RULES
R001AM01-2025

**CHINA CLASSIFICATION SOCIETY**

# RULES FOR CLASSIFICATION OF SEA-GOING STEEL SHIPS

AMENDMENTS

# 2025

Effective from 1 July 2025

**Beijing**

CHINA CLASSIFICATION SOCIETY

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## PART ONE PROVISIONS OF CLASSIFICATION

# CONTENTS

# CHAPTER 2 SCOPE AND CONDITIONS OF CLASSIFICATION

## Appendix 1 LIST OF CLASS NOTATIONS FOR SEA-GOING SHIPS

7. Unless specifically stated otherwise, class notations are generally given in the sequence A ~ K as shown in the table below:

| Types of class notations | Type of ship | Special duties | Service or service restriction | Cargo and loading characteristics | Special features | Automation | Special equipment and system | Special survey | Green ecology | Refrigerated cargo installation | Other notations |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Table | Table A | Table B | Table C | Table D | Table E | Table F | Table G | Table H | Table I | Table J | Table K |

For example, in respect to a bulk carrier constructed under supervision of CCS according to CSR rules, engaged in non-restricted service and service in floating ice condition, with design check by COMPASS-Structure software, with loading computer for calculation of overall strength, intact stability and bulk grains, machinery space periodically unattended, screwshaft condition monitoring and subject to in-water survey, the following characters of classification and class notations are to be assigned:

★CSA Bulk Carrier; CSR; BC-A (Holds Nos. 2, 4 ~~&~~and 6 may be empty); COMPASS (R, D, F); GRAB［20］; Ice Class B; Loading Computer (S, I, G); ESP; In-Water Survey
★CSM AUT-0; SCM

**Type Notations①** **Table A**

| Class notation | Description | | Technical requirements② |
|---|---|---|---|
| Ferry | Ferries | Ships having a continuous deck and carrying passengers (without sleeping berths) and/or vehicles for regular voyages between two sides of straits or islands | 1. For ships not less than 20 m in length, in accordance with Ch. 9, Pt. 2 of the Rules;<br>2. For ships less than 20 m in length, in accordance with Rules for Classification of Sea-going Boats.<br>~~3.~~ Where more than 12 passengers are carried, technical requirements for passenger ships need to be satisfied, unless special provisions are specified by the Administration. In this case, only the Passenger Ship/Boat notation is |

① For high speed craft complying with the provisions of the Rules for Classification of Sea-going Boats, the suffix (HSC) will be added after the type notation.
② The technical requirements listed in this Table are the basic ones for ships assigned to the notation; in other special cases involving ship types, special consideration is to be given by CCS according to the ship's specific conditions.

| Class notation | Description | | Technical requirements② |
|---|---|---|---|
| | | | assigned |
| Icebreaker | ~~Polar~~ iIcebreakers | Polar Class ships which are assigned a class notation for ~~independent navigation in ice-infested polar waters,~~ having an operational profile that includes escort or ice management functions and powering and dimensions that allow it to undertake aggressive operations in ice-covered waters. Relevant polar class is to be affixed after the class notation, e.g. Icebreaker; PC3 | Ch. 13, Pt. 8 of the Rules |
| Icebreaker* | Strengthened icebreakers | Ships for which relevant requirements are expanded and supplemented regarding general and arrangement, structure, propulsion power, machinery installations, steering systems and equipment based on Icebreaker | Rules for Heavy Icebreakers |
| Windfarm Service Vessel | Windfarm service vessels | Vessels that provide support and guarantee services for the operation and maintenance of offshore wind farms | Ch. 38, Pt. 8 of the Rules |
| Ore Carrier | Ore carriers | Ships constructed with single deck, 2 longitudinal bulkheads and a double bottom throughout the ~~cargo length area~~ centre hold and intended primarily to carry ore cargoes in the centre holds only | Ch. 16, Pt. 2 of the Rules; for ore carriers of 250 m and over in length and engaged in unrestricted service, in accordance with Rules for Structures of Ore Carriers |

**Special Duties Notations** **Table B**

| Class notation | Description | | Technical requirements① |
|---|---|---|---|
| IP | International ships carrying industrial personnel | This notation may be assigned to ships for which the Industrial Personnel Safety Certificate is issued according to IMO Code of Safety for Ships Carrying Industrial Personnel | International Code of Safety for Ships Carrying Industrial Personnel |

**Service or Service Restriction Notations** **Table C**

| | | | |
|---|---|---|---|
| Dredging Within R3 | Operation within R3 service area | Restricted service area for dredgers | Ch. 2, Pt. 10 of the Rules |
| Dredging Within R2 | Operation within R2 service area | Restricted service area for dredgers | Ch. 2, Pt. 10 of the Rules |
| Dredging Within R1 | Operation within R1 service area | Restricted service area for dredgers | Ch. 2, Pt. 10 of the Rules |
| Dredging Within Harbor | Operation in harbor water only | Restricted service area for dredgers | Ch. 2, Pt. 10 of the Rules |

**Cargo and Loading Characteristics Notations** **Table D**

| Class notation | Description | | Technical requirements |
|---|---|---|---|
| Maximum cargo | Maximum cargo | This notation is to be added after a harmonized | Ch.2 or Ch. 8, Pt. 2 of the |

① The technical requirements listed in this Table are the basic ones for ships assigned to the notation; in other special cases involving ship types, special consideration is to be given by CCS according to the ship's specific conditions.

| Class notation | Description | | Technical requirements |
|---|---|---|---|
| density x.y t/m$^3$ | density x.y t/m$^3$ | notation to show the limitation when maximum design cargo density for bulk carrier is less than 3.0 t/m$^3$, and maximum allowed cargo density is to be indicated ~~in the brackets~~. This notation is applicable only to BC-A and BC-B.<br>For general dry cargo ships intended to carry cargoes in bulk, this notation is assigned to show the limitation when maximum design bulk cargo density is less than 3.0 t/m$^3$, and maximum allowed bulk cargo density is to be indicated | Rules<br>For CSR ships, Ch. 1, Pt. 9-1 of the Rules |
| No MP | No loading and unloading in multiple ports | This notation is to be added after a harmonized notation to show the limitation when the bulk carrier ~~ship~~ has not been designed for loading and unloading in multiple ports in accordance with the Rules. This notation is applicable to all harmonized notations ~~(~~BC-A, BC-B, BC-C~~)~~.<br>This notation is to be assigned to show the limitation when the ore carrier has not been designed for loading and unloading in multiple ports in accordance with the Rules.<br>For general dry cargo ships intended to carry cargoes in bulk, this notation is assigned to show the limitation when the bulk cargo loading condition has not been designed for loading and unloading in multiple ports in accordance with the Rules | Ch.2 or Ch. 8 or Ch.16, Pt. 2 of the Rules<br>For CSR ships, Ch. 1, Pt. 9-1 of the Rules<br>For ore carriers of 250 m and over in length and engaged in unrestricted service, in accordance with Chapters 6 and 7 of Rules for Structures of Ore Carriers |
| Holds Nos. ×××a, b, … may be empty | Holds Nos. ×××a, b, … may be empty | This notation is to be added after a harmonized notation when specified empty holds are allowed in design of bulk carrier to specify the empty hold No.. The notation is applicable only to BC-A.<br>For general dry cargo ships intended to carry cargoes in bulk, this notation may be assigned to specify the empty hold No. when specified empty holds are allowed in design of bulk cargo loading condition | Ch.2 or Ch. 8, Pt. 2 of the Rules<br>For CSR ships, Ch. 1, Pt. 9-1 of the Rules |
| EL100 | Easy loading | Ore carriers meeting the requirements for easy loading may be assigned this notation | Ch. 16, Pt. 2 of the Rules;<br>for ore carriers of 250 m and over in length and engaged in unrestricted service, in accordance with Section 2, Chapter 12 of Rules for Structures of Ore Carriers |

**Special Features Notations** **Table E**

| Class notation | Description | | Technical requirements |
|---|---|---|---|
| Strengthened for Heavy Cargoes | Strengthened for heavy cargoes | Ships with longitudinal framing for strength deck and bottom within cargo area, and double bottom and strengthening for bottom framing within cargo area, may be assigned this notation.<br>For ore carriers of 250 m and over in length and engaged in unrestricted service, this notation is mandatory for strengthening of double bottom and bottom framing within cargo area.<br>Where the requirements of Section 3 [3], Chapter 12 of Rules for Structures of Ore Carriers are satisfied, (IB) suffix may be added after this notation | 1. Sec. 22, Ch. 2, Pt. 2 of the Rules<br>2. For ore carriers of 250 m and over in length and engaged in unrestricted service, in accordance with Section 3, Chapter 12 of Rules for Structures of Ore Carriers |
| Grab*(×) | Structural strengthening for | Strengthening of inner bottom plating, lower strake of hopper tank sloping plate and transverse | 1.Sec. 23, Ch. 2, Pt. 2 of the Rules |

| | | | |
|---|---|---|---|
| | loading/unloading by grabs | lower stool plating for holds of non-CSR ships designed for loading/unloading by grabs having a maximum weight up to × tons<br>×-unladen grab weight<br>For ore carriers of 250 m and over in length and engaged in unrestricted service, this notation is mandatory, meaning strengthening of inner bottom plating, lower strake of longitudinal bulkhead and transverse lower stool plating for holds of ships designed for loading/unloading by grabs having a maximum weight up to × tons<br>×-unladen grab weight | 2. For ore carriers of 250 m and over in length and engaged in unrestricted service, in accordance with Section 4, Chapter 12 of Rules for Structures of Ore Carriers |
| i-Ship(Tx) | Intelligent towing operation | This notation is applicable to harbor tugs having the function of intelligent towing operation.<br>where:<br>T—representing tugs have the basic function for intelligent towing operation;<br>x—additional functional notation, expressed by the following lowercase letters:<br>m—condition-based maintenance function for towing equipment and system;<br>s—towing operation coordination function | Chapter 10 of Rules for Intelligent Ships |
| PC1 | Operation in polar waters covered by multi-year ice | Year-round operation in all polar waters | Ch. 13, Pt. 8 of the Rules |
| PC2 | | Year-round operation in moderate multi-year ice conditions | |
| PC3 | | Year-round operation in second-year ice which may include multi-year ice inclusions | |
| PC4 | | Year-round operation in thick first-year ice which may include old ice inclusions | |
| PC5 | | Year-round operation in medium first-year ice which may include old ice inclusions | |
| PC6 | | Summer/autumn operation in medium first-year ice which may include old ice inclusions | |
| PC7 | | Summer/autumn operation in thin first-year ice which may include old ice inclusions | |
| PC X(y) | | After obtaining one of the polar class from PC7 to PC2, the notation "PC X(y)" may be assigned when one or more hull regions longitudinally divided of a polar class ship are of a higher polar class, where X is the polar class level and y is the longitudinal region of hull, which may be taken as :<br>B: bow region<br>BI: bow intermediate region<br>M: midbody region<br>S: stern region<br>E.g. PC 6; PC 3(BI, M) means that structures of bow intermediate and midbody regions are strengthened to a higher PC3 after the ship obtains PC6 | |
| ARC-M(x) | Higher strength steel for polar ships | When higher strength steels are used for hull structures exposed to weather and sea, this class notation may be assigned, where x indicates the design service temperature | Rules for Heavy Icebreakers |
| SFA | Spectrum-based fatigue strength assessment | This notation is optional and applies to large membrane tank LNG carriers, container ships and ore carriers. Class notation SFA (XX, YY) may be assigned after assessment in accordance with the relevant technical requirements . XX refers to environmental condition (e.g.: NA refers to North Atlantic Ocean, see IACS Rec.34 for scatter diagram), YY refers to design life (year), may be | Guidelines for Spectrum-based Fatigue Assessment of Hull Structure<br><br>*Note:*<br>*1.for container ships engaged in unrestricted* |

| | | | |
|---|---|---|---|
| | | taken as 20, 25, 30, 35 or 40.<br><br>*Note: for container ships engaged in unrestricted service and of 150 m and over in length and ore carriers engaged in unrestricted service and of 250 m and over in length, the suffix is explained as follows:*<br>*XX - wave environmental conditions of ship operation, WW is taken for the environmental condition based on global wave spectrum and NA is taken for the environmental condition based on North Atlantic wave spectrum;*<br>*YY - fatigue design life, in year; the minimum design fatigue life is 25 years, which may be taken at 5-year intervals starting from the 25th year* | *service and of 150 m and over in length, in accordance with Appendix 1, Chapter 10 of Rules for Structures of Container Ships;*<br>*2. for ore carriers engaged in unrestricted service and of 250 m and over in length, in accordance with Appendix 1, Chapter 10 of Rules for Structures of Ore Carriers* |
| SAF | Hull structure fatigue strength assessment taking into account linear springing | This notation may be assigned to large ships subject to hull structure fatigue strength assessment taking into account linear springing in accordance with the relevant technical requirements<br>*Note:*<br>*1. for container ships satisfying the relevant requirements in 1.1.3, Appendix A of Rules for Structures of Container Ships, hull structure fatigue strength assessment taking into account linear springing is carried out, and this notation is mandatory;*<br>*2. for ore carriers satisfying the relevant requirements in 1.1.3, Appendix A of Rules for Structures of Ore Carriers, hull structure fatigue strength assessment taking into account linear springing is carried out, and this notation is mandatory* | Guidelines for Direct Calculation Assessment of Springing and Whipping of Hull Structures<br><br>*Note:*<br>*1.for container ships engaged in unrestricted service and of 150 m and over in length, in accordance with Appendix A of Rules for Structures of Container Ships;*<br>*2. for ore carriers engaged in unrestricted service and of 250 m and over in length, in accordance with Appendix A of Rules for Structures of Ore Carriers* |
| SWAF | Hull structure fatigue strength assessment taking into account whipping and springing | This notation may be assigned to large ships subject to hull structure fatigue strength assessment taking into account whipping and springing in accordance with the relevant technical requirements<br>*Note:*<br>*1.for container ships satisfying the relevant requirements in 1.1.3, Appendix A of Rules for Structures of Container Ships, hull structure fatigue strength assessment taking into account whipping and springing is carried out, and this notation is mandatory;*<br>*2. for ore carriers satisfying the relevant requirements in 1.1.3, Appendix A of Rules for Structures of Ore Carriers, hull structure fatigue strength assessment taking into account whipping and springing is carried out, and this notation is mandatory;* | Guidelines for Direct Calculation Assessment of Springing and Whipping of Hull Structures<br><br>*Note:*<br>*1.for container ships engaged in unrestricted service and of 150 m and over in length, in accordance with Appendix A of Rules for Structures of Container Ships;*<br>*2. for ore carriers engaged in unrestricted service and of 250 m and over in length, in accordance with Appendix A of Rules for Structures of Ore Carriers* |
| WAU | Hull girder ultimate strength assessment taking into account whipping | This notation may be assigned to large ships subject to hull girder ultimate strength assessment taking into account whipping in accordance with the relevant technical requirements<br>*Note:*<br>*1.for container ships satisfying the relevant requirements in 1.1.3, Appendix A of Rules for* | Guidelines for Direct Calculation Assessment of Springing and Whipping of Hull Structures<br><br>*Note:*<br>*1.for container ships* |

| | | | |
|---|---|---|---|
| | | *Structures of Container Ships, hull girder ultimate strength assessment taking into account whipping is carried out, and this notation is mandatory;*<br>*2. for ore carriers satisfying the relevant requirements in 1.1.3, Appendix A of Rules for Structures of Ore Carriers, hull girder ultimate strength assessment taking into account whipping is carried out, and this notation is mandatory* | *engaged in unrestricted service and of 150 m and over in length, in accordance with Appendix A of Rules for Structures of Container Ships;*<br>*2. for ore carriers engaged in unrestricted service and of 250 m and over in length, in accordance with Appendix A of Rules for Structures of Ore Carriers* |
| FL | Minimum design fatigue life | Where a ship is designed for a minimum design fatigue life of 25 years or more, the class notation FL may be assigned at 5-year intervals starting from the 25th year, e.g. FL (25), FL (30)<br><br>*Note:*<br>*for container ships engaged in unrestricted service and of 150 m and over in length and ore carriers engaged in unrestricted service and of 250 m and over in length, this notation is mandatory, with suffix (XX, YY) added as follows:*<br>*XX - wave environmental conditions of ship operation, WW is taken for the environmental condition based on global wave spectrum and NA is taken for the environmental condition based on North Atlantic wave spectrum;*<br>*YY - fatigue design life, in year; the minimum design fatigue life is 25 years, which may be taken at 5-year intervals starting from the 25th year.*<br>*E.g., FL(NA, 25) means that design life of 25 years under North Atlantic wave environment* | Guidelines for Fatigue Strength of Ship Structure<br><br>*Note:*<br>*1.for container ships engaged in unrestricted service and of 150 m and over in length, in accordance with Chapter 10 of Rules for Structures of Container Ships;*<br>*2. for ore carriers engaged in unrestricted service and of 250 m and over in length, in accordance with Chapter 10 of Rules for Structures of Ore Carriers* |
| GFE | Global finite element strength assessment | ~~(1)~~1.The class notation is mandatory for container ships complying with one of the following conditions:<br>1) Length L greater than 250 m;<br>2) Hatch breadth of strength deck greater than 0.89B;<br>3) Unconventional structural arrangement.<br>~~(2)~~The class notation is optional for other container ships.<br>2.The class notation is mandatory for ore carriers complying with one of the following conditions:<br>1)Length L greater than 350 m;<br>2)Unconventional structural arrangement.<br>The class notation is optional for other ore carriers | 1.Chapter 8 of Rules for Structures of Container Ships;<br>2.Chapter 8 of Rules for Structures of Ore Carriers |
| LIQ(X) | Cargo liquefaction | Where an ore carrier is designed to carry cargoes (e.g. iron ore, etc.) with a moisture content exceeding the Transportable Moisture Limit (TML) which may lead to cargo liquefaction during transportation, the assignment of this notation is mandatory.<br>X — corresponding to the condition under which all cargo holds are designed to carry type A cargo, which may be taken as 1 or 2.<br>For ore carriers with some cargo holds designed to carry liquefied cargo, the suffix "Holds a,b,..." is to be added after LIQ(X), which is identified by LIQ(X, Holds a,b,...), e.g. LIQ(1, Holds NO. 1,3, 5) | Appendix 1, Chapter 12 of Rules for Structures of Ore Carriers |

| | | | |
|---|---|---|---|
| | | | |

**Special Equipment and System Notations** **Table G**

| | | | |
|---|---|---|---|
| ~~Biodiesel Fuel~~ | ~~Fueled by biodiesel fuel or the mixture of biodiesel and regular fuel~~ | ~~This notation may be assigned to power ships fueled by biodiesel fuel or the mixture of biodiesel and regular fuel~~ | ~~Pt. 3 of Guidelines for Ships Using Alternative Fuel~~ |
| BioFuel Oil(Bxx, Yn) | Biofuel oil used by the main propulsion system | This notation may be assigned to ships for which biofuel oil is used by the main propulsion system, where:<br>Bxx: indicating the mixing ratio the biofuel oil used being less than or equal to xx, where xx indicates the volume percentage of biofuel in the biofuel mixture. For example, B30 and B100 indicate that the volume percentage of biofuel in the biofuel mixture is less than or equal to 30% and 100%, respectively.<br>Yn: indicating the type of biofuel, e.g. FAME, FAEE, HVO, SVO etc. Several biofuels may be used at the same time, e.g. BioFuel Oil(B30, FAME; B50, HVO) | Guidelines for Ships Using Biofuel |

# CHAPTER 3 INSPECTIONS OF PRODUCTS

## Section 1 GENERAL PROVISIONS

**3.1.8 Invalidation, suspension ~~and,~~ cancellation and reinstatement of approval certificate**

3.1.8.4 Reinstatement of approval certificate

(1) Reinstatement of approval certificate is not allowed after it is invalidated or canceled.

(2) If the approval certificate is suspended, the customer may apply for reinstatement of the certificate if the conditions for reinstatement are satisfied. If the certificate is still within its validity period and it is confirmed by CCS that the reinstatement conditions are satisfied by the customer, the approval qualification can be reinstated, and the certificate will remain valid with its validity period subject to confirmation by CCS. If the customer fails to satisfy the reinstatement conditions within 3 months, the certificate will become invalid, and the customer is to go through formalities for cancellation of approval certificate. If the approval certificate expires during the suspension period, the certificate will automatically become invalid.

## Section 2 UNIT/BATCH INSPECTIONS

**3.2.1 Application**

3.2.1.1 Unless otherwise provided, the unit/batch inspection procedure of this Section applies to the products with CCS marine product certificate/equivalent document.

3.2.1.2 Appendix 1A of this Chapter is the List of Certification Requirements for Classed Marine Products, as required for the ships classed with CCS.

3.2.1.3 Appendix 1B of this Chapter is the List of Certification Requirements for Statutory Marine Products, as required for the statutory services delegated to CCS.

3.2.1.4 Appendix 1C of this Chapter is the List of Certification Requirements for Lifting Appliances, as required for the issue of certificates relevant to lifting appliances by CCS.

