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CHINA CLASSIFICATION SOCIETY

RULES FOR CLASSIFICATION OF SEA-GOING STEEL SHIPS

CCS RULE CHANGE NOTICE

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CONTENTS

CCS Rule Change Notice For:

RULES FOR CLASSIFICATION OF SEA-GOING STEEL SHIPS

PART ONE

Brief Introduction

1. PR 1B (Rev.7 June 2024) is included, adding requirements for dual class ships in “initial classification survey of newbuildings”, revising the definitions of "double classed ships" and "dual class ships" and adding the definitions of "bilateral agreement", "trilateral agreement", "first Society" and "second Society";

2. PR42 (New June 2024) is included, adding Section 5 in “Surveys During Construction”, i.e. “Assigning Class for a New Building Project when the Design is already Approved by an Initial Society”;

3.URZ7 (Rev.29 Corr.1 May 2024) and URZ7.1 (Rev.15 Corr.1 May 2024) are included, specifying the new criteria for the renewal of weathertight steel cargo hatch covers on exposed decks of ships contracted for construction on or after 1 July 2024.

4. URW35 (Rev.1 Oct.2023) is included, revising the relevant provisions for the approval of non-destructive testing service providers.

CONTENTS

CHAPTER 2 SCOPE AND CONDITIONS OF CLASSIFICATION

Section 1 GENERAL PROVISIONS

2.1.3 Definitions

2.1.3.1 Unless expressly provided otherwise, for the purpose of the Rules:

(29) A **double classed ship** is one which is classed by two Societies and where each Society works as if it is the only Society classing the ship, and does all surveys in accordance with its own Rules, requirements and schedule.

(30) A **dual class ship** is one which is classed by two Societies ~~between which there is a written agreement regarding sharing of work~~.These Societies have a written bilateral agreement that outlines sharing of work, including a working plan, and procedures and, in case of newbuilding, a written trilateral agreement with the shipyard.

(31) **Bilateral Agreement** is an agreement adopted by the two Societies with Dual Class Vessels.

(32) **Trilateral Agreement** is an agreement adopted by the shipyard and the two Societies involved in dual class arrangement (first Society and second Society) for describing the responsibilities between the two Societies during new construction of a vessel.

(33) **First Society** is a Society classing a vessel which, under request of the Owner, enters a double or dual class arrangement with another Society.

(34) **Second Society** is a Society which is requested by an Owner to accept a vessel already classed, or to be classed, by another Society into its class under double or dual class arrangement.

(35~~1~~) **Conditions of class** are requirements to the effect that specific measures, repairs, surveys etc., are to be carried out within a specific time limit in order to retain class.

(36~~2~~) A **CSR ship** is a ship complying with the requirements of Common Structural Rules[①].

(37~~3~~) The term "**not in class (disclassed)**" means class being suspended or canceled (withdrawn).

(38~~4~~) **Critical structural areas** are locations which have been identified from calculations to require monitoring or from the service history of the subject ship or from similar or sister ships (if available) to be sensitive to cracking, buckling or corrosion which would impair the structural integrity of the ship.

CHAPTER 4 SURVEYS DURING CONSTRUCTION①

Section 5 ASSIGNING CLASS FOR A NEW BUILDING PROJECT WHEN THE DESIGN IS ALREADY APPROVED BY AN INITIAL SOCIETY②

4.5.1 General requirements

4.5.1.1 This Section is applicable to assigning class for a newbuilding project by Memorandum of Understanding (MoU) adopted between CCS, a Shipyard and, if applicable, a Ship Owner covering the acceptance by CCS of a design based on the prior approval by an Initial Society for a new building.

4.5.2 Assigning class for a new building project based on the Rules and the Memorandum of Understanding between CCS, the Shipyard and, if applicable, a Owner

4.5.2.1 Whenever CCS is requested by an Owner/Shipyard to class a vessel(s) for new construction project when the design is already approved by an Initial Society, the following procedures are to be applied.

(1) CCS may accept to class a new building project vessel when the design is already approved by an Initial Society for new building and all comments are confirmed as dealt with by the Initial Society approving the design.

