based on the risk analysis and is at least to include the following incidents:

① Failure of ignition (spark ignition or pilot injection systems), for one cylinder unit.

② Failure of a cylinder gas supply valve.

③ Failure of the combustion (to be detected by e.g. misfiring, knocking, exhaust temperature deviation, etc.).

④ Abnormal gas pressure.

⑤ Abnormal gas temperature.*

Note*: The above tests may be carried out using simulation or other alternative methods, subject to special consideration by CCS.

4.3 Shipboard trials

4.3.1 Shipboard trials are to be carried out in accordance with the provisions of Appendix 6, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships. For DF engines, the test loads are to be carried out in all operating modes (gas mode, diesel mode, etc.).

CCS Rule Change Notice For:

RULES FOR CLASSIFICATION OF SEA-GOING STEEL SHIPS

PART FOUR
ELECTRICAL INSTALLATIONS

Brief Introduction

1. Make modifications according to the feedback to clarify the scope of application.

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CHAPTER 2 ELECTRICAL INSTALLATIONS IN SHIPS

Section 9 SAFETY SYSTEMS FOR SHIPS AND PERSONS ONBOARD

2.9.3.4 The pre-discharge alarm and the release of the fixed ~~gas~~ fire-extinguishing system for the protection of machinery spaces where the engines used for main propulsion and main generator sets are located are not to lead to automatic shutdown of ventilation fans and oil pumps in the machinery spaces ~~engine rooms~~.

CCS Rule Change Notice For:

RULES FOR CLASSIFICATION OF SEA-GOING STEEL SHIPS

PART SIX
FIRE PROTECTION, DETECTION AND EXTINCTION

Brief Introduction

1. Make modifications according to the feedback to clarify the scope of application.

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CHAPTER 1 GENERAL

Section 1 GENERAL PROVISIONS

1.1.4.4 The release and alarm of the fixed fire-extinguishing system for the protection of machinery spaces where the engines used for main propulsion and main generator sets are located, including the opening of the release box door for the purpose of test, is not to have automatic linkage with the system that shuts down the ventilation fans and oil pumps in machinery spaces.

CHAPTER 2 FIRE EXTINCTION SYSTEMS

Section 2 FIXED GAS FIRE-EXTINGUISHING SYSTEMS

~~2.2.1.4 The release and alarm of the fixed gas fire-extinguishing system for the protection of machinery spaces, including the opening of the release box door for the purpose of test, is not to have automatic linkage with the system that shuts down the ventilation fans and oil pumps in machinery spaces.~~