3.2.1.5 Appendix 1D of this Chapter is the List of Certification Requirements for Liquefied Natural Gas Specialized Products, as required for the issue of certificates relevant to liquefied natural gas carriers and ships powered by natural gas as fuel by CCS.

3.2.1.6 Appendix 1E of this Chapter is the List of Certification Requirements for Methanol Fuel System Specialized Products, as required for the issue of certificates relevant to ships powered by methanol as fuel by CCS.

3.2.1.7 Appendix 1F of this Chapter is the List of Certification Requirements for Ammonia Transport and Ammonia Fuel Specialized Products, as required for the issue of certificates related to liquid ammonia carriers and ships powered by ammonia as fuel by CCS.

3.2.1.~~5~~8 Appendices 2A, 2B and 2C of this Chapter are list of certification requirements for material and components of products of Appendices 1A, 1B and 1C respectively. Except for diesel engines, boilers, pressure vessels and lifting appliances, certification requirements for raw material of general machinery and electrical installations are not shown in Appendices 2A, 2B and 2C.

## Section 3 DESIGN APPROVAL

**3.3.4 Issue and validity of Design Approval Certificate**

3.3.4.1 Where the products have been assessed according to 3.3.2 and 3.3.3 of this Section and found to comply with CCS rules, guidelines and/or applicable standards and/or the manufacturer's technical requirements, a Design Approval Certificate valid for not more than 5 years will be issued by CCS.

3.3.4.2 The renewal of the approval certificate is to be completed within 3 months before the expiry date of the existing certificate, and the new approval certificate is to be valid to a date not exceeding five years from the date of expiry of the existing certificate.

3.3.4.~~2~~3 The products, of which the design has been approved, and their designer will be entered into CCS Lists of Approved Marine Products.

# Section 4 TYPE APPROVAL

**3.4.6 Issue and validity of Type Approval Certificate**

3.4.6.1 CCS will issue a Type Approval B Certificate valid for not more than 5 years to a manufacturer for whom the drawing examination, type test and on-site audit have been completed according to 3.4.3, 3.4.4 and 3.4.5 respectively and who is found to meet following conditions:

(1) the product design complies with conventions, applicable requirements of CCS rules and/or other applicable standards;

(2) an effective specialized quality management system for marine products is in place for ensuring the quality control level required by the manufacturer.

3.4.6.2 The renewal of the approval certificate is to be completed within 3 months before the expiry date of the existing certificate, and the new approval certificate is to be valid to a date not exceeding five years from the date of expiry of the existing certificate.

3.4.6.~~2~~3 CCS will issue the Type Approval A Certificate for a period not exceeding 5 years to a manufacturer at his request for whom the drawing examination, type test and on-site audit have been completed according to 3.4.3, 3.4.4 and 3.4.5 respectively and who is found to comply with the following requirements:

(1) the requirements for type approval B are met, product quality assurance meeting requirements of ISO 9001, having an additional CCS-approved procedure for ensuring that inspections and tests will be in accordance with CCS rules and guidelines;

(2) product quality is found upon CCS inspection experience and quality system check to be continually kept stable during the period of holding the Type Approval B Certificate;

(3) the operation of the quality management system for marine product is capable of achieving at least the results of the inspections and tests attended by CCS Surveyor.

3.4.6.~~3~~4 The products having a Type Approval Certificate and their manufacturers will be entered into CCS Lists of Approved Marine Products.

# Section 5 WORKS APPROVAL

**3.5.5 Issue and validity of Works Approval Certificate**

3.5.5.1 CCS will issue a Works Approval Certificate valid for not more than 5 years to a manufacturer for whom the drawing examination, type test and on-site audit have been completed according to 3.5.2 to 3.5.4 respectively.

3.5.5.2 The renewal of the approval certificate is to be completed within 3 months before the expiry date of the existing certificate, and the new approval certificate is to be valid to a date not exceeding five years from the date of expiry of the existing certificate.

3.5.5.~~2~~3 The products having Works Approval Certificate and their manufacturers will be entered into CCS Lists of Approved Marine Products.

# Section 7 APPROVAL OF SERVICE FIRM OF INSPECTION AND TESTING

**3.7.4 ~~Approval~~ Verification test**

3.7.4.1 Verification is to be carried out according to approved firm approval test programme.

**3.7.5 Firm approval certificate**

3.7.5.1 On completion of document examination, on-site audit and approval test mentioned in 3.7.2 to 3.7.4, CCS will issue a Firm Approval Certificate for service firm of inspection and testing which is valid not more than 5 years.

3.7.5.2 If inspection firm with CCS approval need to provide third party inspection service, the Surveyor may directly accept inspection report, and on-site witness is not necessary.

3.7.5.3 Inspection firm with approval is to collect and summarize relevant testing information required by CCS at regular interval and submit them to CCS.

3.7.5.4 Test data, test reports and other relevant test information are to be submitted to CCS through CCS Product Inspection and Testing Organization Data Acquisition System.

3.7.5.45 The firm with approval certificate for service firm of inspection and testing will be published in CCS website.

# Appendix 1A LIST OF CERTIFICATION REQUIREMENTS FOR CLASSED MARINE PRODUCTS

| No. | Product name | Document | | Approval mode | | | | Plan approval | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | | C/E | W | DA | TA-B | TA-A | WA | PA | |
| **Hull** | | | | | | | | | |
| 5 | Hull structure equipment | X | – | – | – | – | X | X | |
| 5.6 | Watertight cable transits | — | X | — | X | — | — | X | |
| 5.67 | Portable means of access for inspections | X | – | – | – | – | – | X | Applicable to portable means of access for inspections listed according to approved ship structure access manual and kept on board (extension ladder type and cradle type lifting by winch) |
| 5.78 | Container securing arrangements | X | – | – | – | – | – | X | Applicable to container ships and non-container ships applying for class notation of container securing arrangements |
| 5.89 | Loading computer | – | X | – | X | – | – | X | Applicable to hardware, product inspection is not necessary for the ship provided with two loading computers |
| 12 | Shafting and propeller | | | | | | | | |
| 12.9 | Z propulsion arrangement | X | – | – | – | – | – | X | The first product of the same model is to be subject to type test |
| 12.10 | Side thruster | X | – | – | – | – | – | X | The first product of the same model is to be subject to type test |
| 12.11 | Water jet propulsion arrangement | X | – | – | – | – | – | X | The first product of the same model is to be subject to type test |
| 12.12 | Other thrusters | X | – | – | – | – | – | X | The first product of the same model is to be subject to type test |

# Appendix 1B① LIST OF CERTIFICATION REQUIREMENTS FOR STATUTORY MARINE PRODUCTS

| No. | Product name | Document | | Approval mode | | | | Plan approval | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | | C/E | W | DA | TA-B | TA-A | WA | PA | |
| 2 | Pollution prevention at sea | | | | | | | | |
| 2.14 | Diesel Oxidation Catalyst (DOC) | X | – | – | X | O | – | X | By means of an oxidation reaction, carbon monoxide (CO) and hydrocarbons (HC) (including fugitive methanol) in the exhaust gas are converted into harmless water ($H_2O$) and carbon dioxide ($CO_2$). This requirement also applies to equipment using other technologies to reduce emissions of carbon monoxide (CO) and hydrocarbons (HC) (including fugitive methanol) |
| 2.145 | $NO_x$ emission of diesel engines of over 130 kW | X | – | – | X | O | – | X | EIAPP certificate |
| 2.156 | Ballast water management system | X | – | – | X | O | – | X | |
| 2.167 | Crude oil washing machine | X | – | – | X | O | – | X | |
| 2.178 | Comminuting and disinfecting system | X | – | – | X | O | – | X | For sewage |
| 3 | Fire-resisting material, structure and fire-fighting equipment | | | | | | | | |
| 3.32 | Helicopter deck foam fire-extinguishing arrangement | | | | | | | | Foam fire-extinguishing arrangement protecting helicopter deck |
| 5 | Radio communication equipment | | | | | | | | |
| ~~5.17~~ | ~~Aviation two-way VHF radiotelephone apparatus~~ | ~~O~~ | ~~X~~ | ~~=~~ | ~~O~~ | ~~O~~ | ~~=~~ | ~~X~~ | ~~Accepted upon certification of the site survey unit~~ |
| 5.17 | Aviation two-way VHF radiotelephone apparatus | X | – | – | X | O | – | X | |
| 11 | Lights for helideck | – | X | – | X | – | – | X | Used for helideck boundary lights, floodlights, auxiliary floodlights, status lights, windsock lights, and obstruction lights |

① If the list is not consistent with the requirements of the flag State Government, the provisions of the flag State Government are to prevail.

# Appendix 1F LIST OF CERTIFICATION REQUIREMENTS FOR AMMONIA TRANSPORT AND AMMONIA FUEL SPECIALIZED PRODUCTS

| No. | Product name | Document | | Approval mode | | | | Plan approval | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | | C/E | W | DA | TA-B | TA-A | WA | PA | |
| **Ammonia fuel supply and related systems for dual fuel ships** | | | | | | | | | |
| 12 | Piping, valve and fittings | | | | | | | | |
| 12.12 | Ammonia Slip Catalyst (ASC) | X | – | – | X | O | – | X | Used for ammonia slip treatment; this requirement also applies to equipment using other technologies to reduce ammonia slip |

# Appendix 2A LIST OF CERTIFICATION REQUIREMENTS FOR CLASSED MARINE PRODUCT PARTS

| No. | Product name | Document | | Approval mode | | | | Plan approval | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | | C/E | W | DA | TA-B | TA-A | WA | PA | |
| **Hull** | | | | | | | | | |
| 5 | Hull structure equipment | | | | | | | | |
| 5.6 | Watertight cable transits | | | | | | | | |
| 5.67 | Portable means of access for inspections | | | | | | | | |
| 5.78 | Container securing arrangements | | | | | | | | |
| .1 | Forging | – | X | – | – | – | X | – | For details, see Appendix 1, Chapter 7, PART TWO of the Rules |
| .2 | Casting | – | X | – | – | – | X | – | For details, see Appendix 1, Chapter 7, PART TWO of the Rules |
| 5.89 | Loading computer | | | | | | | | |
| 7 | Anchoring and mooring equipment | | | | | | | | |
| 7.6 | Mooring winch and capstan | | | | | | | | If used as an alternative for windlass, see relevant requirements for windlass |
| .1 | Motors (50 kW and over) | X | – | – | X | O | – | X | |
| .2 | Motors (below 50 kW) | – | X | – | X | – | – | X | |
| .3 | Hydraulic motor | X | – | – | – | – | – | X | |
| .4 | Main shaft (forging) | X | – | – | – | – | X | X[1] | |
| .5 | Main shaft (steel bar) | X[2] | – | – | – | – | – | X[1] | |
| .6 | Hydraulic power unit | X | – | – | – | – | – | X | |
| 7.7 | Winch or capstan for operation | | | | | | | | |
| .1 | Motors (50 kW and over) | X | – | – | X | O | – | X | |
| .2 | Motors (below 50 kW) | – | X | – | X | – | – | X | |
| .3 | Hydraulic motor | X | – | – | – | – | – | X | |
| .4 | Main shaft (forging) | X | – | – | – | – | X | X[1] | |
| .5 | Main shaft (steel bar) | X[2] | – | – | – | – | – | X[1] | |
| .6 | Hydraulic power unit | X | – | – | – | – | – | X | |
| **Machinery (including machinery equipment of refrigerated vessels)** | | | | | | | | | |
| 10 | Machinery equipment | | | | | | | | |
| 10.3 | Diesel engine | | | | | | | | |
| 10.3.1 | Diesel engine (cylinder diameter > 300 mm or single cylinder power >400 kW ) | | | | | | | | For dual fuel engines and gas fuel engines, reference is made to this paragraph for implementation |
| .46 | Explosion-proof device for the engine intake and exhaust manifolds | – | X | – | X | O | – | X | |
| 10.3.2 | Diesel engine (cylinder diameter ⩽ 300mm and single cylinder power ⩽ 400 kW, rated power ⩾ 100kW ) | | | | | | | | For dual fuel engines and gas fuel engines, reference is made to this paragraph for implementation |
| .21 | Explosion-proof device for | – | X | – | X | O | – | X | |

| No. | Product name | Document | | Approval mode | | | | Plan approval | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | | C/E | W | DA | TA-B | TA-A | WA | PA | |
| | the engine intake and exhaust manifolds | | | | | | | | |
| 10.3.3 | Diesel engine (rated power ＜100kW ) | | | | | | | | For dual fuel engines and gas fuel engines, reference is made to this paragraph for implementation |
| .4 | Explosion-proof device for the engine intake and exhaust manifolds | – | X | – | X | O | – | X | |
| **Electrical installations and automatic equipment** | | | | | | | | | |
| 13.21 | Distribution panel for ~~high voltage~~ shore power connection | | | | | | | | |
| .1 | Vacuum circuit breaker | – | X | – | X | – | – | X | |
| .2 | High voltage relay protective device | – | X | – | X | – | – | X | |
| .3 | Electric meter | – | X | – | X | – | – | X | |
| .4 | Insulation monitor | – | X | – | X | – | – | X | |
| .5 | Relay | – | X | – | X[4] | – | – | X | |
| .6 | Fuse | – | X | – | X[4] | – | – | X | |
| .7 | Wire cable | – | X | – | – | – | X | X | |
| .8 | Contactor | – | X | – | X | – | – | X | |
| 13.22 | Control panel for ~~high voltage~~ shore power switch in | | | | | | | | |
| .1 | Circuit breaker | – | X | – | X | – | – | X | |
| .2 | Electric meter | – | X | – | X | – | – | X | |
| .3 | Relay | – | X | – | X[4] | – | – | X | |
| .4 | Fuse | – | X | – | X[4] | – | – | X | |
| .5 | Wire cable | – | X | – | – | – | X | X | |
| .6 | Contactor | – | X | – | X | – | – | X | |
| ~~13.33~~ | ~~Low voltage shore power box~~ | | | | | | | | |
| ~~.1~~ | ~~Circuit breaker~~ | ~~–~~ | ~~X~~ | ~~–~~ | ~~X~~ | ~~–~~ | ~~–~~ | ~~X~~ | ~~Applicable to shore power connection/distribution switch~~ |
| ~~.2~~ | ~~Contactor~~ | ~~–~~ | ~~X~~ | ~~–~~ | ~~X~~ | ~~–~~ | ~~–~~ | ~~X~~ | |
| ~~.3~~ | ~~Electric meter~~ | ~~–~~ | ~~X~~ | ~~–~~ | ~~X~~ | ~~–~~ | ~~–~~ | ~~X~~ | |
| ~~.4~~ | ~~Insulation monitor~~ | ~~–~~ | ~~X~~ | ~~–~~ | ~~X~~ | ~~–~~ | ~~–~~ | ~~X~~ | |
| ~~.5~~ | ~~Relay~~ | ~~–~~ | ~~X~~ | ~~–~~ | ~~X[4]~~ | ~~–~~ | ~~–~~ | ~~X~~ | |
| ~~.6~~ | ~~Fuse~~ | ~~–~~ | ~~X~~ | ~~–~~ | ~~X[4]~~ | ~~–~~ | ~~–~~ | ~~X~~ | |
| ~~.7~~ | ~~Wire cable~~ | ~~–~~ | ~~X~~ | ~~–~~ | ~~–~~ | ~~–~~ | ~~X~~ | ~~X~~ | |

# Appendix 2B LIST OF CERTIFICATION REQUIREMENTS FOR STATUTORY MARINE PRODUCT PARTS

| No. | Product name | Document | | Approval mode | | | | Plan approval | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | | C/E | W | DA | TA-B | TA-A | WA | PA | |
| 3 | Fire-resisting material, structure and fire- fighting equipment | | | | | | | | |
| 3.32 | Helicopter deck foam fire-extinguishing arrangement | | | | | | | | |
| .1 | Low-expansion foam fire-extinguishing medium | – | X | – | – | – | X | – | |
| .2 | Foam storage tank | X | – | – | – | – | X | X | |
| .3 | Proportion mixer | X | – | – | – | – | – | X | |
| .4 | Foam monitor | X | – | – | X | O | – | X | |
| 11 | Lights for helideck | | | | | | | | Used for helideck boundary lights, floodlights, auxiliary floodlights, status lights, windsock lights, and obstruction lights |

# CHAPTER 4 SURVEYS DURING CONSTRUCTION①

## Section 2 SURVEYS AND TESTS

**4.2.1 General requirements**

4.2.1.1 The Surveyor is to carry out surveys according to approved plans (including comments) and confirm the actions taken by the shipyard to implement the plans, and feed different opinions of the shipyard on the implementation of approved plans and associated comments back to the plan approval department in time.

4.2.1.2 The shipyard is to prepare, as required by the rules, lists of certified products for the ship intended to be built, according to Appendices 1A ~~to 2C~~, 1B, 1C, 1D, 1E and 1F of Chapter 3 of this PART and submit them to the attending Surveyor for confirmation.

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

4.2.1.4 New installation of materials containing asbestos is to be prohibited for all ships as from 1 January 2011.

4.2.1.5 For newly constructed dual class ships, the scope of survey is to be in accordance with the bilateral agreement adopted by the two Societies or the trilateral agreement adopted by the two Societies and the shipyard.

4.2.1.6 Unless otherwise specified, the survey of all watertight cable transits installed on all ships contracted for construction on or after 1 July 2024 is to comply with the requirements of Appendix 3 of this Chapter.

## Appendix 1 HULL SURVEY FOR NEW CONSTRUCTION

**7. Newbuilding survey planning**

7.4 Shipbuilding quality standards for the hull structure during new construction are to be reviewed and agreed during the kickoff meeting. Structural fabrication is to be carried out in accordance with IACS Rec.47②, or a Recognized Fabrication Standard (RFS) which has been accepted by CCS prior to the commencement of fabrication/construction. The work is to be carried out in accordance with the Rules and under survey by CCS.

CCS may accept an RFS as an alternative to IACS Rec.47 provided that 7.4.1 or 7.4.2 is complied with as applicable.

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① The requirements for initial classification surveys of ships under construction are given in 5.14.2 of Section 14 of Chapter 5.

② For detailed requirements of IACS Rec.47, see Appendix 2 of this Chapter.

# CHAPTER 5 SURVEYS AFTER CONSTRUCTION

## Section 10 SURVEYS OF ELECTRICAL INSTALLATIONS

**5.10.2 Annual surveys**

5.10.2.2 Survey items

(15) Checking the schedule of batteries used for essential and emergency services, confirming that relevant records have been updated after replacement of batteries.

## Section 18 ADDITIONAL REQUIREMENTS FOR SURVEYS OF LIVESTOCK CARRIERS

**5.18.3 Special survey**

5.18.3.6 Means of access for livestock to and from the ship is to be load tested in accordance with the requirements of 2.2.4, Section 2, Chapter 2, PART EIGHT of the rules.

## Appendix 16 GUIDELINES FOR SURVEY OF PLANNED MAINTENANCE SCHEME（PMS）FOR MACHINERY

### 1 General

**1.3 Requirements for owner or ship management company**

1.3.4 Requirements for PMS database system

(3) Compatibility

① software is to be with good compatibility~~, for example, it is to be compatible with the existing common software such as WINDOWS XP, WIN 7 and WIN 8 etc.~~;

(7) ~~CCS Type Approval and type approval certificates are~~ A Statement of Compliance of management system (software) of planned maintenance scheme for machinery issued by CCS is to be acquired for the above requirements. The period of validity of ~~type approval certificate~~ Statement of Compliance is 5 years and the renewal audit is to be carried out once every 5 years to ensure the effectiveness of the software after maintenance, upgrading or update.

1.3.7 Responsibilities of chief engineer

(3) In general, the chief engineer is to undertake PMS related trainings ~~carried out by CCS or the unit/organization entrusted by CCS~~ organized by CCS or ship company.

### 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) ~~Type approval certificate of PMS computer management software approved by CCS~~ Statement of Compliance of management system (software) of planned maintenance scheme for machinery issued by CCS.

### 3 Survey Requirements

### 3.2 Annual Audit①

3.2.2 During the annual confirmatory audit, the surveyor is to review the ~~annual report~~ detailed record or verify that it has been reviewed by CCS. The ~~annual report~~ detailed record is to include at least the information required in 2.2.1(3) and (5) as well as any change to other paragraphs of 2.2.1.

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

(1) The confirmation examination is to be carried out for PMS computer management system. Verifying that PMS is being correctly and effectively implemented and that the machinery has been functioning satisfactorily since the previous annual audit, together with a general examination of the relevant PMS preventive maintenance items and completion of plans.

(2) The performance and maintenance records are to be examined to verify that the machinery has functioned satisfactorily since the previous annual audit or action has been taken in response to machinery operating parameters exceeding acceptable tolerances and the overhaul intervals have been maintained according to the requirements of the Rules and manufactures.

(3) Examining written details of breakdown or malfunction.

(4) The description of repairs carried out is to be examined. Any damaged machinery part, which has been replaced by a spare one, is to be retained on board – where possible – until examined by the Surveyor; where necessary, the chief engineer is to take photographs for such examination. For the renewed essential parts required by the Rules, the relevant product certificate is to be provided.