(2) CCS may accept to class a new building project vessel in accordance with the Memorandum of Understanding (MoU) adopted by CCS and the shipyard,, subject to the requirements in (3), (4) and (5) being fulfilled. This MoU is to clearly define requirements for submission of plans as required by 4.5.3 below, harmonizing and resolution of plans already approved by an Initial Society for new building project and comments to be dealt with.

(3) CCS is to perform review and approval of plans based on the Rules. As a minimum scope, the approval of the plans listed in 4.5.3 below is required by CCS to verify compliance with the Rules. CCS is to record the written documentary evidence of the above-mentioned plans which were approved as complying with the Rules or with other requirements confirmed acceptable in accordance with the Rules.

(4) CCS is to perform the survey during fabrication, construction and testing of the vessel based on the Rules.

(5) Certification of materials and components of manufacturers is to be carried out by CCS in accordance with the Rules

4.5.3 Plans to be submitted by the Shipyard to CCS

4.5.3.1 This paragraph contains the list of plans to be submitted by the Shipyard to CCS. The list of plans varies from ship to ship, but are to include at least the following.

4.5.3.2 Main plans

(1) General Arrangement;
(2) Capacity Plan;
(3) Hydrostatic Curves;
(4) Loading Manual, where required;
(5) Damage Stability calculation, where required.

4.5.3.3 Steel plans

(1) Midship Section;
(2) Scantling Plan;
(3) Decks;
(4) Shell Expansion;
(5) Transverse Bulkheads

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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 Initial Society is the Society which has previously approved the design using their own Rules and which can provide satisfactory evidence of continued compliance with QSCS.

(6) Rudder and Rudder Stock;
(7) Hatch Covers;
(8) For CSR vessels, plans showing, for each structural element, both as-built and renewal thicknesses and any thickness for "voluntary addition";
(9) Plan of tank testing.
4.5.3.4 Machinery and Electrical plans
(1) Machinery Arrangement;
(2) Intermediate, Thrust- and Screw Shafts;
(3) Propeller;
(4) Couplings and shaft alignment calculation
(5) Main Engines, Propulsion Gears and Clutch Systems (or Manufacturer make, model and rating information);
(6) For Steam Turbine Vessels, Main Boilers, Superheaters and Economisers (or Manufacturer make, model and rating information) and Steam Piping;
(7) Bilge and Ballast Piping Diagram;
(8) Wiring Diagram;
(9) Steering Gear Systems Piping and Arrangements and Steering Gear Manufacturer make and model information;
(10) Diagram of the air, sounding and overflow systems;
(11) Diagram of cooling systems (sea water and fresh water);
(12) Diagram of fuel oil system;
(13) Diagram of the lubricating oil system;
(14) Diagram of the hydraulic systems intended for essential services or located in machinery spaces;
(15) Diagrams of sea water and / or freshwater piping systems
(16) Electrical power balance (main and emergency supply);
(17) General specification for the automation of the ship;
(18) Detailed specification of the essential service systems;
(19) List of components used in the automation circuits, and references (Manufacturer, type, etc.);
(20) General diagram showing the monitoring and/or control positions for the various installations, with an indication of the means of access and the means of communication between the positions as well as with the engineers;
(21) Diagrams of the supply circuits of automation systems, identifying the power source;
(22) List of monitored parameters for alarm/monitoring and safety systems.
(23) Diagram of compressed air system.
4.5.3.5 Torsional vibration calculations.
4.5.3.6 For vessels with ice class notation, plans for flexible couplings and/or torque limiting shafting devices in the propulsion line shafting (or manufacturer make, model and rating information) are also to be provided.
4.5.3.7 For oil tankers, the following plans are also to be provided:
(1) Pumping arrangement at the forward and after ends and drainage of cofferdams and pump rooms.
4.5.3.8 For ships assigned with unattended machinery space notation, the following plans are also to be provided:
(1) Instrument and Alarm List;
(2) Fixed Fire Detection and Alarm System;
(3) List of Automatic Safety Functions (e.g. slowdowns, shutdowns, etc.)
(4) Function Testing Plan.
4.5.3.9 Document(s) of Approval of Alternative Design and Arrangements, if any.
4.5.3.10 Other plans as required by the Rules are also to be provided depending on the type of ship.