(5) 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.

(6) 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.

(7) 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.

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

### 3.3 PMS audit during special class survey

3.3.2 The ~~annual report~~ detailed record of PMS implementation to be submitted by the owner or ship management company and the survey requirements of the Surveyor are the same as 3.2.2 and 3.2.3 above.

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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.

CHINA CLASSIFICATION SOCIETY

# RULES FOR CLASSIFICATION OF SEA-GOING STEEL SHIPS

AMENDMENTS

**2025**

## PART TWO HULL

# CONTENTS

# CHAPTER 2 HULL STRUCTURES

## Section 1 GENERAL PROVISIONS

### 2.1.2 Class notations

2.1.2.1 General dry cargo ships complying with the requirements of this Chapter will be assigned the class notation General Dry Cargo Ship.

2.1.2.2 Ships which have been strengthened for heavy cargoes and comply with the requirements of Section 22 of this Chapter will be assigned the class notation Strengthened for Heavy Cargoes.

2.1.2.3 Ships which have been strengthened for grabs and comply with the requirements of Section 23 of this Chapter will be assigned the class notation Grab*(X).

2.1.2.4 Ships which comply with the requirements of Section 14, Chapter 8 of this PART will be assigned the class notation Double Side Skin.

2.1.2.5 General dry cargo ships intended to carry cargoes in bulk may be assigned the notation Maximum cargo density x.y t/$m^3$. When the maximum density of the bulk cargo designed under the bulk cargo loading condition is less than 3.0 t/$m^3$, this notation is assigned to indicate the limitation and the maximum density value of the bulk cargo allowed to be loaded, see Section 12, Chapter 8 of this PART for detailed requirements.

2.1.2.6 General dry cargo ships intended to carry cargoes in bulk may be assigned the notation No MP. This notation is assigned to show the limitation when the bulk cargo loading condition of general dry cargo ships has not been designed for loading and unloading in multiple ports in accordance with the Rules, see Section 12, Chapter 8 of this PART for detailed requirements.

2.1.2.7 General dry cargo ships intended to carry cargoes in bulk may be assigned the notation Holds a, b, …may be empty. This notation is assigned to specify the empty hold No. when specified empty holds are allowed in the design of bulk cargo loading condition of general dry cargo ships, see Section 12, Chapter 8 of this PART for detailed requirements.

### 2.1.4 Direct strength calculation and fatigue strength assessment for hull structure

2.1.4.1 For general dry cargo ships of 150 m or over in length, FE direct strength calculation and verification are to be carried out for the strength of primary structural members within cargo area. When containers are carried, reference may be made to applicable requirements of Appendix 2, Chapter 7 of this PART. When bulk cargoes are carried, reference may be made to applicable requirements of Appendix 1, Chapter 8 of this PART.

2.1.4.2 For general dry cargo ships of 150 m or over in length, the fatigue strength check may be carried out for the following structural members in the cargo area. For check method, reference may be made to CCS Guidelines for Fatigue Strength of Ship Structure:

(1) connections of longitudinals (bottom, side, deck and inner shell) to transverse web frames;

(2) connections of longitudinals (bottom, side, deck and inner shell) to transverse bulkheads;

(3) connections of hopper tank sloping plate or inner shell to inner bottoms (if any);

(4) connections of transverse bulkheads to inner bottoms and girders.

## Section 19 BULWARKS AND GUARDRAILS

### 2.19.3 Guardrails

2.19.3.1 Guardrails fitted on superstructure and freeboard decks are to have at least three courses. The opening below the lowest course of the guardrails is not to exceed 230 mm. The other courses are to be not more than 380 mm apart. In the case of ships with rounded gunwales the guardrail supports are to be placed on the flat of the deck. In other locations, guardrails with at least two courses are to be fitted.

2.19.3.2 Where external glass balustrades are fitted, reference may be made to relevant requirements of Section 8, Chapter 9 of this PART.

# CHAPTER 3 EQUIPMENT AND OUTFITS

## Section 1 RUDDERS

### 3.1.9 Strength of rudder horns and rudder trunk

3.1.9.1 Rudder horns

The bending moments and shear forces are to be determined by a direct calculation or in line with the guidelines given in 2.4 and 2.5 of Appendix 1 for semi spade rudder with one elastic support and semi spade rudder with 2-conjugate elastic support respectively.

The section modulus around the horizontal $x$-axis $W$ is not to be less than:

$$W = M_b K / 67 \quad \text{cm}^3$$

where: $M_b$ — bending moment at the section considered, in N·m.

The shear stress $\tau$ is not to be larger than:

$$\tau = 48/K \quad \text{N/mm}^2$$

where: $K$ — material factor as given in 3.1.1.3(2) or 3.1.1.3(5) of this Section.

(1) Equivalent stress

At no section within the height of the rudder horn is the equivalent stress to exceed $120/K$ N/mm$^2$.

The equivalent stress $\sigma_v$ is to be calculated by the following formula:

$$\sigma_v = \sqrt{\sigma_b^2 + 3\left(\tau^2 + \tau_T^2\right)} \quad \text{N/mm}^2$$

where: $\sigma_b = M_b / Z_x$, in N/mm$^2$;

$Z_x$ — section modulus of rudder horn at the section considered, in cm$^3$;

$\tau = B_1 / A_h$, in N/mm$^2$;

$B_1$ — supporting force in the pintle bearing, in N;

$A_h$ — effective shear area of rudder horn in $y$-direction, in mm$^2$;

$\tau_T = M_T 10^3 / 2 A_T t_h$, in N/mm$^2$;

$M_T$ — torsional moment, in N·m;

$A_T$ — area in the horizontal section enclosed by the rudder horn (including the area of inner hollow area), in mm$^2$;

$t_h$ — plate thickness of rudder horn, in mm;

$K$ — material factor, as given in 3.1.1.3(2) or 3.1.1.3(5) of this Section respectively.

## Section 2 ANCHORING AND MOORING EQUIPMENT

### 3.2.3 Chain cables

3.2.3.5 ~~The inboard end of the chain cables is to be secured to the hull structure~~ The inboard end of the chain cable is to be connected to the structure by fasteners and so arranged that they will be capable of being immediately released from a position easily accessible outside the chain locker. Fasteners and their hull support structures are to be able to withstand breaking load which is not less than 15% and not greater than 30% of the anchor chain fitted.

### 3.2.4 Towlines and mooring lines

3.2.4.3 The strength of mooring lines and the number of head, stern, and breast lines (see Figure 3.2.4.2) for ships with an Equipment Number EN > 2000 are based on the side-projected area $A_1$. Side projected area $A_1$ is to be calculated similar to the side-projected area A according to 3.2.1.2 but considering the following conditions:

Ballast draft is to be considered for the calculation of the side-projected area $A_1$. For ship types with small change of draft, e.g. passenger ships and ro-ro ships, the summer load waterline may be used for the calculation of the side-projected area $A_1$.

Wind shielding of the pier can be considered for the calculation of the side-projected area $A_1$ unless the ship is intended to be regularly moored to jetty type piers. A height of the pier surface of 3 m over waterline may be assumed, i.e. the lower part of the side projected area with a height of 3 m above the waterline for the considered loading condition may be disregarded for the calculation

of the side-projected area $A_1$.

Deck cargo as given by the nominal capacity condition (as defined in 3.6.2.10 of this Chapter) is to be included for the determination of side-projected area $A_1$. The summer load waterline may be used for the calculation of condition with deck cargo. Deck cargo may not need to be considered if a ballast draft condition generates a larger side-projected area $A_1$ than the full load condition with cargo on deck. The larger of both side-projected areas is to be chosen as side-projected area $A_1$.

(1) The mooring lines as given here under are based on a maximum current speed of 1.0 m/s and the following maximum wind speed, in m/s:

$V_W$ $= 25 - 0.002(A_1 - 2000)$ for passenger ships, ferries, and car carriers with 2000 m$^2$ < $A_1$ ≤ 4000 m$^2$

$= 21$ for passenger ships, ferries, and car carriers with $A_1$ > 4000 m$^2$

$= 25$ for other ships

The wind speed is considered representative of a 30 second mean speed from any direction and at a height of 10 m above the ground. The current speed is considered representative of the maximum current speed acting on bow or stern (±10°) and at a depth of one-half of the mean draft. Furthermore, it is considered that ships are moored to solid piers that provide shielding against cross current. Additional loads caused by, e.g., higher wind or current speeds, cross currents, additional wave loads, or reduced shielding from non-solid piers may need to be particularly considered. Furthermore, it is to be observed that unbeneficial mooring layouts can considerably increase the loads on single mooring lines.

Breast line: A mooring line that is deployed perpendicular to the ship, restraining the ship in the off-berth direction.

Spring line: A mooring line that is deployed almost parallel to the ship, restraining the ship in fore or aft direction.

Head/Stern line: A mooring line that is oriented between longitudinal and transverse direction, restraining the ship in the off-berth and in fore or aft direction. The amount of restraint in fore or aft and off-berth direction depends on the line angle relative to these directions.

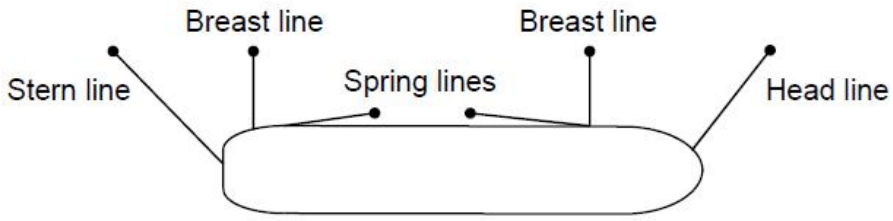


**Figure 3.2.4.2 Breast line, spring line, head/stern line**

(2) The ship design minimum breaking strength, in kN, of the mooring lines for ships with EN>2000 is not to be less than the value obtained from the following formula and to be limited to 1275 kN:

$$MBL_{SD} = 0.1 \cdot A_1 + 350 \quad \text{kN}$$

However, in this case the mooring lines are to be considered as not sufficient for the wind speed given in (1), the acceptable wind speed $V_W^*$, in m/s, can be estimated as follows:

$$V_W^* = V_W \sqrt{\frac{MBL_{SD}^*}{MBL_{SD}}} \qquad MBL_{SD}^* = \left(\frac{V_W^*}{V_W}\right)^2 \cdot MBL_{SD}$$

where: $V_w$ is the wind speed as per (1);

$MBL_{SD}^*$ is the ship design breaking strength of the mooring lines intended to be supplied, to be taken less than corresponding to an acceptable wind speed of 21 m/s:

$$MBL_{SD}^* \geq \left(\frac{21}{V_W}\right)^2 \cdot MBL_{SD}$$

$MBL_{SD}$ — the breaking strength as recommended according to the formula in (2).

If lines are intended to be supplied for an acceptable wind speed $V_W^*$ higher than $V_W$ as per (1), the ship design minimum breaking strength is to be taken as:

$$MBL_{SD}^* = \left(\frac{V_W^*}{V_W}\right)^2 \cdot MBL_{SD}$$

## Section 7 SUPPORT STRUCTURE FOR DECK EQUIPMENT

### 3.7.3 Supporting structure for cranes, derricks and lifting masts

~~3.7.3.12 In all conditions, the stresses taken in calculation for the supporting structures and foundations of lifting appliances are not to exceed the permissible values given in Table 3.7.3.12.~~

~~**Permissible Stress** **Table 3.7.3.12**~~

| ~~Type of element~~ | ~~Permissible stress~~ |
|---|---|
| ~~Grillage~~ | ~~Direct stress: $[\sigma] = 0.67R_{eH}$~~<br>~~Shear stress: $[\tau] = 0.39R_{eH}$~~ |
| ~~Plate element~~ | ~~Equivalent stress: $[\sigma_e] = 0.80R_{eH}$~~ |

~~where: $R_{eH}$ – yield stress of material, in N/mm$^2$.~~

3.7.3.12 In all conditions, the stresses taken in calculation for the supporting structures and foundations of lifting appliances are not to exceed the permissible values as follows:

(1) Strength assessment by means of beam theory or grillage analysis:

Direct stress: $0.67R_{eH}$

Shear stress:$0.39R_{eH}$

Direct stress means the sum of bending stress and axial stress, with the corresponding shear stress acting perpendicular to the direct stress. Stress concentration factors are not considered.

(2) Strength assessment by means of FE analysis method:

Von Mises stress: $0.8R_{eH}$

$R_{eH}$ is specified minimum yield stress of material, in N/mm$^2$.

# Appendix 1 GUIDELINES FOR CALCULATION OF BENDING MOMENT AND SHEAR FORCE DISTRIBUTION

### 2 The Forces on Rudder–Rudder Stock

### 2.4 Semi spade rudder with one elastic support

Data for the analysis

$l_{10} - l_{40}$ = lengths of the individual girders of the system, in m;

$I_{10} - I_{40}$ = moments of inertia of these girders, in cm$^4$.

$Z$ — spring constant of support in the rudder horn:

$Z=1/(f_b+f_t)$ kN/m, for the support in the rudder horn (see Figure 2.4.1);

$f_b$ — unit displacement of rudder horn, in m, due to a unit force of 1 kN acting in the centre of support:

$$f_b = \frac{1.3h^3}{6.18I_n}$$ m/kN (guidance value);

$I_n$ — moment of inertia of horizontal section of rudder horn around the $x$-axis, in cm$^4$ (see also Figure 2.4.1);

$f_t$ — unit displacement due to torsion, in m/kN;

$$f_t = \frac{he^2 \sum u_i / t_i}{3.14 \times 10^8 F_T^2}$$ m/kN

$F_T$ — ~~mean sectional area of rudder horn~~ mean of areas enclosed by outer and inner boundaries of the thin walled section of rudder horn (excluding the area of the inner hollow area), in $m^2$;

$u_i$ — breadth in [mm] of the individual plates forming the ~~mean horn sectional~~ $F_T$ area;

$t_i$ — thickness within the individual breadth $u_i$, in mm;

$h$ — Height of the rudder horn, in m, defined in Figure 2.4.1. This value is measured downwards from the upper rudder horn end, at the point of curvature transition, to the mid-line of the lower rudder horn pintle;

$e$ — distance as defined in Figure 2.4.2, in m, measured to $h/2$ of the height of the rudder horn;

## 2.5 Semi spade rudder with 2-conjugate elastic support

Data for the analysis

$K_{11}$, $K_{12}$, $K_{22}$: Rudder horn compliance constants calculated for rudder horn with 2-conjugate elastic supports (Figure 2.5.1).The 2-conjugate elastic supports are defined in terms of horizontal displacements, $y_i$, by the following equations:

at the lower rudder horn bearing:

$$y_1 = -K_{12}B_2 - K_{22}B_1$$

at the upper rudder horn bearing:

$$y_2 = -K_{11}B_2 - K_{12}B_1$$

where: $y_1$, $y_2$ — horizontal displacements, in m, at the lower and upper rudder horn bearings, respectively;

$B_1$, $B_2$ — horizontal support forces, in kN, at the lower and upper rudder horn bearings, respectively;

$K_{11}$, $K_{12}$, $K_{22}$: — obtained, in m/kN, from the following formulae:

$$K_{11}=1.3\times\frac{\lambda^3}{3EJ_{1h}}+\frac{e^2\lambda}{GJ_{th}}$$

$$K_{12}=1.3\times\left[\frac{\lambda^3}{3EJ_{1h}}+\frac{\lambda^2(h-\lambda)}{2EJ_{1h}}\right]+\frac{e^2\lambda}{GJ_{th}}$$

$$K_{22}=1.3\times\left[\frac{\lambda^3}{3EJ_{1h}}+\frac{\lambda^2(d-\lambda)}{EJ_{1h}}+\frac{\lambda(h-\lambda)^2}{EJ_{1h}}+\frac{(h-\lambda)^3}{3EJ_{2h}}\right]+\frac{e^2\lambda}{GJ_{th}}$$

where: $h$ — height of the rudder horn, in m, defined in Figure 2.5.1. This value is measured downwards from the upper rudder horn end, at the point of curvature transition, to the mid-line of the lower rudder horn pintle;

$\lambda$— length, in m, as defined in Figure 2.5.2. This length is measured downwards from the upper rudder horn end, at the point of curvature transition, to the mid-line of the upper rudder horn bearing. For $\lambda = 0$, the above formulae converge to those of spring constant $Z$ for a rudder horn with 1-elastic support, and assuming a hollow cross section for this part;

$e$ — rudder-horn torsion lever, in m, as defined in Figure 2.5.1 (value taken at $z = h/2$);

$J_{1h}$ — moment of inertia of rudder horn about the $x$-axis, in $m^4$, for the region above the upper rudder horn bearing. Note that $J_{1h}$ is an average value over the length λ (see Figure 2.5.1);

$J_{2h}$ — moment of inertia of rudder horn about the $x$-axis, in $m^4$, for the region between the upper and lower rudder horn bearings. Note that $J_{2h}$ is an average value over the length $h - \lambda$ (see Figure 2.5.1);

$J_{th}$ — torsional stiffness factor of the rudder horn, in $m^4$. For any thin wall closed section:

$$J_{th}=\frac{4F_T^2}{\sum_i \frac{u_i}{t_i}} \quad m^4$$

$F_T$ — mean of areas enclosed by outer and inner boundaries of the thin walled section of rudder horn(excluding the area of the inner hollow area), in $m^2$;

$\mu_i$ — length, in mm, of the individual plates forming the ~~mean horn sectional~~ $F_T$ area;

$t_i$ — thickness, in mm, of the individual plates mentioned above.

Note that the $J_{th}$ value is taken as an average value, valid over the rudder horn height.

For a generic section of the rudder horn, located in the region above its upper bearing, the following stresses are to be calculated:

$\tau_S$ — shear stress, in N/mm$^2$, to be obtained from the following formula:

$$\tau_s = \frac{F_{A1} + F_{A2}}{A_H} \quad \text{N/mm}^2$$

$\tau_T$ — torsional stress, in N/mm$^2$, to be obtained for hollow rudder horn from the following formula:

$$\tau_T = \frac{M_T 10^{-3}}{2F_T t_H} \quad \text{N/mm}^2$$

For solid rudder horn, $\tau_T$ is to be calculated based on the specific geometrical shape.

where:

$F_{A1}$, $F_{A2}$ — support forces, in N;

$A_H$ — effective shear sectional area of the rudder horn, in mm$^2$, in $y$-direction;

$M_T$ — torque, in N·m;

$F_T$ — mean of areas enclosed by outer and inner boundaries of the thin walled section of rudder horn(excluding the area of the inner hollow area), in m$^2$;

$t_H$ — Plate thickness of rudder horn, in mm. For a given cross section of the rudder horn, the maximum value of $\tau_T$ is obtained at the minimum value of $t_H$.

# Chapter 4 STRENGTHENING FOR NAVIGATION IN ICE

## Section 1 GENERAL PROVISIONS

### 4.1.1 General requirements

4.1.1.2 Ships, which comply with the requirements of Section 2 of this Chapter, may be assigned an appropriate ice class notation in accordance with 4.2.1.2, Section 2 of this Chapter; ships, which comply the requirements of Section 3 of this Chapter, may be assigned the notation of Ice Class B.

**Table 4.1.1.2**

| Applicable ice navigation waters | Ice class | Requirements in corresponding chapters of the Rules | Additional requirements for ships having icebreaking capability | Additional provisions for icebreakers |
|---|---|---|---|---|
| Polar ~~open~~ sea | PC1 ~ PC7 | Sections 1 ~ 2, Chapter 13 of PART EIGHT | – | Sections 1 and 2, Chapter 13 of PART EIGHT |
| | Icebreaker* | Rules for Heavy Icebreakers | – | – |
| Baltic or other sea areas with similar ice conditions in winter | B1*, B1 ~ B3 | Section 2, Chapter 4 of PART TWO | Chapter 9 of PART EIGHT | – |
| Drift ice sea areas other than large stationary ice such as for coastal ice condition in northern part of China in winter | B | Section 3, Chapter 4 of PART TWO | – | – |

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 (FSICR)① is given in Table 4.1.1.4.

**Table 4.1.1.4**

| CCS | FSICR |
|---|---|
| B1* | IA Super |
| B1 | IA |
| B2 | IB |
| B3 | IC |
| B | Between II and IC |
| Ships with the character of classification CSA ~~B~~ | II |

① See TRAFICOM/281964/03.04.01.00/2023 for equivalence.