Section 6 ASSIGNING DUAL CLASS FOR A NEW BUILDING

4.6.1 General requirements

4.6.1.1 Each Society acts on behalf of the other Society in accordance with the trilateral agreement adopted by the two Societies and the shipyard. This agreement is to clearly define modalities such as submission of plans, rules to be applied, harmonizing and resolution of plan approval comments between societies.

4.6.2 Plan submission and survey

4.6.2.1 Plans and documents related to classification requirements are to be submitted to each Society by the shipyard.

4.6.2.2 One set of plans and documents fully approved by the First Society shall be provided to the Second Society and each Society is to perform review and approval of plans based on its own classification Rules. As a minimum scope, the approval of the plans listed in 4.5.3, Section 5, Chapter 4 of this PART is required by the Second Society to verify compliance with its applicable classification Rules. The Second Society is to record written documentary evidence of the above-mentioned plans which were approved as complying with the Second Society's own Rules or with other requirements confirmed acceptable in accordance with its own Rules.

4.6.2.3 Each Society is to perform the survey during fabrication, construction and testing of the vessel based on its own classification Rules and in accordance with the work agreed by the two Societies and described in the trilateral agreement, and/or the bilateral agreement adopted by the two Societies, if any.

CHAPTER 5 SURVEYS AFTER CONSTRUCTION

Section 4 HULL AND EQUIPMENT SURVEYS

5.4.1 General requirements

5.4.1.3 Thickness measurements Acceptance Criteria

(1) The acceptance criteria for thickness measurements are according to relevant provisions of Appendix 1 of this Chapter depending on ship's age and structural elements concerned, e.g 2.4 for corrugated transverse bulkhead, 2.6 or 2.7 for all cargo hatch covers and coamings on exposed decks.

Section 5 ADDITIONAL REQUIREMENTS FOR HULL AND EQUIPMENT SURVEYS OF GENERAL DRY CARGO SHIPS①

5.5.1 General requirements

5.5.1.2 Thickness measurements Acceptance Criteria

(1) The acceptance criteria for thickness measurements are according to the relevant requirements of Appendix 1 of this Chapter depending on ship's age and structural elements concerned, e.g. 2.4② for corrugated transverse bulkhead, 2.6③ or 2.7 for all cargo hatch covers and coamings on exposed decks.

Section 14 INITIAL CLASSIFICATION SURVEYS OF SHIPS CONSTRUCTED NOT UNDER THE SUPERVISION OF CCS

5.14.2 Initial classification surveys of ships under construction

5.14.2.3 Requirements for double classed ships or dual class ships:

(1) for double classed ships, the scope of survey is to be in accordance with 5.14.2.1 or 5.14.2.2;

(2) for dual class ships:~~,~~

① Plans submission and survey are to be in accordance with 4.6.2, Section 6, Chapter 4 of this PART;

② ~~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.~~ If the ship applies for the dual class before the date of launching, the scope of survey is to be in accordance with 5.14.2.1 or 5.14.2.2.

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① For surveys, assessment and repair of hull structure, refer to IACS Rec.55 "General Dry Cargo Ships - Guidelines for Surveys, Assessment and Repair of Hull Structure".

② 2006 edition of the Rules or subsequent revisions or corrigenda as applicable.

③ For ships contracted for construction on or after 1 July 2012, see 2.20.2.10, Section 20, Chapter 2, PART TWO of 2012 edition of the Rules. For ships contracted for construction on or after 1 July 2016, see 2.20.2.10, Section 20, Chapter 2, PART TWO of 2016 Amendments of the Rules.

Appendix 1 CRITERIA FOR RENEWAL OF HULL STRUCTURAL MEMBERS

2 Criteria for local strength

2.7 For all weathertight steel cargo hatch covers on exposed decks of ships contracted for construction on or after 1 July 2024, steel renewal is required where the gauged thickness of the plating of double skin hatch covers, single skin hatch covers, hatch coamings, coaming stays and stiffeners is less than t_{net} + 0.5 mm. Where the gauged thickness is within the range t_{net} + 0.5 mm and t_{net} + 1.0 mm, coating① or annual gauging may be adopted as an alternative to steel renewal. For the internal structure of double skin hatch covers, thickness gauging is required when hatch cover top or bottom plating renewal is to be carried out or when deemed necessary, at the discretion of CCS Surveyor, on the basis of the plating corrosion or deformation condition. In these cases, steel renewal for the internal structures is required where the gauged thickness is less than t_{net}. For corrosion addition t_s = 1.0 mm, the thickness for steel renewal is t_{net}, and when gauged thickness is between t_{net} and t_{net} + 0.5 mm, coating or annual gauging may be adopted as an alternative to steel renewal, where t_{net} being the net thickness, to be calculated in accordance with 2.20.2, Section 20, Chapter 2, PART TWO of the Rules.

2.~~7~~8 For the following bulk carriers of 150 m in length and upwards and carrying solid bulk cargoes having a density of 1.78 t/m^3 and above, steel renewal is required where the gauged thickness of transverse watertight corrugated bulkheads between cargo holds Nos.1 and 2 is less than t_{net} + 0.5 mm and coating (applied in accordance with the coating manufacturer's requirements) or annual gauging may be adopted as an alternative to steel renewal where the gauged thickness is within the range t_{net} + 0.5 mm and t_{net} + 1.0 mm, with t_{net} being calculated in accordance with IACS UR S19:

(1) bulk carriers contracted for construction before 1 July 1998 and not complying with IACS UR S18;

(2) bulk carriers the keels of which were laid or which were at a similar stage of construction before 1 July 1999 and not complying with IACS UR S18.

2.~~8~~9 For bulk carriers which were not built in accordance with Section 3, Chapter 8 of PART TWO of the Rules, steel renewal is required where the gauged thickness of side shell frames of cargo holds is less than t_{REN} mm. Where the gauged thickness is within the range t_{REN} mm and t_{COAT} mm, sand blasting, coating and reinforcements are to be done and the coating is to be maintained in "as-new" or an equivalent condition (i.e. without breakdown or rusting) at special and intermediate surveys. The t_{REN} and t_{COAT} above are to be calculated in accordance with IACS UR S31.

2.~~9~~10 For Polar Class ships, steel renewal is required where the shell plating corrosion/abrasion additions within the ice-strengthened hull areas is greater than the value specified in Table 13.2.11.2, Chapter 13, PART EIGHT of the Rules minus 0.5 mm.

① Coating is to be maintained in GOOD condition, as defined in 5.1.5.1(15) of this Chapter.

Appendix 23 REQUIREMENTS FOR NDT SERVICE SUPPLIERS

1 General

1.1 Scope

~~Firms providing NDT (Non-Destructive Testing) services on ship and offshore structures/components subject to classification, need to fulfil the requirements set out in this Appendix. In this document, such firms will be referred to as the Supplier.~~

1.1.1 Firms providing Non-Destructive Testing (NDT) and Advanced Non-Destructive Testing (ANDT[①]) Services on the new construction of ships and offshore structures subject to classification, need to fulfil the requirements set out in this Appendix. In this Appendix, such firms will be referred to as the NDT Service Supplier.

1.1.2 This Appendix applies to:

(1) Independent NDT companies;

(2) Internal departments of fabricators, e.g., shipyards, hull block/section fabricators performing NDT.

The NDT service specified in this Appendix covers the service application to the following hull structure and associated items at the fabrication stage during new construction:

(1) The welding of components that are integrated into the ship or offshore structure;

(2) The fabrication of independent fuel or cargo tanks (including those intended for low flashpoint fuels, e.g. type A, B and C independent tanks as described in IMO IGC and IGF Codes);

(3) Items listed within the definition of hull structure, as defined in 2.1, Appendix 1, Chapter 4 of this PART;

(4) Rudders of welded construction.