# Chapter 7 CONTAINER SHIPS

## Appendix 1 CONTAINER SECURING

### ~~6 Lashing Calculation Program~~

**~~6.1 General requirements~~**

~~6.1.1 The lashing calculation program is a software program installed in the onboard computer, which is to be capable of calculating container securing strength in accordance with the requirements of this Appendix.~~

~~6.1.2 Recommendations for the lashing calculation program include program approval and full scale installation inspection.~~

**~~6.2 Requirements for specific approval of lashing calculation program~~**

~~6.2.1 The specific approval of lashing calculation program means, for the purpose of a specific ship, the approval of the program installed on board, i.e. the approval of the design method, calculation functions and principles, input data, output data, operation manual and test report and other documents.~~

~~6.2.2 The specific approval of lashing calculation program may specifically include the following:~~

~~(1) Design method, calculation functions and principles of the program are to be in conformity with the requirements and comply with the functional requirements of 6.2.3 of this Appendix.~~

~~(2) All input data of the program are to be consistent with those of the actual ship.~~

~~(3) By comparing calculation results for test conditions selected according to 6.4 of this Appendix with those of CCS plan approval software, the error is to be controlled within ±5%.~~

~~(4) Operation manual of the lashing calculation program is to comply with the requirements of 6.5 of this Appendix.~~

~~6.2.3 Lashing calculation program is to have the following functional requirements:~~

~~(1) The program is to be such that a common user can not alter the inputted data of the actual ship such as the geometric characteristics and permissible values.~~

~~(2) The program is to be such that any user can not alter the inputted calculation program.~~

~~(3) The program is to, as far as possible, reduce significant or illogical input errors.~~

~~(4) The program is to be capable of clearly judging whether a calculation condition complies with the relevant requirements and carrying out calculation for a certain condition. Where the calculation results exceed permissible values, the user is to be alerted by distinct means such as prominent display, special markings or visual and audible alarms, screen display or printout.~~

~~(5) The program interface is to be fully user-friendly and to alert the user with an alarm in case of any operational error. Data loss or computer crash caused by the user's error is to be minimized.~~

~~(6) The program is to be provided with passwords so that the computer will refuse to work and alert the user with an alarm where any illegal password is input.~~

~~(7) The program is to be capable of calculating the container securing strength under any condition, and carrying out calculation and storing the date and time of calculation results by means of screen display and printout. The screen display and printout are to include the following information under any condition:~~

- ~~initial metacentric height;~~
- ~~position of container stack;~~
- ~~actual weight of stacked container;~~
- ~~maximum permissible stack weight;~~
- ~~lashing arrangement of stacked containers;~~
- ~~transverse acceleration of each tier of container;~~
- ~~racking force of each tier of container;~~
- ~~vertical tension and pressure between each tier of container;~~
- ~~stack bottom pressure;~~
- ~~lashing force;~~
- ~~transverse horizontal pressure and tension;~~
- ~~warnings (if any strength criteria is exceeded).~~

**6.3 Steps for implementing approval of lashing calculation program**

6.3.1 The applicant is to submit the following plans and information to CCS for approval:

(1) Instructions for lashing calculation program, which is to include program design method, calculation function and data structure;

(2) Operation manual of lashing calculation program;

(3) Test report of lashing calculation program.

6.3.2 The applicant is to provide relevant plan or data of a specific ship (e.g. general arrangement of ship, container securing manual/arrangement plan) for information or checking calculation.

6.3.3 On completion of approving above plans and information, cover pages of operation manual of lashing calculation program and test report may be affixed with an approval stamp, and it is to be indicated in the issued plan approval comment that class notation CLC or class notations CLC(V) and CLC(V,W) are recommended to be assigned.

**6.4 Test condition**

6.4.1 Test condition is to be selected from container securing manual/arrangement plan of the ship.

6.4.2 Test condition is at least to include:

(1) container lashing arrangement condition corresponding to minimum and maximum initial metacentric height;

(2) for ships assigned class notation CLC(V) or CLC(V,W), the corresponding additional condition.

6.4.3 Test condition is to include all functions of program as far as possible.

6.4.4 Approved test condition is to be kept as input data to ensure that they can not be revised by the user. A copy of approved test condition is to be kept on board.

**6.5 Operation manual**

6.5.1 At least one copy of operation manual of lashing calculation program approved by CCS is to be kept on board.

6.5.2 The operation manual of lashing calculation program is to be written by a language used by the user on board, and the language is to be the same as that for screen display, printout and the approved container securing manual/arrangement plan kept on board. Where the language is not English, a translation into English is to be provided.

6.5.3 The operation manual is to be written in a clear and unambiguous manner. The use of flowcharts is recommended for illustrating operational processes.

6.5.4 The operation manual is to include the following:

(1) particulars and version number of the lashing calculation program;

(2) specification of hardware needed to run the lashing calculation program and guidance for program installation;

(3) program running steps shown in menus and dialogues, error messages and warnings likely to be encountered during the program run and instructions for subsequent actions to be taken in such case;

(4) description of test conditions;

(5) operation of program shown by calculation cases;

(6) input and output data, calculation results shown by screen display, necessary explanatory text;

(7) explanation for function keys.

**6.6 Full scale installation inspection**

6.6.1 The shipowner or the entrusting party is to submit application to CCS survey unit of port of call of ship.

6.6.2 The crew may grasp operation and calculation of lashing calculation program of the ship by means of study or training, and installation inspection is to be carried out by crew of the ship.

6.6.3 Full scale installation inspection is to be carried out with the presence of CCS surveyor. Installation inspection is generally to include following items:

(1) Checking that the user's operation manual and test report approved by CCS are kept on board the ship.

~~(2) Examining the environment and position for installing the program: confirming that the position and method for installing the program are as required in the instruction.~~
~~(3) Program stability test: the program is to be capable of working normally after a continuous running period of one hour.~~
~~(4) Program security test: where an illegal password is inputted (or in case of human inadvertent operation), the program should refuse to work.~~
~~(5) Program safety test: a common user is not to be capable of changing the application program and the input ship's data such as geometrical characteristics and permissible values.~~
~~(6) Program functional test: the calculation results from the program operated by the crew of the ship based upon the conditions as stated in the approved test report, the calculations are to be the same as those in the approved test report.~~
~~6.6.4 During installation inspection, test report printed by lashing calculation program is to be confirmed and endorsed by site surveyor. On completion of satisfactory installation inspection, site surveyor is to issue report and CCS is to assign relevant class notation.~~
~~6.6.5 For ships provided with lashing calculation program approved by other IACS member societies, the operation manual and test report approved by these Societies may be reviewed and installation inspections are to be carried out in accordance with 6.6.3 of this Appendix.~~
~~6.6.6 For ships provided with lashing calculation program not complying with the relevant requirements of CCS or approved by a party which is not a member of IACS, the program approval and the installation inspection is to be carried out once again.~~

## 6 Lashing Software

### 6.1 General requirements

6.1.1 All seagoing dedicated container ships are to be provided with lashing software complying with the requirements of this section.
6.1.2 Lashing software is an electronic data processing tool for onboard analysis of forces in container stacks and thereby reflects the parameters of the lashing system as described in the Cargo Securing Manual.
6.1.3 An approved lashing software is not a substitute for the approved Cargo Securing Manual. It is considered as a supplement to the approved Cargo Securing Manual.
6.1.4 The lashing software is a ship specific tool, and the results of the calculations are only applicable to the ship for which it has been approved.

### 6.2 Operation manual

6.2.1 An operation manual is to be provided for the lashing software and be kept on board, which is to be approved by CCS.
6.2.2 The language of the operation manual is to be the same as the language of the approved Cargo Securing Manual. A translation into another language considered appropriate may be required.
6.2.3 The operation manual is to contain descriptions and instructions, as appropriate, as per the following list:
(1) a general description of the lashing software;
(2) installation;
(3) function keys;
(4) menu displays;
(5) input and output data;
(6) required minimum hardware to operate the software;
(7) instruction on testing the lashing software with the test loading condition;
(8) a list of all terms, definitions, error messages and warnings likely to be encountered by the user; and
(9) in the case of error messages and warnings, there are to be unambiguous user instructions for subsequent action to be taken in each case.

### 6.3 Functional requirements

6.3.1 The lashing software is to be capable of calculating forces on containers and container securing equipment for any loading conditions for each container stack.

6.3.2 It is also to be capable of indicating the respective permissible values in order to assist the master in his/her judgement on whether the ship is loaded within the approved limits. The following parameters are to be presented:
(1) summary of ship particulars such as IMO No., length, and breadth;
(2) summary of loading conditions showing relevant input parameters such as draught and GM;
(3) stack and container positions;
(4) actual stack weights verified against permissible stack weights;
(5) relevant properties of securing devices, including permissible loads;
(6) accelerations and other external forces such as wind containers are exposed to;
(7) listing of all calculated forces on containers and container securing equipment, and evaluation of compliance of the calculated forces with the corresponding allowable values.
6.3.3 The container and lashing arrangements in each bay on deck and in holds are to be shown graphically.
6.3.4 The data are to be presented on screen and in hard copy printout in a clear and unambiguous manner.
6.3.5 A clear warning is to be given on screen and in hard copy printout if any of the allowable forces are exceeded.
6.3.6 In addition to the printout content, each page of the printout is to contain ship's identification, lashing software name and version number, date and time of the printout, and the title of the loading condition. The printout is to be paginated sequentially, and the total number of printout pages are to be shown.
6.3.7 Units of measurement are to be clearly identified and used consistently.
6.3.8 Incorrect data input by the users, such as negative draught values, are to be prohibited. An error message is to be prompted on screen and in hard copy printout in a clear and unambiguous manner.

## 6.4 Test Loading Conditions

6.4.1 The lashing software is to be delivered with test loading conditions for selected stacks and bays covering applicable stowage patterns for containers of different dimensions contained in the Cargo Securing Manual. It is generally to cover the container stacking of the ship's bow, amidships and stern bay, including at least one lashing calculation for the conditions listed in the Cargo Securing Manual. For ships assigned the CLC (V) or CLC (V,W) notation, the corresponding additional conditions are to be supplemented.
6.4.2 The test loading conditions and their results are to be permanently stored in the computer where the lashing software is installed and be protected against unintentional or unauthorized modifications and access.

## 6.5 Approval of Lashing Software

6.5.1 The lashing software is subject to approval and is to include:
(1) verification of type approval, if any;
(2) verification that the latest ship data has been used;
(3) verification and approval of the test loading conditions and their results;
(4) verification if requirements of 6.3 are satisfied;
(5) checking of proper installation, and verification of the instrument on board in accordance with the approved test loading conditions;
(6) checking the availability of the operation manual on board.
6.5.2 In case of modifications implying changes in the ship’s design or container securing arrangement, the software is to be modified accordingly and re-approved.
6.5.3 Any changes in software version related to the container securing calculations are to be reported and be approved.
6.5.4 Upon installation, the lashing software is to be verified with the approved test loading conditions in the presence of surveyor. It is to be checked that the operation manual for the lashing software is available on board.
6.5.5 Verification does not absolve the shipowner of responsibility for ensuring that the information supplied into the lashing software is consistent with the current condition of the ship and approved Cargo Securing Manual.

### 6.6 Acceptable Tolerances

6.6.1 The results of the lashing software are compared with those of the CCS plan approval software. The tolerance of the accuracy of the results from the lashing software is to be below 1.0% of the allowable values. However, deviations may be accepted provided that there is a satisfactory explanation for the deviation and that there will be no adverse effects on the safety of the ship.

### 6.7 Annual and Special Survey

6.7.1 At each annual and special survey, it is to be checked that the operation manual is available on board.

6.7.2 The lashing software is to be checked for accuracy annually by the ship's Master by applying the test loading conditions. If the surveyor is not present for lashing software check, a copy of the test loading condition results obtained by this check is to be retained on board as documentation of satisfactory testing for the surveyor's verification at the next scheduled survey.

6.7.3 At each special survey this checking is to be done in the presence of surveyor.

## 7 Specific Route and Season

### 7.1 Transverse acceleration for specific route

7.1.1 For container securing of specific route, transverse acceleration $a_{vt}$ is to be calculated as follows:

$$a_{vt} = a_t \cdot f_{route} \qquad \text{m/s}^2$$

where: $a_t$ — transverse acceleration calculated according to 4.2.1 of this Appendix, in m/s$^2$;
$f_{route}$—specific route factor.

7.1.2 For each specific route, CCS will determine route factor $f_{route}$ by statistical calculation of ship motion. CCS will develop specific wave scatter diagram based on acceptable wave statistical data to obtain $f_{route}$. For each specific route, latitude and longitude coordinates of a series of points along the route is to be provided by the shipowner or the information on sea areas passed by the route is to be provided. Division of sea areas and statistical data of wave in sea area are to be agreed by CCS. For each passed sea area, at least one point is to be given. If possible, time percentage for each passed sea area is to be provided.

7.1.3 For container securing of short voyage (port to port, navigation time within 72 hours), the specific route factor may be calculated as follows:

$$f_{route} = 1 - (H_s - 13)^2 / 240$$

where: $H_s$ — the maximum expected significant wave height on the route during the navigation time, in m.

## 8 Approval and Certification of Container Securing Systems

### 8.1 General requirements

8.1.1 All seagoing dedicated container ships are to comply with the requirements of this section.

8.1.2 It is important for the safety of the ship and the protection of the cargo and personnel that the cargo is secured properly especially accounting for strength of the supporting structures and securing fittings. Hereto, a scope containing the following for approval and/or certification of container securing systems is defined:

(1) fixed and portable container securing fittings;

(2) arrangement plan of fixed container securing fittings;

(3) drawings of container supporting structures (container stanchions, hatch covers, lashing bridges, and cell guides, if any);

(4) cargo safe access plan;

(5) container stowage and securing plan;

(6) lashing software.

## 8.2 Fixed and Portable Container Securing Fittings

8.2.1 Fixed container securing fittings are used to secure and support containers and are permanently welded to the ship structure.

8.2.2 Portable1 container securing fittings are used to secure containers and are not categorised as fixed container securing fittings.

8.2.3 Minimum Breaking Load corresponds to the minimum load at which the first crack appears in the tested representative samples.

8.2.4 Minimum Proof Load corresponds to the test load below which visible permanent deformation is not allowed.

8.2.5 Drawings of fixed and portable container securing fittings are to show dimensions, materials, design loads, and manufacturer's markings.

8.2.6 Each fixed and portable container securing fitting type is subject to prototype testing to determine the minimum breaking loads. The minimum breaking load obtained from prototype testing is to be equal to or exceed the design minimum breaking load. Requirements for prototype testing are given in 2.2 of this Appendix.

8.2.7 Fixed and portable container securing fittings are subject to production testing prior to delivery or installation. A number of samples from a batch of the container securing fittings is to be loaded to minimum proof load of the fittings. The production testing approval documents of delivered container securing fittings are to be kept on board and may be included in the approved Cargo Securing Manual. Requirements for production testing are given in 2.3 of this Appendix.

8.2.8 The plan detailing the arrangement of the fixed container securing fittings is to be approved. The arrangement plan is to include the following for all areas where the fittings are installed:

(1) The type of fixed container securing fittings such as container foundations and lashing eye plates;

(2) Unambiguous location of installed fittings such as their location relative to clearly described locations of the ship structures.

## 8.3 Drawings of Container Supporting Structures

8.3.1 The drawings of the structures necessary for conducting container stowage and securing are subject to approval. The drawings are to be detailed enough to allow their model generation for structural analyses. A plan is to be provided showing all relevant design loads for structural assessment of the container supporting structures and their foundations.

8.3.2 Structures involved in container stowage and securing include hatch covers, container stanchions, lashing bridges and cell guides.

## 8.4 Cargo Safe Access Plan

8.4.1 The cargo safe access plan is to be examined for its compliance with the requirements prescribed in MSC.1/Circ.1353/Rev.2 (refer to CCS Guidelines for the Preparation of the Cargo Securing Manual).

## 8.5 Container Stowage and Securing Plan

8.5.1 If the stowage and securing plan, as referred to in MSC.1/Circ.1353/Rev.2 4.2.1 and 4.2.2 (refer to CCS Guidelines for the Preparation of the Cargo Securing Manual), is required by the Administration, the plan is subject to approval in accordance with 8.5.2 and 8.5.3.

8.5.2 The container stowage plan is to include at least the following information for each container type the ship is designed for:

(1) longitudinal and athwartship views of under deck and on deck stowage locations of containers including reefers as appropriate;

(2) alternative stowage patterns for containers of different dimensions;

(3) maximum stack masses;

(4) maximum stack heights with respect to approved sight lines; and

(5) maximum nominal container capacity.

8.5.3 The container securing arrangement plan is to contain all information necessary to prepare lashing calculations. The container securing arrangement plan is to include at least the following information:

(1) summary of ship particulars such as IMO No., length and breadth;
(2) summary of loading conditions showing relevant input parameters such as draught and GM;
(3) longitudinal views of under deck and on deck stowage locations of containers as appropriate showing nominal capacity;
(4) maximum stack masses;
(5) relevant properties of securing fittings, including permissible loads;
(6) graphical presentation of container and lashing arrangements in each bay on deck and in holds for sample loading conditions for each container type the ship is allowed to carry;
(7) stack total mass and the sequence of masses in a stack;
(8) minimum quantity of fittings required to secure containers for the presented sample loading conditions.

**8.6 Lashing Software**

8.6.1 If the ship is provided with lashing software on board, the approval is to follow the requirements of Section 6 of this Appendix.

# CHAPTER 8 BULK CARRIERS

## Section 1 GENERAL PROVISIONS

### 8.1.1 Application

~~8.1.1.5 The requirements of 8.11.5 of this Chapter are not applicable to self-unloading bulk carriers.~~

## Section 12 HARMONIZED NOTATIONS AND CORRESPONDING DESIGN LOADING CONDITIONS FOR BULK CARRIERS

### 8.12.2 Application

8.12.2.1 Typical bulk carriers of 150 m or over in length and constructed with single deck, double bottom, topside tanks and hopper tanks in the cargo hold region and of single side skin or double side skin construction are to comply with relevant requirements of this Section. General dry cargo ships intended to carry cargoes in bulk may also be assigned relevant notations provided that relevant requirements of this Section are satisfied.

### 8.12.3 Harmonized notations and annotations

8.12.3.2 Additional notations:

~~The following additional notations and annotations are to be provided giving further detailed description of limitations to be observed during operation as a consequence of the design loading condition applied during the design in the following cases:~~

(1) {Maximum cargo density x.y t/m$^3$} ~~for notations BC–A and BC–B if the maximum design cargo density is less than 3.0 t/m$^3$;~~ : When the maximum design cargo density is less than 3.0 t/m$^3$, for bulk carriers, the limitation is to be given after the harmonized notation, indicating the maximum cargo density allowed to be loaded. This additional notation is only applicable to notations BC–A and BC–B. For general dry cargo ships intended to carry cargoes in bulk, when the maximum density of the bulk cargo designed under the bulk cargo loading condition is less than 3.0 t/m$^3$, this notation is assigned to indicate the limitation and the maximum density value of the bulk cargo allowed to be loaded.

(2) {No MP} ~~for all notations when the vessel has not been designed for loading and unloading in multiple ports in accordance with the conditions specified in 8.12.5.3;~~:When requirements for loading and unloading in multiple ports have not been raised in accordance with 8.12.5.3 in the design of bulk carrier, the limitation is to be given after the harmonized notation. This additional notation is applicable to all harmonized notations (BC-A, BC-B, BC-C). For general dry cargo ships intended to carry cargoes in bulk, this notation is assigned to show the limitation when the bulk cargo loading condition has not been designed for loading and unloading in multiple ports in accordance with the Rules.

(3) {Holds a, b, …may be empty} ~~for notation BC–A.~~ : When specified empty holds are allowed in the design of bulk carriers, this additional notation is to be given after the harmonized notation. This notation is only applicable to notation BC-A. For general dry cargo ships intended to carry cargoes in bulk, this notation is assigned to specify the empty hold No. when specified empty holds are allowed in the design of bulk cargo loading condition.

### 8.12.5 Design loading conditions (for local strength)

8.12.5.2 ~~General conditions applicable for all notations~~ For all ships within the scope of application, the cargo hold is to be checked in accordance with the following loading conditions.

(1) Any cargo hold is to be capable of carrying $M_{Full}$ with fuel oil tanks in double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom in way of the cargo hold being empty, at maximum draught (see Figure 8.12.5.2(1)).

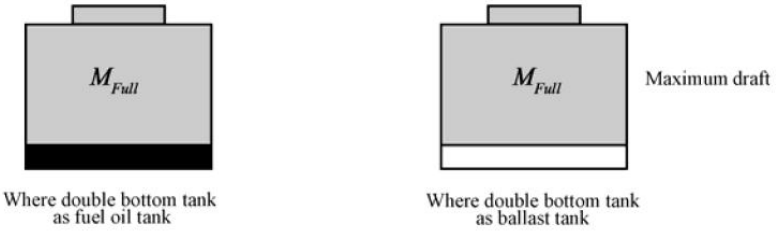


**Figure 8.12.5.2(1)**

(2) Any cargo hold is to be capable of carrying minimum 50% of $M_H$, with all double bottom tanks in way of the cargo hold being empty, at maximum draught (see Figure 8.12.5.2(2)).

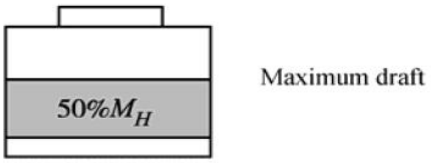


**Figure 8.12.5.2(2)**

(3) Any cargo hold is to be capable of being empty, with all double bottom tanks in way of the cargo hold being empty, at the deepest ballast draught (see Figure 8.12.5.2(3)).