1.1.3 NDT Service Suppliers in the context of this Appendix are not included as part of the scope of Appendix 8, Chapter 5 of this PART.CCS shall verify the NDT Service Supplier in order to determine compliance with the requirements of this Appendix.

1.2 Objective

The objective of this Appendix is to ensure that the NDT Service Supplier is using appropriate procedures, has qualified and certified personnel and has implemented written procedures for training, experience, education, examination, certification, performance, application, control, verification and reporting of NDT. In addition, the NDT Service Supplier shall furnish appropriate equipment and facilities commensurate with providing a professional service.

1.3 Terms and definitions

The following terms and definitions apply for this document.

NDT	Non-destructive testing - the development and application of technical methods to examine materials or components in ways that do not impair their future usefulness and Serviceability, in order to measure geometrical characteristics and to detect, locate, measure and evaluate flaws. NDT is also known as non-destructive examination (NDE), non-destructive inspection (NDI) and non-destructive evaluation (NDE). Comprising, but not limited to the following methods and techniques: MT, PT, RT, ~~RT-D,~~ VT, UT, ~~PAUT, TOFD,~~ and ET ~~and/or ACFM~~
ANDT	The above definition of NDT applies, however ANDT includes advanced methods such as RT-D, PAUT, TOFD and AUT
NDT Service Supplier	Independent NDT company or NDT department/section that forms a part of a company providing NDT services on the new construction of ships and/~~or~~ offshore ~~components/~~structures, as applicable to the bodies performing NDT on the items as listed in paragraph 1.1.2 of this Appendix.
Society	The Classification Society
MT	Magnetic Particle Testing
PT	Penetrant Testing
RT	Radiographic Testing
RT-D	Digital Radiography (Several techniques within the method RT, e.g. Computed

① For the remainder of this Appendix, wherever there is a reference to NDT, it also includes ANDT.

	Radiography or Direct Radiography)
UT	Ultrasonic Testing
PAUT	Phased Array Ultrasonic Testing (Technique within the method UT)
TOFD	Time of Flight Diffraction (Technique within the method UT)
AUT	Automated Ultrasonic Testing. A technique by which an object is tested by ultrasound using probes operating under mechanical control and where ultrasonic data is collected automatically
ET	Electromagnetic Testing (i.e. Eddy Current Testing and/or Alternating Current Field Measurements [ACFM])
VT	Visual Testing
Industrial sector	Section of industry or technology where specialised NDT practices are used, requiring specific product-related knowledge, skill, equipment and/or training
Product sector	A category of component that may be defined by type of manufacturing, fabrication, and/or shape, which may have unique, and/or general manufacturing/fabrication defect characteristics. Product sector examples include (but not limited to): castings, wrought products (forgings), rolled products, extruded products, and welds. NDT personnel may hold certification in a method which is related to a product sector

1.4 References

The following referenced documents are to be used for the application of this document as appropriate. For undated references, the latest edition of the referenced document (including any amendments) applies.

(1) ISO 9712:2021~~2012~~; Non-destructive testing - Qualification and certification of NDT personnel;

(2) ISO/IEC 17020:2012; Conformity assessment – Requirements for the operation of various types of bodies performing inspection;

(3) ISO/IEC 17024:2012; Conformity assessment – General requirements for bodies operating certification of persons;

(4) ISO 9001:2015; Quality Management Systems – Requirements~~.~~;

(5) SNT-TC-1A: 2020; Personnel Qualification and Certification in Nondestructive Testing;

(6) ANSI/ASNT CP-189:2020; ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel.

Other national adoptions of the standards listed above are accepted as compliant and hence are accepted for use together with this document.

2 Requirements for ~~the~~ NDT Service Supplier

The NDT Service Supplier shall document, as required in 2.2 to 2.9, that it has the competence and control needed to perform the specified NDT services.