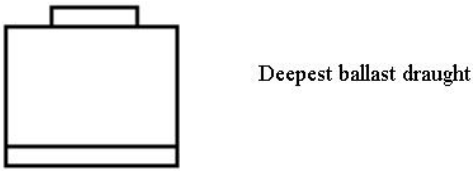


**Figure 8.12.5.2(3)**

8.12.5.3 ~~Condition applicable for all notations~~ For all ships within the scope of application, the cargo hold is to be checked in accordance with the following loading conditions, except when notation (No MP) is assigned

(1) Any cargo hold is to be capable of carrying $M_{Full}$ with fuel oil tanks in double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom in way of the cargo hold being empty, at 67% of maximum draught (see Figure 8.12.5.3(1)).

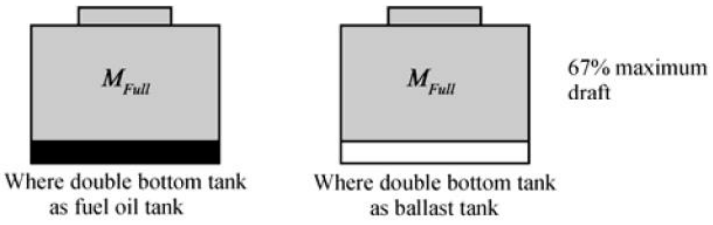


**Figure 8.12.5.3(1)**

(2) Any cargo hold is to be capable of being empty with all double bottom tanks in way of the cargo hold being empty, at 83% of maximum draught (see Figure 8.12.5.3(2)).

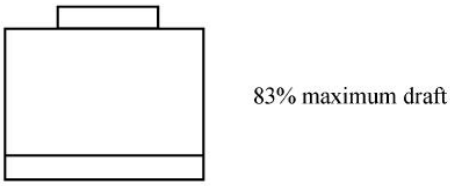


**Figure 8.12.5.3(2)**

(3) Any two adjacent cargo holds are to be capable of carrying $M_{Full}$ with fuel oil tanks in double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom in way of the cargo hold being empty, at 67% of the maximum draught. This requirement to the mass of cargo and fuel oil in double bottom tanks in way of the cargo hold applies also to the condition where the adjacent hold is filled with ballast, if applicable (see Figure 8.12.5.3(3)).

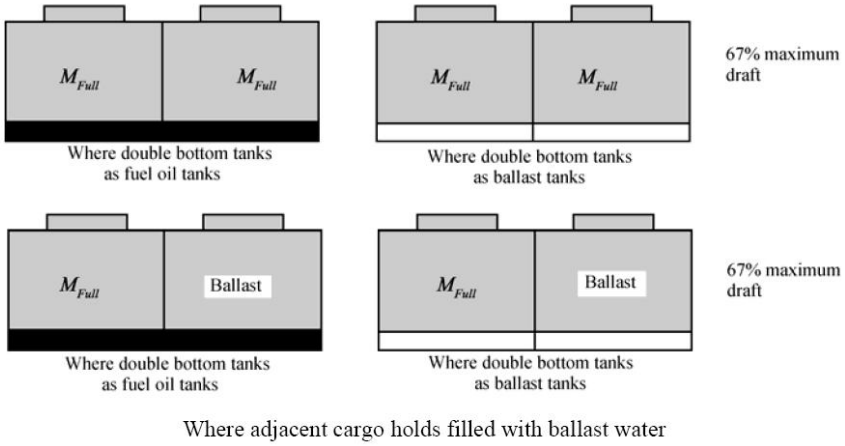


**Figure 8.12.5.3(3)**

(4) Any two adjacent cargo holds are to be capable of being empty, with all double bottom tanks in way of the cargo hold being empty, at 75% of maximum draught (see Figure 8.12.5.3 (4)).

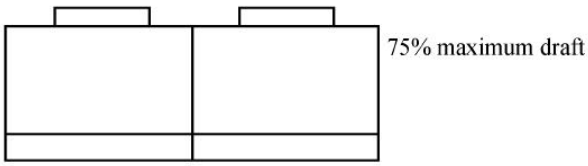


**Figure 8.12.5.3(4)**

8.12.5.4 ~~Additional conditions applicable for BC-A notation only~~ Additional requirements for ships where empty holds are allowed in the bulk cargo loading condition

(1) Cargo holds, which are intended to be empty at maximum draught, are to be capable of being empty with all double bottom tanks in way of the cargo hold also being empty (see Figure 8.12.5.4 (1)).

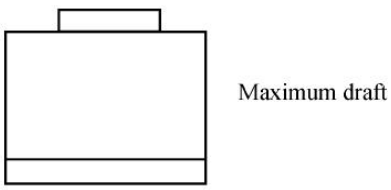


**Figure 8.12.5.4(1)**

(2) Cargo holds, which are intended to be loaded with high density cargo, are to be capable of

carrying $M_{HD}$ plus 10% of $M_H$, with fuel oil tanks in the double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom being empty in way of the cargo hold, at maximum draught. In operation the maximum allowable cargo mass is to be limited to $M_{HD}$ (see Figure 8.12.5.4 (2)).

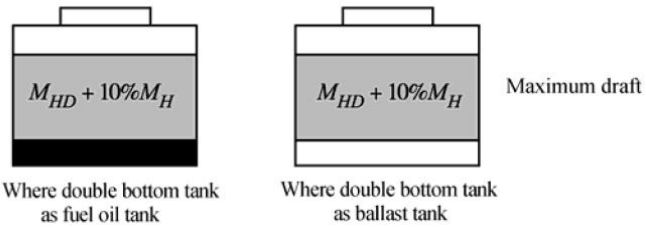


**Figure 8.12.5.4(2)**

(3) Any two adjacent cargo holds which according to a design loading condition may be loaded with the next holds being empty, are to be capable of carrying 10% of $M_H$ in each hold in addition to the maximum cargo load $M'_{HD}$ according to that design loading condition, with fuel oil tanks in the double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom in way of the cargo hold being empty, at maximum draught. In operation the maximum allowable mass is to be limited to the maximum cargo load according to the design loading conditions (see Figure 8.12.5.4 (3)).

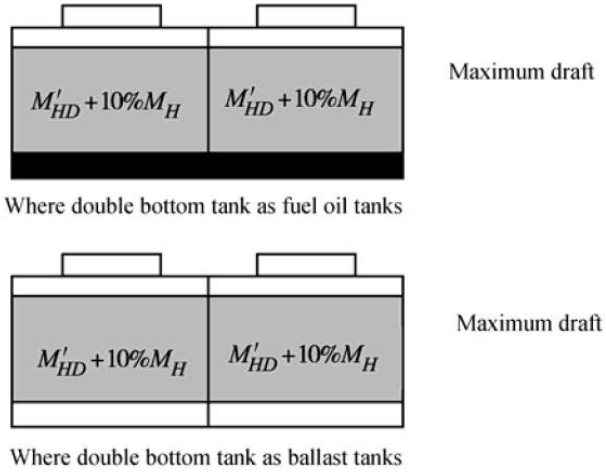


**Figure 8.12.5.4(3)**

## Section 13 REQUIREMENTS FOR THE FITTING OF A FORECASTLE

### 8.13.2 Arrangement

8.13.2.3 All points of the aft edge of the forecastle deck are to be located at a distance $l_f$:

$$l_f \le 5\sqrt{H_F - H_C} \quad \text{m}$$

from the hatch coaming plate in order to apply the reduced loading to the No.1 forward transverse hatch coaming and No.1 hatch cover in applying ~~8.11.4.1~~2.20.2.2(2)② and ~~8.11.5.2~~ 2.20.2.9(2)③, respectively, of ~~this~~ Chapter 2 of this PART.

# CHAPTER 9 ROLL ON-ROLL OFF SHIPS, PASSENGER SHIPS, RO-RO PASSENGER SHIPS AND FERRIES

## Section 2 HULL STRUCTURE

**9.2.3 Transverse strength**

9.2.3.1 For roll on-roll off ships, ro-ro passenger ships and ferries carrying vehicles, the transverse strength of the hull is to be checked in accordance with the relevant requirements of Section 7 of this Chapter.

# CHAPTER 16 ORE CARRIERS

## Section 1 GENERAL PROVISIONS

### 16.1.1 Application

16.1.1.1 This Chapter applies to the determination of structural arrangements and scantlings within the cargo region of self-propelled single deck ore carriers with machinery aft, having two longitudinal bulkheads in the cargo region and a double bottom throughout the centre hold, intended for the carriage of ore cargoes in the centre hold. A typical cross section of such ore carriers is shown in Figure 16.1.1.1. Ore carriers of 250 m and over in length and engaged in unrestricted service are to satisfy the requirements of CCS Rules for Structures of Ore Carriers.

### 16.1.2 Class notation

16.1.2.1 Ore carriers complying with the requirements of this Chapter are eligible to be assigned the class notation of Ore Carrier.

16.1.2.2 When requirements for loading and unloading in multiple ports have not been raised in the design of ore carriers in accordance with CCS Guidelines for Direct Strength Analysis of Hull Structure of Ore Carriers, No MP notation is to be assigned to indicate the limitation.

# CHAPTER 18 TWIN-HULL CRAFT

## Appendix 1 DIRECT STRENGTH CALCULATION OF TWIN-HULL CRAFT

### 5 Yielding Strength Assessment

~~5.1.2 If meshes finer than those specified in Section 5, Chapter 1 of this Chapter are used, the average stress value of all fine meshes under the specified mesh size is to be taken.~~

5.1.~~3~~2 Where the loads are applied in accordance with 2.2.1 to 2.2.3 of this Appendix, the equivalent stress of plate element within fine mesh area is not to be greater than $1.2 \times 235/K$ ($K$ is material factor). Where the loads are applied through equivalent design wave in 2.2.4 of this Appendix, the equivalent stress of plate element within fine mesh area is not to be greater than $1.5 \times 235/K$ ($K$ is material factor).

CHINA CLASSIFICATION SOCIETY

# RULES FOR CLASSIFICATION OF SEA-GOING STEEL SHIPS

AMENDMENTS

**2025**

## PART THREE
## MACHINERY INSTALLATIONS

# CONTENTS

# CHAPTER 1 GENERAL

## Section 2 GENERAL PROVISIONS

**1.2.11 Clean energy and power**

1.2.11.7 Ships using liquefied petroleum gas as fuel are, in addition to the relevant provisions of this PART, to comply with relevant requirements of CCS Guidelines for Ships Using Liquefied Petroleum Gas Fuel.

1.2.11.8 Ships using ammonia as fuel are, in addition to the relevant provisions of this PART, to comply with relevant requirements of CCS Guidelines for Ships Using Ammonia Fuel.

# CHAPTER 4 MACHINERY PIPING SYSTEMS

## Section 8 THERMAL OIL SYSTEM

**4.8.1 General requirements**

4.8.1.2 Heating of liquid cargoes with flash points below 60℃ is in general to be arranged by means of double circuit systems, with a ~~separate~~ secondary system located completely within the cargo area. However, a single circuit system may be accepted on the following conditions:

(1) System is so arranged that a positive pressure in the coil is to be at least 3 m water column above the static head of the cargo when circulating pump is not in operation.

(2) The thermal oil system expansion tank is to be fitted with high and low level alarms.

(3) Means are to be provided in the thermal oil system expansion tank for detection of flammable cargo vapors. Applicable portable equipment may be accepted.

(4) Valves for ~~the individual~~ each heating coil~~s~~ are to be provided with locking arrangement to ensure that the coils are under static pressure at all times.

# CHAPTER 6 BOILERS AND PRESSURE VESSELS

## Section 5 THERMAL OIL HEATERS

### 6.5.5 Monitoring and protection

6.5.5.1 Monitoring and protective measures are to be provided for thermal oil heaters according to Table 6.5.5.1.

**Monitoring and Alarm Items for Thermal Oil Heaters** **Table 6.5.5.1**

| Items to be monitored | Local control | | | Remark |
|---|---|---|---|---|
| | Indication | Alarm | Automatic shutoff | |
| Thermal oil expansion tank level | × | Low | × | High alarm is also to be provided for single circuit thermal oil system |
| Thermal oil flow or pressure | × | Low | × | |
| Thermal oil outlet temperature | × | High | × | |
| Combustion air pressure or forced ventilation① | | Low or shutoff | × | |
| Oil fuel pressure① | × | Low | | Standby pumps to start automatically |
| Heavy oil fuel temperature or viscosity① | × | Low and great | | For heavy oil fuel only |
| Uptake temperature① | × | High | × | |
| Burner flame or ignition① | | Flameout/failure | × | Each burner to be monitored |
| Exhaust temperature② | × | High | | |

Notes:

× = functional requirement

① Applicable for oil-fired heaters.

② Applicable for exhaust gas heaters.

# CHAPTER 9 DIESEL ENGINES

## Section 1 GENERAL PROVISIONS

**9.1.9 Gas/low flash-point fuel engines**

9.1.9.2 In addition to the relevant provisions of this Chapter, methanol/ethanol fuel engines are to comply with the applicable requirements of Appendix 10 of this Chapter and CCS Guidelines for Ships Using Methanol/Ethanol Fuel.

9.1.9.3 In addition to the relevant provisions of this Chapter, ammonia fuel engines are to comply with the applicable requirements of Appendix 11 of this Chapter and CCS Guidelines for Ships Using Ammonia Fuel.

## Section 4 PIPING SYSTEMS

**9.4.6 Compressed air systems for essential services**

9.4.6.1 Compressed air systems for essential services mean compressed air systems provided for the proper operation of SCR purging systems (if applicable), gas fuel double-wall duct ventilation systems (if applicable) etc. on board ships, other than those used for engine starting.

9.4.6.2 The arrangements for the supply of compressed air to essential services are to ensure that sufficient compressed air to satisfy the total demand of the essential services is available at all times during normal operation, during maintenance, and in the event of a failure of the compressed air system.

9.4.6.3 Where compressed air is supplied from the engine starting air system, either continuously in normal operation, or periodically during maintenance or in the event of a failure of the compressed air system, the required compressed air demand is not to reduce the capacity and availability of the engine starting air.

## Section 5 STARTING ARRANGEMENTS

**9.5.1 Mechanical starting arrangements**

9.5.1.6 Where the main engines are arranged for starting by compressed air, at least two starting air receivers of about equal capacity are to be fitted, which can be used independently. The total capacity of air receivers is to be sufficient to provide, without their being replenished, not less than 12 consecutive starts alternating between ahead and astern of each main engine of the reversible type, and not less than 6 starts of each main non-reversible type engine connected to a controllable pitch propeller or other device enabling the start without opposite torque. When other consumers such as auxiliary engines starting systems, control systems, whistle, SCR purging systems (if applicable), gas fuel double-wall duct ventilation systems (if applicable) etc., are to be connected to starting air receivers, their air consumption is also to be taken into account. Regardless of the above, for multi-engine installations the number of starts required for each engine may be reduced to 3 times, the total number of starts is not to be less than 12 times, but unnecessarily exceed 18 times.

## Appendix 10 SAFETY OF METHANOL/ETHANOL FUEL ENGINES

### 3 Specific Design Requirements

### 3.1 Dual fuel engines

3.1.4 In case of an emergency stop or a normal stop, the methanol/ethanol fuel is to be automatically shut off not later than the ignition source. It is not to be possible to shut off the ignition source without first or simultaneously closing the methanol/ethanol fuel supply to each cylinder or to the complete engine.

### 3.2 Fuel only engines

3.2.2 In case of an emergency stop or a normal stop, the methanol/ethanol fuel is to be automatically shut off not later than the ignition source. It is not to be possible to shut off the ignition source without first or simultaneously closing the methanol/ethanol fuel supply to each cylinder or to the complete engine.

# Appendix 11 SAFETY OF AMMONIA FUEL ENGINES

## 1 General Requirements

### 1.1 Application and scope

1.1.1 This Appendix applies to engines supplied with ammonia as fuel.

1.1.2 This Appendix only specifies relevant requirements for engines supplied with ammonia as fuel, and in addition, ammonia fuel engines are to comply with relevant provisions of this Chapter.

1.1.3 Ammonia fuel engines intended for ammonia carriers are, in addition to satisfying the requirements of this Appendix, to comply with the provisions of Chapter 16, PART THREE of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk.

Note: When this Appendix refers to CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, the terms "natural gas", "liquefied natural gas" or "methane" in relation to the fuel are to be understood to mean anhydrous ammonia to which the requirements of this Appendix apply.

1.1.4 This Appendix covers the following applications, 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) Ammonia dual fuel engine means an engine that can burn ammonia as fuel simultaneously with liquid fuel oil, either as pilot oil or bigger amount of liquid fuel oil (ammonia fuel mode), and also has the capability of running on liquid fuel oil only (fuel oil mode).

(2) Ammonia fuel only engine means an engine capable of operating in ammonia mode only and not able to switch over to oil fuel operation.

(3) Ammonia fuel engine means either an ammonia fuel only engine or an ammonia dual fuel engine.

(4) Pilot fuel means the fuel oil that is injected into the cylinder to ignite the ammonia and air mixture on ammonia dual fuel engines.

(5) Ammonia fuel means anhydrous ammonia suitable for safe operation on board and meeting the requirements of engines (corresponding to UN code 1005).

(6) Ammonia fuel valve unit is a set of valves and fittings used to control the ammonia fuel supply to each engine, which is used to control or adjust the ammonia fuel supply before the engine.

(7) Double block and bleed valve means a set of two valves in series in a pipe and a third valve enabling the pressure release from the pipe between those two valves. The arrangement may also consist of a two-way three-port valve and a closing valve instead of three separate valves.

(8) Recognized standards mean applicable international or national standards acceptable to CCS or standards laid down and maintained by IMO and an organisation acceptable to CCS.

(9) Safety Concept is a document describing the safety philosophy with regard to ammonia 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 and toxic 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 ammonia fuel engines, in addition to those required in 9.1.12.1 of this Chapter:

| No. | Plans and documents |
|---|---|
| (1) | Schematic layout or other equivalent documents of ammonia fuel system on the engine |
| (2) | Ammonia piping system (including double-walled arrangement where applicable) |
| (3) | Parts for ammonia admission system① |
| (4) | Arrangement of explosion relief valves (crankcase②, 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 fuel oil system (main and pilot fuel systems) on the engine (where applicable) |
| (7) | Shielding of high pressure fuel pipes for pilot fuel system, assembly (only for ammonia dual fuel engine) |
| (8) | High pressure parts for pilot fuel oil injection system①(only for ammonia dual fuel engine) |
| (9) | Ignition system (where applicable) |
| (10) | Schematic diagram of engine control system related to ammonia fuel (including monitoring, alarm and safety protection devices) |
| (11) | Engine test procedures and test reports related to ammonia fuel |

Note:

① The documentation to contain specification of pressures, pipe dimensions and materials.
② If required by 9.1.12 of this Chapter.

1.3.2 The following plans and documents are to be submitted for information with regard to the approval of ammonia fuel engines, in addition to those required in 9.1.12.2 of this Chapter:

| No. | Plans and documents |
|---|---|
| (1) | Safety concept① |
| (2) | Report of the risk analysis② |
| (3) | Ammonia fuel specification |
| (4) | Other plans and documents as deemed necessary by CCS |

Note:
① see 1.5 of this Appendix.
② see 1.4 of this Appendix.

## 1.4 Risk analysis

1.4.1 The risk analysis is to address:
(1) a failure or malfunction of any system or component involved in the ammonia fuel mode operation of the engine;
(2) a fuel leakage downstream of the ammonia valve unit;
(3) the safety of the engine in case of emergency shutdown or blackout, when running on ammonia fuel mode;
(4) the inter-actions between the ammonia 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 to:
(1) Identify all the possible failures in the concerned equipment and systems which could lead:
① to the presence of ammonia in components or locations not designed for such purpose,
② to ignition, fire, explosion or personnel poisoning.

(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 or 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 required for engines is to cover at least the following equipment and systems:
(1) failure of the ammonia-related systems or components, in particular ammonia piping and cylinder ammonia supply valves etc. Failures of the ammonia supply components not located directly on the engine, are not to be considered in the analysis;
(2) failure of the ignition system, where applicable (oil fuel pilot injection or sparking plugs);
(3) failure of the ammonia combustion or abnormal combustion (misfiring, knocking);
(4) failure of the engine monitoring, control and safety systems;
Note: With regard to electronic control systems, a failure mode and effects analysis (FMEA) is to be carried out in accordance with no. (23) of Table 9.1.12.2 of this Chapter.
(5) ammonia leakage into engine components (such as the intake and exhaust main) and the external systems connected to them (such as the exhaust pipe).
(6) changes of operating modes for ammonia dual fuel engines, including fuel oil mode, ammonia fuel mode and other working mode;
(7) hazard potential for crankcase ammonia fuel accumulation, for engines where the space below the piston is in direct communication with the crankcase.

### 1.5 Safety concept

A detailed analysis and assessment of events that may occur during the use of ammonia fuel engines are to be conducted. If necessary, safety measures for handling each event are to be incorporated into the safety concept of the ammonia fuel engine, covering at least the following:
(1)ammonia accumulation in the ammonia fuel engine;
(2)ammonia slip at the side of the ammonia fuel engine, e.g. exhaust emission, pressure relief valve etc.;
(3)ammonia leakage into the cooling water system, lubricating oil system and other auxiliary systems;
(4) crankcase ammonia fuel accumulation, for engines where the space below the piston is in direct communication with the crankcase;
(5)unburned ammonia accumulation throughout the exhaust pipe system, from the cylinder to the outlet of the exhaust pipe.

## 2 Design Requirements

### 2.1 General principles

2.1.1 The manufacturer is to declare the ammonia fuel mode operating scope for the engine (applicable to ammonia dual fuel engine).
2.1.2 Components containing or likely to contain ammonia are to be designed to:
(1) minimise the risk of fire and explosion, with 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) to withstand the overpressure due to the ignition of leaked ammonia in the most severe condition or the fitting of suitable pressure relief devices of an approved type.
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 Ammonia fuel engine-mounted fuel pipes are to be designed and manufactured in accordance with Chapter 5 and Chapter 16 of CCS Rules for Construction and Equipment of Ships

Carrying Liquefied Gases in Bulk.

2.2.2 Engine-mounted ammonia pipes are to be arranged in accordance with the following requirements:

(1) Pipes and equipment containing ammonia fuel are defined as hazardous area Zone 0. The space between the ammonia fuel piping and the wall of the outer pipe or duct is defined as hazardous area Zone 1.

(2) Double-wall pipe or duct is to be arranged in accordance with 16.4.3 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk.

The pipe or duct is to be pressure tested in accordance with 2.7.1, Chapter 2 of this PART to ensure gas tight integrity and to demonstrate that it can withstand the maximum pressure at gas pipe rupture.

A double block and bleed valve is to be fitted on the main fuel supply pipe; an ammonia temperature detection device is to be fitted in front of the main fuel valve to measure the temperature at the inlet of the ammonia main pipe.

(3) Materials susceptible to ammonia corrosion such as copper, copper alloys, zinc, zinc alloys, cadmium and mercury are not to be used in pipes, valves, fittings and other equipment in contact with ammonia. Stress corrosion caused by ammonia is to be considered in ammonia fuel piping systems made of carbon manganese steel or nickel steel.

(4) For engines using liquid ammonia fuel, the pressure in the fuel pipe is to ensure that the ammonia fuel is in a liquid state. The design pressure of the liquid ammonia fuel piping system is to be at least 1.8 MPa (corresponding to the vapor pressure of ammonia at 45 ℃).

(5) For an engine using gaseous ammonia fuel, if the ambient temperature at the maximum expected pressure of the air intake is lower than the dew point temperature of ammonia, the ammonia fuel is to be fully heated and the following measures are to be taken to prevent liquid ammonia from entering the engine:

① Ammonia fuel inlet temperature monitoring;

② Ammonia fuel inlet pressure monitoring.

(6) The ammonia fuel piping is to be provided with means for inerting or purging, and the purged fuel is to be stored in a suitable collection tank or treated by an ammonia treatment system, if available.

(7) The arrangement and installation of ammonia fuel piping are to provide the necessary flexibility to accommodate the sway or vibration of the engine and prevent fatigue damage at the connection between the piping and the engine.

2.2.3 Charge air system on the engine is to comply with 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 comply with 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. It is to be ensured that after pressure release, ammonia fuel is directed to an open area which satisfies requirements for hazardous area and toxic area. The selected explosion-proof devices are to meet the requirements in Appendix 9 of this Chapter.

(3) Each ammonia engine is to be provided with independent exhaust system.

(4) In accordance with the requirements of 1.5(5) of this Appendix, safety assessment is to be carried out to unburned ammonia fuel possibly existing in the engine exhaust and safety disposal plan is to be detailed in the safety concept, so as to ensure that the engine exhaust does not affect the safety of the ship and personnel.

2.2.5 The protection of crankcase is to comply with the following requirements:

(1)The crankcase is to be fitted with a crankcase safety valve in accordance with the requirements of 9.7.4 of this Chapter.

(2)For maintenance purposes, a connection, or other means, are to be provided for crankcase

inerting and ventilating and gas concentration measuring.
(3) For engines where the space below the piston is in direct communication with the crankcase, protection of crankcase is also to comply with the following requirements:
Detailed assessment is to be carried out to hazard potential for crankcase gas accumulation. If it cannot be proved that the gas concentration in the crankcase will not exceed the lower explosive limit for ammonia under any circumstances, an appropriate device is to be fitted in the crankcase to monitor ammonia accumulation in the crankcase.
Except for two-stroke crosshead engines, each engine crankcase is to be provided with a vent system independent of other engines. A flame arrester or other equivalent device is to be fitted on the vent pipe, and the vent outlet is to be directed to an open area or another location where the gas can be safely disposed.
(4)For engines using glands to isolate the space below the piston from the crankcase, appropriate means for drainage are to be provided. The drained mixture is to be stored in a suitable collection tank. The vent outlet of the collection tank is to be fitted with appropriate monitoring and alarm devices, and appropriate measures are to be taken after the outlet to collect ammonia to avoid diffusion.
2.2.6 The explosion-proof category and temperature group of explosion-proof equipment for explosive gas environments that may be mixed with ammonia vapor are to not be lower than IIA, T1 respectively.
2.2.7 If the fuel can leak directly into the engine auxiliary system media (lubricating oil, cooling water), appropriate monitoring and alarm devices are to be fitted in the auxiliary system, and appropriate measures are to be taken after the outlet of these media to collect fuel vapor to avoid diffusion. The cooling water containing leaked ammonia is to be replaced in time to avoid corrosion of material. The fuel and the mixture of ammonia and water collected from the auxiliary system medium are to be stored in a suitable collection tank.
2.2.8 Control, monitoring, alarm and safety system are to comply with the following requirements:
(1) The control system, safety system and alarm system of the engine are to be designed or made to function independently of each other, and when one or more systems fail, the normal operation of the other systems is not to be affected.
(2) The ammonia supply valves are to be controlled by the engine control system or by the engine ammonia demand.
(3) Combustion is to be monitored on an individual cylinder basis.
(4) If monitoring of combustion for each individual cylinder is not practicable due to engine size and design, common combustion monitoring may be accepted.
(5) A means is to be provided to monitor and detect poor combustion or misfiring in the engine. In the event that it is detected, continued operation in the ammonia fuel mode may be allowed, provided that the fuel supply to the concerned cylinder is shut off and provided that the operation of the engine with one cylinder cut-off is acceptable with respect to torsional vibrations.
(6) Unless the risk analysis required by 1.4 of this Appendix proves otherwise, the monitoring and safety system functions for ammonia dual fuel or ammonia fuel only 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.
Note: For ammonia dual fuel engines, Table 1 applies only to the ammonia fuel mode.

**Monitoring and Safety System Functions for ammonia Fuel Engines**

**Table 1**

| Parameter | Alarm | Automatic activation of the double block and bleed valve | Automatic switching over to oil fuel mode① | Engine shutdown |
|---|---|---|---|---|
| Abnormal pressures in the ammonia fuel supply line | × | × | × | ×⑤ |
| Ammonia fuel supply systems - malfunction | × | × | × | ×⑤ |
| Pilot fuel injection malfunction | × | ×② | × | ×②⑤ |
| Exhaust gas temperature after each cylinder - high | × | ×② | × | ×②⑤ |

| | | | | |
|---|---|---|---|---|
| Exhaust gas temperature after each cylinder, deviation from average – low[③] | × | ×[②] | × | ×[②⑤] |
| Cylinder pressure or ignition - failure, including misfiring, knocking and unstable combustion | × | ×[②④] | ×[④] | ×[②④⑤] |
| Oil mist concentration in crankcase or bearing temperature[⑥] - high | × | × | | × |
| Ammonia concentration in crankcase - high or pressure in the crankcase – high[④] (for engines where the space below the piston is in direct communication with the crankcase) | × | × | × | |
| Engine stops - any cause | × | × | | |
| Failure of the control-actuating medium of the ammonia fuel block valve | × | × | × | |

Symbol: × Applicable

Note:

① Ammonia dual fuel engine only, when running in ammonia fuel mode.

② For ammonia fuel only engines, the block valve 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 Ammonia fuel only engine only.

⑥ Where required by 9.7.6 of this Chapter.

2.2.9 The ammonia fuel injection valve is to be certified according to the following hazardous area classification:

(1) The interior of the valve contains ammonia fuel; therefore, it is to be certified for hazardous area zone 0.

(2) In accordance with 2.2.2(2), when the ammonia fuel injection valve is fitted within the double wall pipe or ventilation pipe, the external part of the valve is to be certified for hazardous area zone 1.

However, if the ammonia fuel injection valve has not been certified for the hazardous area classification for which it is intended to operate, an analysis is to be conducted in accordance with the IEC 60079-10-1 or IEC 60092-502 standard, which is to be documented as evidence to demonstrate that the valve is suitable for the area in which it will operate.

2.2.10 The ammonia fuel injection valve is to satisfy the following requirements:

(1) The ammonia fuel injection valve is to have good performance characteristics and durability throughout its service life.

(2) The ammonia fuel injection valve is to be provided with a sealing system to effectively prevent fuel leakage around the valve shaft.

(3) An appropriate method is to be provided to clean the driving oil of the ammonia fuel injection valve.

## 3 Specific Design Requirements

### 3.1 Ammonia dual fuel engines

3.1.1 The maximum continuous power that an ammonia dual fuel engine can develop in ammonia fuel mode may be lower than the approved MCR of the engine (i.e. in oil fuel mode), depending in particular on the ammonia quality. This maximum power available in ammonia fuel mode and the corresponding conditions are to be stated by the engine manufacturer and demonstrated during the type test. The 110% load tests are not required in the ammonia fuel mode of ammonia dual fuel engines when 4.1.4, 4.2.1 and 4.3 of this Appendix are implemented in

accordance with the provisions in 1.3 of Appendix 4, 2.3 and 3.4 of Appendix 6 of this Chapter.

3.1.2 Ammonia dual fuel engines are to be arranged to use either oil fuel or ammonia fuel for the main fuel charge and with pilot oil fuel for ignition. The engines are to be arranged for rapid changeover from ammonia 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 ammonia 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 ammonia 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 ammonia fuel operation is to be automatic but manual interruption is to be possible in all cases.

In case of shut-off of the ammonia supply, the engines are to be capable of continuous operation by oil fuel only.

After changeover from ammonia fuel mode to oil fuel mode due to a failure, the use of ammonia fuel mode is not allowed until the failure is rectified.

If the engine has an emergency stop in ammonia fuel mode, or has a sudden flameout during the operation of ammonia fuel mode, measures are to be taken to purge the exhaust pipe before restarting the engine, and the purge gas is to be handled properly (such as using an ammonia gas treatment system).

3.1.3 Ammonia supply to the combustion chamber is not to be possible without operation of the pilot oil injection or sparking plug, where applicable.

Note: Pilot injection is to be monitored for example by fuel oil pressure and combustion parameters.

3.1.4 In case of an emergency stop or a normal stop, the ammonia fuel is to be automatically shut off not later than the ignition source. It is not to be possible to shut off the ignition source without first or simultaneously closing the ammonia fuel supply to each cylinder or to the complete engine.

### 3.2 Ammonia fuel only engines

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

3.2.2 In case of an emergency stop or a normal stop, the ammonia fuel is to be automatically shut off not later than the ignition source. It is not to be possible to shut off the ignition source without first or simultaneously closing the ammonia fuel supply to each cylinder or to the complete engine.

### 3.3 Two stroke engines

3.3.1 Risk analysis is to be carried out in accordance with the requirements of 1.4 to consider the risk due to potential ammonia accumulation in the gas-purging space.

3.3.2 Risk analysis is to be carried out in accordance with the requirements of 1.4 to consider the possible failure of piston rod glands.

## 4 Type Testing, Factory Acceptance Tests and Shipboard Trials

### 4.1 Type Testing

4.1.1 Type approval of ammonia dual fuel and ammonia fuel only engines is to be carried out in accordance with 9.10.1 and 9.10.2 of this Chapter, taking into account the additional requirements below.

4.1.2 In addition to the criteria given in 9.1.2.1(1) of this Chapter, the type of engine is defined by the following:

(1) ammonia admission method (direct cylinder injection, cylinder intake channel injection etc.);

(2) ammonia supply valve operation (mechanical or electronically controlled);

(3) ignition system (pilot injection, spark ignition etc.);

(4) ignition system (mechanical or electronically controlled).

4.1.3 In addition to the safety precautions mentioned in 1.2, Appendix 4 of this Chapter, measures to verify that ammonia fuel piping on engine is gas tight and liquid 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 1.3, Appendix 4 of this Chapter.

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

4.1.5 In addition to the measurements and records required in 1.4, Appendix 4 of this Chapter, the following engine data are to be measured and recorded:

(1) Each fuel index for ammonia and fuel oil as applicable (or equivalent reading).

(2) Ammonia pressure and temperature at the inlet of the ammonia manifold.

(3) Crankcase ammonia gas concentration.

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

4.1.6 In addition to internal tests required in 2.1, Appendix 4 of this Chapter, the following conditions are to be tested:

(1) Ammonia dual fuel engines are to run the load points in both ammonia fuel and fuel oil modes (with and without pilot injection in service) as found applicable for the engine type.

(2) For ammonia dual fuel engines with variable ammonia/fuel oil ratio, different ammonia/fuel oil ratios are to be selected between the minimum and maximum allowable values for load tests (the most common and severe ratios are to be selected for testing).

(3)For ammonia dual fuel engines, switch over between ammonia fuel and fuel oil 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 of this Chapter. The following requirements are to be considered:

(1) The following test conditions are to be considered for ammonia dual fuel engine during the load test:

① All load points must be run in both ammonia fuel and fuel oil modes that apply for the engine type as defined by the engine designer. This also applies to the overspeed test.

② For ammonia dual fuel engines with variable ammonia/fuel oil ratio, different ammonia/fuel oil ratios as necessary are to be selected between the minimum and maximum allowable values for load tests.

(2) The following items are to be carried out for functional test:

① For ammonia dual fuel engines, the lowest specified speed is to be verified in fuel oil mode and ammonia fuel mode.

② For ammonia dual fuel engines, switch over between ammonia fuel and fuel oil modes are to be tested at different loads.

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

For engines intended to produce electrical power, capability to take sudden load and loss of load is to be verified in accordance with the provisions of 9.7.10.1 of this Chapter.

Notes:

1. For ammonia dual fuel 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 of this Chapter.

(3) Ammonia fuel only and ammonia dual fuel 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 ammonia supply valve;

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

④ Abnormal ammonia pressure;

⑤ Abnormal ammonia temperature.

Note: The above tests may be carried out using simulation or other alternative methods, subject to special

consideration by CCS.

4.1.8 Component inspection is to be carried out in accordance with the provisions of 2.3, Appendix 4 of this Chapter. The components to be inspected after the test run are to include also:

(1) ammonia supply valve;

(2) spark igniter (ammonia fuel only engine);

(3)pilot fuel injection valve/spark igniter (ammonia dual fuel engine).

4.1.9 Engine type approval certificate

For ammonia dual fuel engines, if the maximum continuous power in different operating modes is inconsistent, the respective maximum continuous power in diesel mode and in ammonia fuel mode is to be indicated on the type approval certificate.

## 4.2 Factory acceptance test

4.2.1 Factory acceptance tests are to be carried out in accordance with Appendix 6 of this Chapter. For ammonia dual fuel engines, the load tests referred to in 2.3, Appendix 6 of this Chapter are to be carried out in ammonia fuel mode at the different percentages of the maximum power available in ammonia fuel mode (see 3.1.1 of this Appendix).

4.2.2 In addition to the safety precautions mentioned in 1.1, Appendix 6 of this Chapter , measures to verify that ammonia fuel piping on engine is gas tight and liquid 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 of this Chapter, the following engine data are to be recorded:

(1) Fuel index, both ammonia and diesel as applicable (or equivalent reading);

(2) Ammonia pressure and temperature at the inlet of the ammonia manifold.

4.2.4 Test loads for various engine applications are given in 2.3, Appendix 6 of this Chapter. For ammonia dual fuel engines, all load tests are to be carried out in applicable ammonia fuel and fuel oil modes. In addition the scope of the trials may be expanded depending on the engine application, service experience, or other relevant reasons.

4.2.5 Ammonia fuel 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 ammonia supply valve;

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

④ Abnormal ammonia pressure;

⑤ Abnormal ammonia 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 After gas pipes are installed on board, gas tightness test is to be carried out.

4.3.2 Shipboard trials are to be carried out in accordance with the provisions of Appendix 6 of this Chapter. For ammonia dual fuel engines, the test loads are to be carried out in all operating modes (ammonia fuel mode, fuel oil mode, etc.). For ammonia dual fuel engines, when load tests specified in 3.4, Appendix 6 of this Chapter are carried out in ammonia fuel mode, test loads are taken as each percentage of the maximum output power in ammonia fuel mode (see 3.1.1 of this Appendix).

# CHAPTER 10 TRANSMISSION GEARING

## Appendix 1 APPRAISAL OF GEAR STRENGTH

### 1 General

**1.5 Relevant factors**

1.5.4 Face load distribution factors $K_{H\beta}$ and $K_{F\beta}$

1.5.4.2 The factors $K_{H\beta}$ and $K_{F\beta}$ mainly depend on:

(1) gear tooth manufacturing accuracy;

(2) errors in mounting due to bore errors;

(3) bearing clearances;

(4) wheel and pinion shaft alignment errors;

(5) elastic deflection of gear elements, shafts, bearings, housing and foundations which support the gear elements;

(6) thermal expansion and distortion due to operating temperature;

(7) compensating design elements(tooth crowning, end relief, etc.).

1.5.4.3 The face load distribution factors $K_{Hh}$ and $K_{Fa}$ are to be determined according to the Method C outlined in the reference standard ISO 6336-1. Alternative methods acceptable to CCS may be applied.

In case the hardest contact is at the end of the face width, $K_{F\beta}$ is defined as follows:

$$K_{F\beta} = (K_{H\beta})^N$$

where: $N = \frac{(b/h)^2}{1+(b/h)+(b/h)^2}$, where ($b$/$h$) is the ratio of tooth width and tooth depth, to be taken as the minimum value of $b_1/h_1$ and $b_2/h_2$. Only one helical face width is to be taken for herringbone gear $b$. When $b/h < 3$ the value $b/h = 3$ is to be used.

In case of gears where the ends of the face width are lightly loaded or unloaded (end relief or crowning): $K_{F\beta} = K_{H\beta}$.

# CHAPTER 11 SHAFTING AND PROPELLERS

## Section 3 SHAFT TRANSMISSION UNITS

**11.3.4 Clutches and control devices**

11.3.4.7 In case the control device of the clutch loses power, the clutch is to be able to maintain its current state until power is restored. Otherwise, an uninterrupted backup power source (e.g. electrical power source or air source) is to be provided.

CHINA CLASSIFICATION SOCIETY

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AMENDMENTS

**2025**

## PART FOUR ELECTRICAL INSTALLATIONS

# CONTENTS

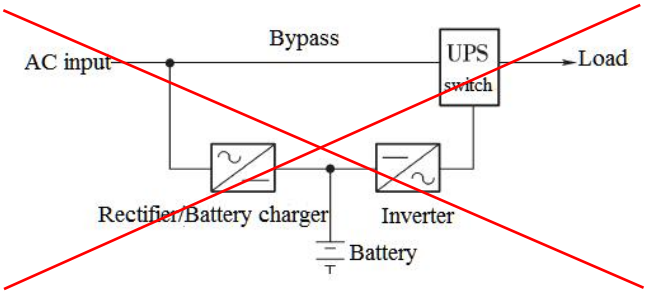
# CHAPTER 1 GENERAL

## Section 1 GENERAL PROVISIONS

1.1.2.1 For the purpose of this PART:

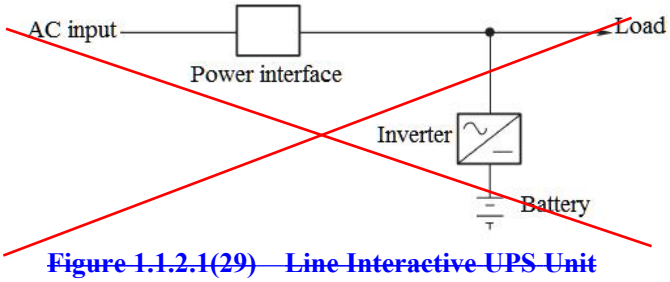
(27) Uninterruptible power system (UPS)[①] is a combination of converters, switches and energy storage ~~means~~ devices (such as ~~for example~~ batteries), constituting a power system for maintaining continuity of load power in case of AC input power failure.