2.1 Requirements for documents

The following documents shall be available for ~~the Society~~ CCS upon request:

(1) an outline of NDT Service Supplier's organisation and management structure, including any subsidiaries;

(2) information on the structure of the NDT Service Supplier's Quality Management System;

(3) quality manual and documented procedures covering the requirements given in item 2.2;

(4) for companies with in-house certification of ~~persons~~ personnel scheme; a written practice developed in accordance with a recognised standard or recommended practice (i.e. ASNT's SNT-TC-1A, 2020 ~~2016~~, ANSI/ASNT CP-189, 2020 ~~2016~~ or similar);

(5) operational work procedures for each NDT method including selection of the NDT technique;

(6) training- and follow-up programmes for NDT operators including practical training on various ship and offshore products;

(7) written statement issued by the employer, based upon the scope of certification, authorising the operator to carry out specified tasks;

(~~7~~8) procedure for supervisor's authorisation of NDT operators;

(~~8~~9) experience of the NDT Service Supplier in the specific service area;

(~~9~~10) for companies which obtain certification from an accredited certification body; a list of documented training and experience for NDT operators within the relevant NDT service area, including qualifications and third party certification per ISO 9712:2021~~2012~~ based certification

schemes;
(~~10~~11) description of equipment(s) used for the NDT services performed by the NDT Service Supplier;
(~~11~~12) a guide for NDT operators to use equipment mentioned above;
(~~12~~13) record formats for recording results of the NDT services referred to in item 2.9;
(~~13~~14) information on other activities which may present a Conflict of interest, if applicable;
(~~14~~15) record of customer claims and corrective actions, where applicable;
(~~15~~16) any legal proceedings against the company in the past/currently in the courts of law, where applicable.

2.2 Quality management system

2.2.1 The NDT Service Supplier shall have a documented quality management system, covering at least:
(1) work procedures for all tasks and operations, including the various NDT methods and NDT techniques for which the NDT Service Supplier is involved;
(2) preparation, issuance, maintenance and control of documents;
(3) maintenance and calibration of the equipment;
(4) training programs for the NDT operators and the supervisors;
(5) maintenance of records for NDT operators' and the supervisors' training, qualification and certification;
(6) certification of NDT operators including re-validation and recertification;
(7) procedure for test of operators' visual acuity;
(8) supervision and verification of operation to ensure compliance with the NDT procedures;
(9) quality management of subsidiaries;
(10) job preparation;
(11) order reference system where each engagement is traceable to when, who and where the test was carried out;
(12) recording and reporting of information, including retention time of records;
(13) code of conduct for the NDT Service Supplier's activities; especially the NDT activities;
(14) periodic review of work process procedures;
(15) corrective and preventive action;
(16) feedback and continuous improvement;
(17) internal audits;
(18) the provision of accessibility to required codes, standards and procedures to assist NDT operators.

2.2.2 A documented quality system complying with the most current version of ISO/IEC 17020:2012 and including the above would be considered acceptable. The NDT Service Supplier should satisfy the requirements of Type A or Type B or Type C inspection body, as described in ISO/IEC 17020:2012. In all cases, production staff shall not be allowed to inspect their own work in the case of Type C inspection body.

2.3 Qualification and certification of NDT personnel

2.3.1 The NDT Service Supplier is responsible for the qualification and preferably 3rd party certification of its supervisors and operators to a recognised certification scheme based on ISO 9712:2021 ~~2012~~.

2.3.2 Personnel qualification to an employer based qualification scheme as e.g. SNT-TC-1A, 2020 ~~2016~~ or ANSI/ASNT CP-189, 2020 ~~2016~~ may be accepted if the NDT Service Supplier's written practice is reviewed and found acceptable by the Society. The NDT Service Supplier's written practice shall as a minimum, except for the impartiality requirements of a certification body and/or authorised body, generally comply with the requirements of ISO 9712:2021 ~~2012~~.
For NDT operators holding certificates issued via an employer based scheme, the employer's certification shall be deemed revoked when employment is terminated by either party.

2.3.3 The supervisors' and operators' certificates and competence shall comprise all industrial and product sectors and techniques being applied by the NDT Service Supplier.