~~(28) Off-line UPS unit is a UPS unit where under normal operation the output load is powered from the bypass line (raw mains) and only transferred to the inverter if the bypass supply fails or goes outside preset limits. This transition will invariably result in a brief (typically 2 to 10 ms) break in the load supply. See Figure 1.1.2.1(28).~~



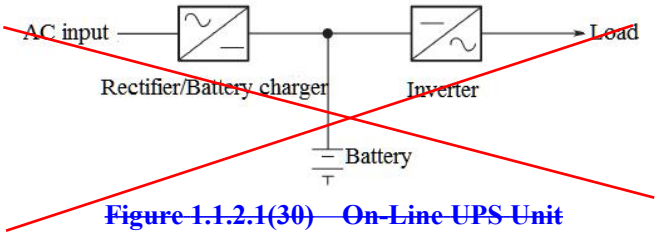

~~**Figure 1.1.2.1(28) Off-Line UPS Unit**~~

~~(29) Line interactive UPS unit is an off-line UPS unit where under normal operation the output load is powered from the UPS inverter or the power interface and when the input power goes outside the preset voltage and frequency limits, the load is transferred to stored energy power and the input power is disconnected from the power interface. See Figure 1.1.2.1(29).~~




~~**Figure 1.1.2.1(29) Line Interactive UPS Unit**~~

~~(30) On-line UPS unit is a UPS unit where under normal operation the output load is powered from the inverter, and will therefore continue to operate without break in the event of the supply input failing or going outside preset limits. See Figure 1.1.2.1(30).~~




~~**Figure 1.1.2.1(30) On-Line UPS Unit**~~

(28)Double-conversion UPS topology[②] comprises an AC to DC converter, generally a rectifier, and DC to AC converter, generally an inverter. When the AC input power is out of UPS pre-set tolerances, the UPS

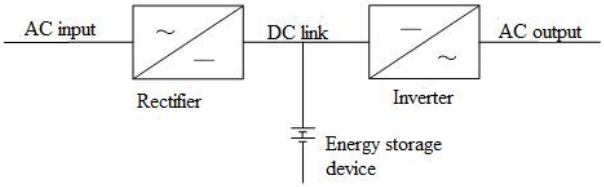
[①] Refer to IEC 62040-3 Uninterruptible power systems (UPS) - Part 3: Method of specifying the performance and test requirements.

[②] Refer to IEC 62040-3 Uninterruptible power systems (UPS) - Part 3: Method of specifying the performance and test requirements, Annex B.

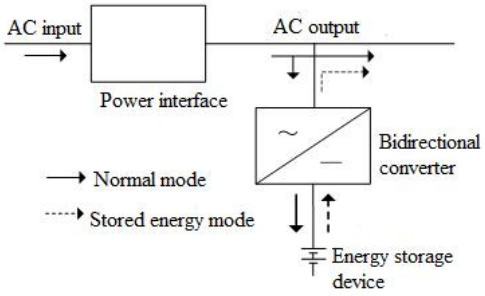
enters stored energy mode.

(29)Line-interactive UPS topology[①] comprises bidirectional AC to DC power conversion, generally through a bidirectional converter and an AC power interface.When the AC input power voltage or frequency is out of UPS pre-set tolerances, the UPS enters stored energy mode.

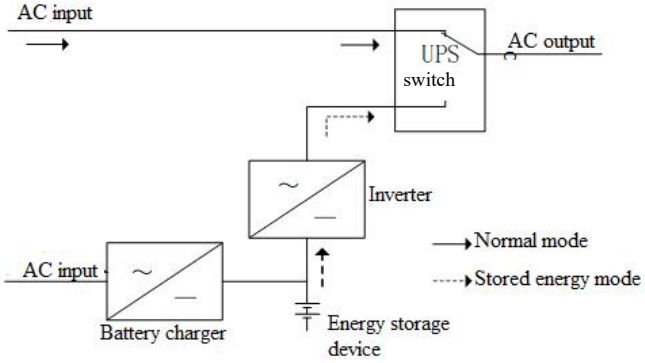
(30)Standby UPS topology[①] comprises a battery charger, a DC to AC converter, generally a uni-directional inverter and a UPS switch. When the AC input power is out of UPS pre-set tolerances, the UPS enters stored energy mode.




Double-conversion UPS topology




Line-interactive UPS topology




Standby UPS topology

Notes:

① Energy storage device: system consisting of a single or multiple devices designed to provide power to the UPS inverter/converter.

②AC input power failure: variation in the AC input power which could cause the UPS to operate in stored energy mode.

③ Bidirectional converter: converter which has the functions of both a rectifier and an inverter, and which can reverse the flow of power from AC to DC and vice-versa.

**Figure 1.1.2.1(28)(29)(30)　UPS Topology**

## Section 3　DESIGN, CONSTRUCTION AND INSTALLATION

1.3.1.17　The UPS unit for emergency services in 3.9.1.1, Section 9, Chapter 3 of this PART is to be suitably located for use in an emergency. UPS units utilising valve regulated sealed batteries may be located in compartments with normal electrical equipment, provided the ventilation arrangements are in accordance with the requirements of IEC 62040-1, IEC 62040-2, IEC 62040-3, IEC 62040-4 and/or IEC62040-5-3 publication (as applicable), or an acceptable and relevant national or international standard.

[①] Refer to IEC 62040-3 Uninterruptible power systems (UPS) - Part 3: Method of specifying the performance and test requirements, Annex B.

# CHAPTER 2 ELECTRICAL INSTALLATIONS IN SHIPS

## Section 2 EMERGENCY SOURCE OF ELECTRICAL POWER

2.2.1.13 ~~UPS units utilizing valve regulated sealed batteries, as described in 2.2.2.1 and 2.2.3.1 of this Section, may be located in compartments with normal electrical equipment, provided the ventilation arrangements are in accordance with the requirements of IEC 62040-1, IEC 62040-2, IEC 62040-3, IEC 62040-4 and/or IEC62040-5-3 publication (where applicable) or an acceptable standard.~~UPS units specified in Section 9, Chapter 3 of this PART may be used to provide an alternative power supply or transitional power supply to emergency services as defined in 2.2.2 and 2.2.3 of this Section.

2.2.2.1(3) for a period of 36 h:

① all internal communication equipment required in an emergency;

② the navigational aids as required in the SOLAS Convention in force, where such provision is unreasonable or impracticable, this requirement may be waived for ships of less than 5,000 gross tonnage, subject to agreement of CCS;

③ the fire detection and fire alarm system, and the fire door holding and release system; and

④ for intermittent operation of the daylight signaling lamp, the ship's whistle, the manually operated call points and all internal signals that are required in an emergency (e.g. general emergency alarm system, alarms for warning of the release of extinguishing media),

unless such services mentioned above in ① to ④ have an independent supply for the period of 36 h from an accumulator battery ~~or have an uninterruptible power system (UPS) complying with the requirements of Section 9, Chapter 3 of this PART~~ suitably located for use in an emergency;

2.2.3.1(4) for a period of 18 h:

① all internal communication equipment as required in an emergency;

② the navigational aids as required in the SOLAS Convention in force, where such provision is unreasonable or impracticable, this requirement may be waived for ships of less than 5,000 gross tonnage, subject to agreement of CCS;

③ the fire detection and fire alarm system;

④ intermittent operation of the daylight signaling lamp, the ships whistle, the manually operated call points and all internal signals that are required in an emergency (e.g. general emergency alarms system, alarms for warning of the release of extinguishing media, etc.),

unless such services mentioned above in ① to ④ have an independent supply for the period of 18 h from an accumulator battery ~~or have an uninterruptible power system (UPS) complying with the requirements of Section 9, Chapter 3 of this PART~~ suitably located for use in an emergency;

## Section 5 PROTECTION

2.5.9.5 Permanently fixed cables between the shore connection box and the main or emergency switchboard are to be protected by a circuit-breaker or an isolating switch and fuses. Such protection is to be fitted in the shore connection box.

## Section 18 ADDITIONAL REQUIREMENTS FOR SHIPS CARRYING

2.18.5.1 Where solid dangerous goods in bulk (solid dangerous goods capable of creating explosive gas atmosphere) and MHB are to be carried, electrical equipment of certified safe type installed in hazardous areas are to be in compliance with the minimum requirements of Table 2.18.5.1.

**Characteristics of Electrical Equipment for Use in Hazardous Areas (Example)**

**Table 2.18.5.1**

| Dangerous goods | IMO class | Dominant risk① | Protection against explosive dust atmosphere | Protection against explosive gas atmosphere | |
|---|---|---|---|---|---|
| | | | Degree of protection | Explosion group | Temperature class |
| Aluminium ferrosilicon powder UN1395 | 4.3 | $H_2$ | — | IIC | T2 |
| Aluminium silicon powder uncoated UN1398 | 4.3 | $H_2$ | — | IIC | T2 |
| Aluminium smelting by-products or Aluminium remelting by-products UN3170 | 4.3 | H2 | — | IIC | T2 |
| Aluminium smelting/remelting by-products, processed | MHB(WF and/or WT and/or CR) | H2 | — | IIC | T1 |
| Ammonium nitrate UN1942 | 5.1 | — | — | — | T4 |
| Ammonium nitrate-based fertilizer UN2067 | 5.1 | — | — | — | T4 |
| Ammonium nitrate-based fertilizer UN2071 | 9 | — | — | — | T4 |
| Ammonium nitrate-based fertilizer | — | — | — | — | T4 |
| Ammonium nitrate-based fertilizer MHB | MHB(OH) | — | — | — | T4 |
| Brown coal briquettes | MHB (CB and/or SH) | Dust, methane | IP55 | IIA | T4 |
| Coal | MHB (CB and/or SH and/or WF and/or CR) | Dust, methane | IP55 | IIA | T4 |
| Direct reduced iron (A) | MHB (SH and/or WF) | $H_2$ | — | IIC | T2 |
| Direct reduced iron (B) | MHB (SH and/or WF) | $H_2$ | — | IIC | T2 |
| Direct reduced iron (C) | MHB (SH and/or WF) | $H_2$ | — | IIC | T2 |
| Direct reduced iron (D) | MHB (SH and/or WF) | $H_2$ | — | IIC | T2 |
| Ferrophosphorus (including briquettes) | MHB (WF and/or WT) | $H_2$ | — | IIC | T1 |
| Ferrosilicon, with at least 25% but less than 30% silicon, or 90% or more silicon ~~(including briquettes)~~ | MHB (WF and/or WT) | $H_2$ | — | IIC | T1 |
| Ferrosilicon UN1408, with 30% or more but less than 90% silicon(including briquettes) | 4.3 | $H_2$ | — | IIC | T1 |
| Iron oxide, spent or sponge iron, spent UN1376 | 4.2 | Dust | IP55 | IIA | T2 |
| Seed cake, containing vegetable oil UN1386(b) | 4.2 | Hexane | — | IIA | T3 |
| Seed cake UN2217 | 4.2 | Hexane | — | IIA | T3 |

| Dangerous goods | IMO class | Dominant risk① | Protection against explosive dust atmosphere | Protection against explosive gas atmosphere | |
|---|---|---|---|---|---|
| | | | Degree of protection | Explosion group | Temperature class |
| Seed cakes and other residues of processed oily vegetables | MHB (SH) | Dust | IP55 | IIA | T3 |
| Silicomanganese (low-carbon) | MHB(WF and/or WT and/or TX) | $H_2$ | — | IIC | T1 |
| Solidified fuels recycled from paper and plastics | MHB (SH) | Combustible | IP55 | — | T3 |
| Sugarcane biomass pellets | MHB(CB and/or WF and/or WT and/or OH) | Combustible, dust | IP55 | IIA | T3 |
| Sulphur UN1350 (crushed lump and coarse grained) | 4.1 | Combustible, dust | IP55 | — | T4 |
| Zinc Ashes UN1435 | 4.3 | $H_2$ | — | IIC | T2 |
| Wood torrefied | MHB(CB and/or SH and/or CR) | Combustible, dust | IP55 | — | T3 |
| Wood pellets, containing additives and/or binders | MHB(WF) | Dust | IP55 | — | T3 |
| Wood pellets, not containing any additives and/or binders | MHB(OH) | Dust | IP55 | — | T3 |

Note: ① The term “risk” relates only to the risk of explosion due to dangerous goods and electrical appliances.

# CHAPTER 3 CONSTRUCTION AND TESTING OF ELECTRICAL EQUIPMENT

## Section 9 UNINTERRUPTIBLE POWER SYSTEM

3.9.1.1 ~~The UPS① units, to which this Section applies, may provide an alternative power supply or transitional power supply, in lieu of independent accumulator batteries, to services as defined in 2.2.2.1(3) and 2.2.3.1(4) of Chapter 2 of this PART.~~
The UPS① units specified in this Section apply to the following scenarios:
(1) when providing an alternative power supply or transitional power supply to emergency services as defined in 2.2.2 and 2.2.3, Chapter 2 of this PART;
(2) where required, constituting a means of continuous and uninterruptible power supply to essential services as defined in 1.1.2.1(1), Chapter 1 of this PART;
(3) when providing power supply in accordance with 2.9.6.4, Chapter 2 of this PART.
3.9.1.2 In addition to the scenarios specified in 3.9.1.1, the use of UPS units in other scenarios may refer to the requirements of this Section, subject to the agreement of CCS.

3.9.3.2 The operation of the UPS unit is not to depend upon external services.
3.9.3.3 The ~~type~~ configuration and topology of UPS unit employed, ~~whether off-line, line-interactive or on-line, is~~ are to be appropriate to the power supply requirements of the connected load equipment.
3.9.3.4 ~~An external bypass is to be provided.~~ When external bypass is provided, bypass transfer switch is to be arranged to protect the load against power disturbances or interruption arising from inrush or fault current.
3.9.3.5 The UPS unit is to be monitored and audible and visual alarm is to be given in ~~a normally attended location~~ continuously manned station(s) for:
(1) power supply failure (voltage and frequency) to the connected load;
(2) earth fault;
(3) operation of battery protective device;
(4) when the battery is being discharged; ~~and~~
(5) when the bypass is in operation in case an external bypass is provided ~~for on-line UPS units.~~;
(6) any other fault and abnormal conditions of UPS unit (as applicable).

3.9.4.1 The output power is to be maintained for the duration required for the connected equipment as stated in 2.2.2~~.1(3)~~ and 2.2.3~~.1(4)~~ of Chapter 2 of this PART.
3.9.4.2 No additional circuits are to be connected to the UPS unit without verification that the UPS unit has adequate capacity. The UPS unit battery capacity is, at all times, to be capable of supplying the designated loads for the time specified in Chapter 2 of this PART.

3.9.5.1 UPS units of 50 kVA and over are to be surveyed by CCS Surveyors during manufacturing and testing. Testing specified in 3.9.5.2 is at least to be completed.
3.9.5.2 Appropriate testing is to be carried out to demonstrate that the UPS unit is suitable for its intended environment. This is expected to include as a minimum the following tests:
(1) Functionality, including operation of alarms specified in 3.9.3.5;
(2) Temperature rise;
(3) Ventilation rate;
(4) Battery capacity.

① Refer to IEC publication 62040-3.

# CHAPTER 4 SUPPLEMENTARY REQUIREMENTS FOR CARGO SHIPS OF LESS THAN 500 GROSS TONNAGE

## Section 1 CARGO SHIPS OF LESS THAN 500 GROSS TONNAGE

### 4.1.7 Lighting

4.1.7.1 Main engine rooms, large machinery spaces other than main engine rooms, large galleys, passageways (including accesses), stairways leading to boat decks, public spaces and berthing compartments accommodating more than 16 passengers specified in 2.7.2.2, Chapter 2 of this PART may be reduced to requirements only for main engine rooms and boiler rooms.

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## PART SIX FIRE PROTECTION, DETECTION AND EXTINCTION

# CONTENTS

# CHAPTER 1 GENERAL

## Section 1 GENERAL PROVISIONS

### 1.1.4 Basic requirements for arrangement of fire stations and systems

1.1.4.4 ~~The release and alarm of the fixed fire-extinguishing system for the protection of machinery spaces where main propulsion engine and main generator set are located, including the need to open the door of the release box for test purposes, are not to be automatically linked to the system that cuts off the fan and oil pump in the machinery space.~~ The fixed fire-extinguishing system for the protection of machinery spaces where main propulsion engine and main generator set are located is to be designed such that any action other than the release of fire extinguishing media are not to lead to automatic shutdown of ventilation fans and oil pumps in these machinery spaces, such as opening the release box (cabinet) door during fire drills.


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## PART SEVEN AUTOMATION SYSTEMS

# CONTENTS

# CHAPTER 2 BASIC REQUIREMENTS

## Section 6 COMPUTER BASED SYSTEMS

2.6.1.2 Computer based systems are, in addition to satisfying the requirements of this Section, to satisfy relevant requirements in the Guidelines for Type Approval Test of Electric and Electronic Products and the class notation Cyber Security (P[SL0]) in the Guidelines for Ship Cyber Security.

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## PART EIGHT ADDITIONAL REQUIREMENTS

# CONTENTS

# CHAPTER 5 ADDITIONAL REQUIREMENTS FOR FISHING VESSELS

## Section 1 GENERAL PROVISIONS

### 5.1.1 General requirements

5.1.1.2 Fishing vessels complying with the provisions of CCS Rules for Construction of Ocean-going Steel Fishing Vessels and this Chapter are to be assigned the Fishing Vessel class notation.

# CHAPTER 13 ADDITIONAL REQUIREMENTS FOR POLAR CLASS SHIPS

## Section 1 GENERAL REQUIREMENTS FOR POLAR CLASS SHIPS

### 13.1.1 Application

13.1.1.2 Ships that comply with the requirements of Sections 2 and 3 of this Chapter can be considered for a Polar Class notation “PC X” (where X is the corresponding class number) as listed in Table 13.1.2.1. The requirements of Sections 2 and 3 are in addition to the open water requirements. If the hull and machinery are constructed such as to comply with the requirements of different polar classes, then both the hull and machinery are to be assigned the lower of these classes in the classification certificate. Compliance of the hull or machinery with the requirements of a higher Polar Class is also to be indicated in the classification certificate or the equivalent. Where a higher Polar Class is used for one or more longitudinal hull areas (see 13.2.2.1 for definitions of hull area division in the longitudinal direction) of the polar class ships, the class notation of “PC X(y)” may also be assigned where y refers to the longitudinal hull areas, to be taken as B: bow region, BI: bow intermediate region, M: midbody region, S: stern region.

# CHAPTER 15 ADDITIONAL REQUIREMENTS FOR ELECTRICALLY PROPELLED SHIPS

## Section 2 ADDITIONAL REQUIREMENTS FOR ELECTRICAL PROPULSION INSTALLATIONS

### 15.2.5 Propulsion generators and propulsion motors

15.2.5.1 Variable speed propulsion motors fitted with an integral fan are to be capable of operating at speeds below the rated speed with full-load torque, full-load current, full-load excitation or in similar conditions, and temperature rises are not to exceed the limits given in 3.2.3 of PART FOUR of the Rules.

# CHAPTER 18 ADDITIONAL REQUIREMENTS FOR HEAVY EQUIPMENT CARRIER

## Section 5 EXTRA BALLAST OPERATIONAL PROCEDURE MANUAL

### 18.5.2 Contents of the Extra Ballast Operational Procedure Manual

18.5.2.5 The sketch of maximum draft waterline mark (starboard) is given in Figure 18.5.2.5:

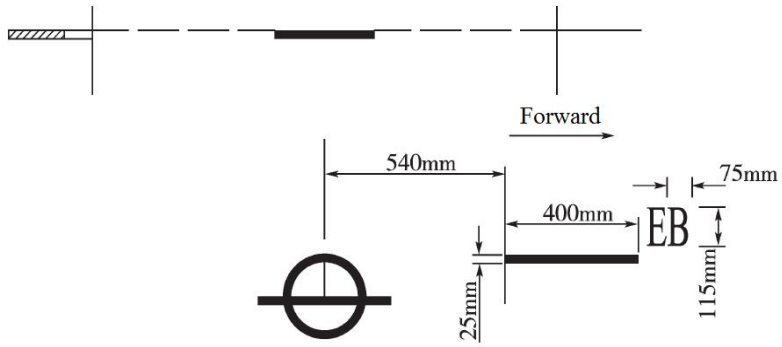



**Figure 18.5.2.5 The Sketch of Maximum Draft Waterline Mark (starboard)**

where: EB means the extra ballast.

# CHAPTER 19 AC SHORE CONNECTION SYSTEMS

## Section 2 SYSTEM DESIGN

19.2.1.3 During shore supply, at least one of the ship's main generators or harbor generators is to be standby and, upon blackout of the shore supply, automatically started and connected to the main switchboard.

# CHAPTER 23 ADDITIONAL REQUIREMENTS FOR SHIPS OPERATING IN LOW AIR TEMPERATURE ENVIRONMENTS

## Section 1 GENERAL PROVISIONS

### 23.1.1 General requirements

23.1.1.4 Where the design and construction of ship are different from the provisions of this Chapter, a risk analysis method may be used to evaluate the ships and their equipment, so as to ensure the achievement of goals and functional requirements of this Chapter or develop operational limitations. The operational limitations are to be indicated in relevant design information.

### 23.1.2 Definitions

23.1.2.1 For the purpose of this Chapter:

(1) Mean Daily Low Temperature (MDLT) means the mean value of the daily low temperature for each day of the year over a minimum 10 year period. A data set acceptable to the Administration may be used if 10 years of data is not available. (Refer to Figure 23.1.2.1 for MDLT)

(2) Low air temperature environment means water areas with the lowest MDLT (LMDLT) lower than -10℃, such as the Arctic Ocean, the Antarctic Ocean, Gulf of St. Laurence, the northern Baltic Sea, Sea of Okhotsk, the Bohai Sea and the northern Huanghai Sea, etc. In general, waters of this type are covered by regional sea ice in the winter. (Refer to Figure 23.1.2.1 for LMDLT)

(3) Design Service Temperature (DST) means a temperature indicator set for the ship measuring the service performance of materials, equipment and systems in low air temperature environments in the design. The temperature is determined by the shipowner in accordance with the purpose and service condition of the ship and is in general to be set at least 10℃ below the LMDLT for the intended area and season of operation.

(4) Minimum Anticipated Temperature (MAT) means the lowest ambient temperature that may be anticipated in the intended navigation areas of the ship during the voyage. ~~And~~ If accurate historical statistical data is not available, MAT is in general to be taken as at least 20℃ lower than LMDLT.

(5) Positive temperature spaces mean spaces that are maintained constantly above 0℃ by lagging heat insulating materials or installing air conditioning systems thus making freezing unlikely.

(6) Low temperature spaces mean spaces where the ambient temperature is constantly below 0℃ thus making freezing likely.

(7) Anti-icing means preventing the exposed areas and facility surfaces from accumulation and freezing of ice and snow (i.e. ice and snow accretion) by means of covering, heating or other measures which are generally applied to areas such as superstructures, deck passageways, railings and handholds, cargo decks and helicopter platforms as well as equipment for navigation, mooring, life-saving and fire-fighting.

(8) De-icing means removing ice and snow accretion in the exposed areas and facility surfaces by using tools.

(9) Anti-freezing means keeping the liquid inside tanks, equipment and pipelines exposed to low air temperature environments from freezing by excitation, circulation, insulation and heating, etc.

## Section 11 ANTI-ICING AND DE-ICING MEASURES

### 23.11.3 Plans and documents

23.11.3.1 The following plans and documents are to be submitted for approval:

(1) Arrangement of anti-icing and de-icing equipment, indicating heating capacity;

(2) Single line diagram of heating cables, if provided;

(3) Piping diagram of steam or heating fluids, if provided;

(4) Stability calculations in which ice accretion is considered~~;~~ .

~~(5) Anti-icing and de-icing procedures manual.~~

~~Items (4) and (5) above are always to be kept on board ships.~~

23.11.3.2 The following plans and documents are to be submitted for information:

(1) Anti-icing and de-icing procedures manual.

23.11.3.3 Anti-icing and de-icing procedures manual is always to be kept on board ships.

# CHAPTER 34 ADDITIONAL REQUIRMENTS FOR ASSESSMENT OF ANTI-COLLISION CAPACITY OF SHIPS ~~EVALUATION OF COLLISION RESISTANCE CAPABILITY OF SHIPS~~

## Section 1 GENERAL PROVISIONS

### 34.1.1 General requirements

34.1.1.1 This Chapter applies to ships applying for the class notation related to ~~evaluation of collision resistance capability~~ assessment of anti-collision capacity on a voluntary basis.

34.1.1.2 Ships applying for ~~evaluation of collision resistance capability~~ assessment of anti-collision capacity generally are subject to, but not limited to the following three critical situations:

(1) Structural damage to cargo tanks with subsequent leakage of, e.g., oil, chemicals or liquefied gas, etc.;

(2) Structural damage leading to water ingress into dry cargo holds during carriage of particularly valuable or dangerous cargo;

(3) Structural damage to fuel oil tanks with subsequent leakage of fuel oil.

34.1.1.3 ~~Evaluation of collision resistance capability~~ Assessment of anti-collision capacity of ships is intended to calculate the deformation energy absorbed by the hull structure and critical striking speed of striking ships ~~of different magnitude~~ that the hull structure can bear when the ship structure is struck by another ship and the hull structure shell plate (inner hull plate for a double hull ship) is in the critical damaged state, and to give the displacement – critical striking speed curve of the struck ship, so as to guide the operation of the ship.

34.1.1.4 The simplified method or FE method may be used for ~~evaluation of collision resistance capability~~ assessment of anti-collision capacity. For the FE ~~method~~ calculation, the applicable general ~~FE analysis~~ procedure may be used. If non-general procedures are used, the explanatory documents on the reliability of the ~~calculation procedures~~ computer programs are to be provided by the unit applying for the notation.

### 34.1.2 Definitions

34.1.2.1 The **critical damaged state** refers to the state when the maximum plastic deformation of the hull structure shell plate (inner hull plate for a double hull ship) of the struck ship occurs without rupture.

34.1.2.2 The **initial striking speed** $V_0$, in knots, refers to the speed of the striking ship when ~~striking occurs~~ it comes into contact with the struck ship.

34.1.2.3 The **critical striking speed** $V_{cr}$, in knots, refers to the maximum striking speed that the struck ship can bear in the damage critical situation. If the speed of the striking ship exceeds this value, the expected critical state will occur.

34.1.2.4 The **critical deformation energy** $E_{cr}$, in MJ, refers to the plastic deformation energy absorbed by the hull structure when ~~large~~ the maximum plastic deformation occurs in the hull structure shell plate (inner hull plate for a double hull ship) of the struck ship without rupture in case of a collision. When that amount of energy is exceeded, the expected critical state will occur.

### 34.1.4 Plans and documents

34.1.4.1 The following plans and documents are to be submitted for approval in addition to the plans and documents required by relevant chapters and PARTS of the Rules:

(1) Critical striking speed curve.

34.1.4.2 The following plans and documents are to be submitted for information:

(1) ~~Strength a~~ Analysis report for anti-collision capacity, including structural collision deformation energy analysis and critical speed analysis.

(2) List of critical situations in which the ship is involved.

## Section 2 EVALUATION METHODS

### 34.2.1 Evaluation conditions

34.2.1.1 The bow of the striking ship meets the side of the struck ship at 90°, and the struck ship has no speed and remains upright.

34.2.1.2 The impact area is to be taken as the side and deck structure between the two transverse bulkheads of the cargo hold area within 0.4$L$ amidships of the struck ship.

34.2.1.3 The location of collision is to be the most dangerous collision point selected according to the relative draft of the striking ship and the struck ship.

34.2.1.4 The most dangerous bulbous bow form is to be selected according to the ship type and displacement~~, and the structure is assumed to be rigid~~.

### ~~34.2.2 Critical deformation energy of the side structure~~

~~34.2.2.1 The Minorsky method or a validated analytical method may be accepted to calculate critical deformation energy of the side structure. Assuming that the structural response is quasi-static and the material is ideal elastic plastic, the structural plastic deformation energy is calculated when the side structure in the impact area of the struck ship is damaged to the critical state.~~

~~34.2.2.2 When the FE method is adopted, the dynamic response of the structure is to be calculated. The bow of the striking ship ramming into the struck ship at the initial striking velocity $V_0$, and the kinetic energy loss of the striking ship is all transformed into the kinetic energy of the struck ship and the plastic deformation energy absorbed by the structure, until the critical damaged state of the side structure is reached. For the impact on the attached water mass of the ship, the total mass of the striking ship is to be 1.1 times its own displacement, and the total mass of the struck ship is to be 2 times its own displacement.~~

### ~~34.2.3 Critical striking speed of the ship~~

~~34.2.3.1 The critical striking speed $V_{cr}$ of the ship is to be calculated according to the following formula:~~

$$V_{cr} = 19.41\left\{\frac{10E_{cr}}{\Delta}\left(1 + 1.815\frac{\Delta}{\Delta_0}\right)\right\}^{0.5} \quad \text{kn}$$

where: $\Delta$ displacement of the striking ship, in t;

$\Delta_0$ displacement of the struck ship, in t;

$E_{cr}$ critical deformation energy of the struck ship, in MJ, see 34.2.2 of this Chapter.

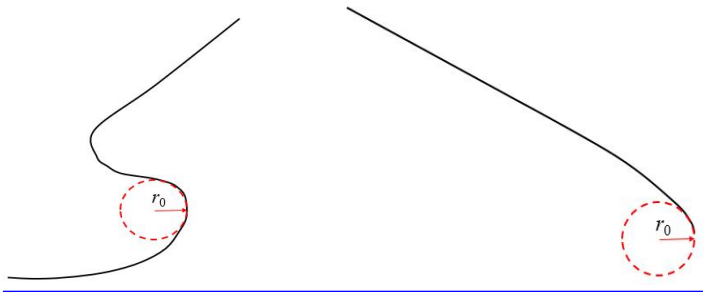
**34.2.2 Simplified calculation method for critical deformation energy of the side structure**

34.2.2.1 The simplified method is applicable to the assessment condition when the striking ship has a bulbous bow and the impact area is at the side structure of the struck ship. Assuming that the structural response is quasi-static and the material is ideal elastic plastic, the structural plastic deformation energy is calculated when the side structure in the impact area of the struck ship is damaged to the critical state.

34.2.2.2 Simplification of impact mechanics model and determination of material parameters

(1) Simplification of the bulbous bow of the striking ship

The bulbous bow of the striking ship is simplified as a hemispherical rigid ram, and a circle consistent with the profile of the bulbous bow is obtained by taking the central longitudinal section of the ship and the waterplane close to the tip of the bulbous bow. The radius of the circle is the calculated radius $r_0$ of the hemispherical ram, in mm, as shown in Figure 34.2.2.2.




**(a) Central longitudinal section (b) Half-breadth waterplane**

**Figure 34.2.2.2 Selection of the radius of the hemispherical ram**

(2) Simplification of the side structure of the struck ship

The damage side area of the struck ship is simplified as a rectangular area composed of the primary members on the side (such as the shell plate, deck, bulkhead, platform, etc.). The longitudinal length $2l$ of the area, in mm, is to be taken as the distance between the two transverse bulkheads, and the vertical range is the height from the inner bottom to the deck or platform.

For the transverse frames and stiffeners of the side structure, their thickness can be equivalent to the thickness of the side shell plate. The total equivalent thickness of the side shell plate is calculated as follows:

$$t_{eqs} = t_{0s} + \frac{\sum_{i}^{m1} V_{F-i} + \sum_{i}^{m2} V_{s-i}}{A_{0s}} \quad \text{mm}$$

where: $t_{0s}$——thickness of the side shell plate, in mm;

$V_{F-i}$, $V_{s-i}$——volume of the transverse frames and stiffeners in the side damage area, in $mm^3$;

$m1$, $m2$——number of the transverse frames and stiffeners in the side damage area;

$A_{0S}$——area of the side damage area, in $mm^2$.

(3) Determination of mechanical property parameters of materials

1) The flow stress $\sigma_0$ of the material is calculated according to the following formula:

$$\sigma_o = \frac{1}{2}(R_{eH} + R_m) \quad \text{MPa}$$

where: $R_{eH}$——yield strength of the material, in MPa;

$R_m$——tensile strength of the material, in MPa.

2) The hardening index $n$ of the material is calculated according to the following formula:

$$n = 1.5 \ln\left[1 + \frac{1}{0.24 + 0.01395 R_m}\right]$$

3) The hardening strength $k$ of the material is calculated according to the following formula:

$$k = 0.85 R_m \left(\frac{e}{n}\right)^n \quad \text{MPa}$$

where: $e$——natural constant.

34.2.2.3 Calculation for critical deformation energy of the side structure of the struck ship

For bulbous bow ramming, the critical deformation energy $E_{cr}$ when the side shell plate is deformed to the critical damaged state is calculated according to the following formula:

$$E_{cr} = 0.5 F_c w_c \times 10^{-6} \quad \text{MJ}$$

where: $F_c$——impact force, in N, to be calculated as follows:

$$F_c = 0.758 \pi t_{eqs} r_0 k$$

where: $t_{eqs}$, $r_0$, $k$ as defined in 34.2.2.2;

$w_c$——depth of the ramming, in mm, to be calculated as follows:

$$w_c = 0.5\sqrt{(7n + 0.7) l r_0}$$

where: $n$, $l$ as defined in 34.2.2.2.

### 34.2.3 FE method for calculation of critical deformation energy

34.2.3.1 The FE analysis of anti-collision capacity of ships can assess the impact of the bulbous bow and the flare area on the struck ship. The damaged area of the struck ship includes the side and deck structure. The bow of the striking ship ramming into the struck ship at the initial striking speed $V_0$, and the kinetic energy loss of the striking ship is all transformed into the kinetic energy of the struck ship and the plastic deformation energy absorbed by the structure, until the critical damaged state of the side structure is reached.

34.2.3.2 Structural modelling

(1) Modelling of the striking and struck ships

For the striking ship, the forepeak area of the ship's bow is selected, of which the shell plate, deck, frames and members are modelled by plate elements, and the hull after the forepeak tank may be modelled by rigid beam. The rigid beam is collinear with the center of gravity of the ship. The beam section may be tubular and the outside diameter is close to the moulded breadth, and is to be coupled with the forepeak section.

For the struck ship, the range between two transverse bulkheads in the midship region is selected, of which the plates, frames and members are modelled by plate elements, and the outer part of the hull may be modelled by rigid beam. The rigid beam is collinear with the center of gravity of the ship. The beam section may be tubular and its outer diameter is close to the moulded breadth, and is to be coupled with the hold/tank section of the struck ship.

Considering the influence of hydrodynamical added mass during collision, the total mass of the striking ship is to be 1.04 times its own displacement, and the total mass of the struck ship is to be 1.9 times its own displacement. The density of the FE model is to be based on the total mass of the ship.

(2) Meshing

The FE meshes of the contact area of the striking and struck ships is to be graded as 100 mm × 100 mm

while other regions are graded by longitudinals or similar spacing. Where possible, the aspect ratio of plate elements is to be kept close to one and the use of triangular elements is to be avoided.

(3) Material properties and failure criteria

The exponent for reinforced material properties are assigned to the models of the striking bow and the struck hold/tank, and the yield strength $R_{eH}$ and tensile strength $R_m$ of the material are determined according to the grade of the steel, and the hardening index $n$ and hardening strength $k$ of the material are obtained, as shown in 34.2.2.2(3). The material reinforcement formula is as follows:

$$\sigma_{eq} = \begin{cases} R_{eH} & \varepsilon_{eq} \le \varepsilon_{plat} \\ k\varepsilon_{eq}^{n} & \varepsilon_{eq} > \varepsilon_{plat} \end{cases}$$

where: $\sigma_{eq}$, $\varepsilon_{eq}$——equivalent stress and equivalent strain of the element;

$\varepsilon_{plat}$——strain value at the end of the yield phase of the material.

The element failure strain $\varepsilon_F$ adopts the following formula:

$$\varepsilon_F(l_e, t) = 2n + (\varepsilon_u - 2\mathrm{n})\frac{t}{l_e}$$

where: $l_e$, $t$——size and thickness of the element, in mm;

$\varepsilon_u$——failure strain value when $l_e/t = 1$, to be taken as 0.58.

The corrected material failure strain $\varepsilon_{Fd}$ after considering the strain rate is determined in accordance with Figure 34.2.3.2.

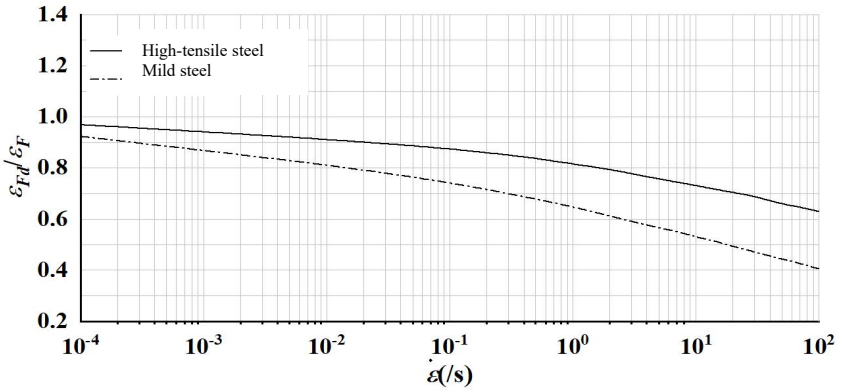



Figure 34.2.3.2 Influence of strain rate on failure strain

34.2.3.3 FE calculation and result extraction

(1) Boundary conditions

For the striking ship, restrain the degree of freedom of rotations in three directions along the hull beam and degree of freedom of displacement along the moulded depth direction.

For the struck ship, no restraint is applied.

(2) Definition of contact

Self-contact is defined. The contact algorithm adopts penalty function method and the friction coefficient is 0.3.

(3) Impact calculation

The initial striking speed $V_0$ (generally not less than 7 kn) is assigned to the striking ship, and explicit dynamics computation is carried out, and the calculation time is generally not less than 5 s.

(4) Data extraction

The energy absorption-time curve, the impact force-time curve and the structural damage (deformation) diagram of the struck hold/tank section are extracted during the collision. The energy absorption value

when the ship structure is in the critical damaged state is taken as the critical deformation energy $E_{cr}$.

# Section 3 EVALUATION CRITERIA

~~**34.3.1 Evaluation criteria collision resistance capability**~~

~~34.3.1.1 Ships of approximately equal displacement and with design draughts approximately identical to that of the struck ship to be examined are to be assumed as striking ships. The critical striking speed, $V_{cr}$, of the ship is not to be less than 7 kn.~~

**34.3.1 The ultimate energy absorption value of the struck ship**

34.3.1.1 During the collision, the ultimate energy absorption value $E_u$ of the struck ship is calculated as follows:

$$E_u = 0.193 \frac{m_a m_b V_0^2}{(1.04 m_a + 1.09 m_b)} \quad \text{MJ}$$

where: $m_a$, $m_b$——mass of the striking and struck ships respectively, in t;

$V_0$——striking speed, in kn.

**34.3.2 Critical striking speed of the striking ship**

34.3.2.1 The critical striking speed of the striking ship is calculated according to the following formula:

$$V_{cr} = 2.27 \sqrt{E_{cr} \frac{(1.04 m_a + 1.09 m_b)}{m_a m_b}} \quad \text{kn}$$

where: $m_a$, $m_b$——mass of the striking and struck ships respectively, in t;

$E_{cr}$——critical deformation energy of the struck ship, in MJ.

**34.3.3 Assessment criteria for anti-collision capacity**

34.3.3.1 The assessment criteria for anti-collision capacity of the struck ship is as follows:

(1) $E_{cr} \geq E_u$, and

(2) $V_{cr} \geq V_0$

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## PART TEN SHIPS IN RESTRICTED SERVICE

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# CHAPTER 2 HULL

## Section 1 GENERAL PROVISIONS

### 2.1.1 General requirements

2.1.1.3 For passenger ships, ferries, traffic ships and public affair ships engaged in restricted service that are not high-speed and whose main hull is made of aluminum alloy, hull structures are to comply with the requirements of CCS Guidelines for Structure of Non-High-Speed All-Aluminum Alloy Sea-Going Ships.

### 2.1.3 Reduction of rule scantlings of structural members

2.1.3.4 For ships of less than 65 m in length and engaged in restricted service, the~~The requirements for~~ minimum thickness of plating ~~after reduction~~ is to comply with the following requirements:

(1) ~~For ships of less than 65 m in length,~~ the thickness of shell plating is to be not less than 5 mm~~.~~;

(2) ~~For ships of less than 65 m in length,~~ the thickness of strength deck is to be not less than 5 mm and the thickness of other decks is to be not less than 4 mm~~.~~;

(3) ~~For ships of less than 65 m in length,~~ the thickness of inner bottom plating in double bottom is to be not less than 5 mm~~.~~;

(4) ~~For ships of less than 65 m in length,~~ the thickness of weather tight steel hatch covers is to be not less than 5 mm.

## Section 2 SHIP TYPE REQUIREMENTS

### 2.2.4 Dredgers

2.2.4.1 Dredgers operating in restricted service are to be assigned one of the following class notations:

(1) Operating in service category 3: Dredging Within R3;

(2) Operating in service category 2: Dredging Within R2;

(3) Operating in service category 1: Dredging Within R1;

(4) Operating only within harbour: Dredging Within Harbour.

2.2.4.2 For the check of longitudinal strength of dredgers under operating conditions in accordance with the requirements of Chapter 14 of PART TWO of the Rules, the wave bending moment and wave shear force may be reduced as follows:

(1) 15% for ships intended for service category 1;

(2) 30% for ships intended for service category 2;

(3) 45% for ships intended for service category 3;

(4) 70% for dredgers intended for operations in harbours only.

### 2.2.7 Container ships

2.2.7.1 Container ships engaged on non-international voyages need not comply with relevant requirements in paragraphs 6, 7 and 8 of Appendix 1 Container Securing, Chapter 7, PART TWO of the Rules.