2.3.4 ~~Level 3 personnel shall be certified by an accredited certification body.~~Level 3 personnel shall be certified by one of the following means:
(1) obtain certification from an accredited certification body.
(2) obtain certification from an employer based scheme via the examination method, as detailed in the written practice. It is not permissible to directly appoint a level 3 without examination if the

intended certification route is from an employer based scheme.

2.4 Supervisor

~~The Supplier shall have a supervisor or supervisors, responsible for the appropriate execution of NDT operations and for the professional standard of the operators and their equipment, including the professional administration of the working procedures. The supplier shall employ, on a full-time basis, at least one supervisor independently certified to Level 3 in the method(s) concerned as per the requirements of item 2.3. It is not permissible to appoint Level 3 personnel; they must be certified by an accredited certification body. It is recognised that a Supplier may not directly employ a Level 3 in all the stated methods practiced. In such cases, it is permissible to employ an external, independently certified, Level 3 in those methods not held by the full-time Level 3(s) of the Supplier.~~

~~The supervisor shall be directly involved in review and acceptance of NDT Procedures, NDT reports, calibration of NDT equipment and tools. The supervisor shall on behalf of the Supplier re-evaluate the qualification of the operators annually.~~

The NDT Service Supplier shall have a supervisor or supervisors, responsible for the following:

(1) validate NDT instructions and procedures established and reviewed by level 3 personnel;

(2) review of NDT reporting;

(3) supervise all tasks and NDT operations at all levels;

(4) inspection of NDT equipment, tools and calibration;

(5) re-evaluate the qualification of the operators annually on behalf of the NDT Service Supplier.

Normally, the NDT Service Supplier shall employ (on a full-time basis) a level 3 supervisor, certified to level 3 in the applicable method(s) as per the requirements of this Appendix.

It is recognised that an NDT Service Supplier may not directly employ a Level 3 in all the stated methods practiced. In such cases, it is permissible to employ an external Level 3 who is certified by an accredited certification body in those methods not held by the full-time Level 3(s) of the NDT Service Supplier.

Alternatively, and by agreement with CCS, the NDT Service Supplier may appoint an internal (full-time employed) supervisor of NDT activities, who does not hold level 3 certification. In this case, the supervisor shall be certified to a minimum of level 2. For NDT Service Suppliers operating this alternative approach, the NDT Service Supplier shall comply with all other requirements of this Appendix and shall employ (either part time or on a contract basis) Level 3 NDT Services (to carry out functions such as procedure development, procedure approval, consultancy, review etc.) from outside the NDT Service Supplier organisation. The appointed external level 3 shall be certified by an accredited certification body in all the applicable methods appropriate to the scope of the NDT operations.

2.5 Operators

2.5.1 The operator carrying out the NDT and interpreting indications, shall as a minimum, be qualified and certified to Level 2 in the NDT method(s) concerned and as described in item 2.3. However, operators only undertaking the gathering of data using any NDT method and not performing data interpretation or data analysis may be qualified and certified as appropriate, at level 1.

2.5.2 The operator shall have adequate knowledge of materials, weld, structures or components, NDT equipment and limitations that are sufficient to apply the relevant NDT method for each application appropriately.

2.6 Equipment

2.6.1 The NDT Service Supplier shall maintain records of the NDT equipment used and detail information related to maintenance, calibration and verification activities. If the NDT Service Supplier hires equipment, such equipment shall have updated calibration records, and the operators shall be familiar with the specific equipment type prior to using it. Under any circumstance, the NDT Service Supplier shall possess sufficient equipment to carry out the services being a part of the NDT scope required by CCS ~~the Society~~.

2.6.2 Where the equipment is of unique nature, the NDT operators shall be trained by competent personnel in the operation and use of the equipment before carrying out NDT using this equipment.

2.7 Work instructions and procedures

The NDT Service Supplier shall produce written procedures for the NDT being applied. These

procedures are to be written, verified or approved by the NDT Service Supplier's Level 3 (either internal, or external, as described in section 2.4). Procedures shall define all relevant information relating to the inspection including defect evaluation against acceptance criteria in accordance with the Society Rules. All NDT procedures and instructions shall be properly documented in such a way that the performed testing can be easily retraced and/or repeated at a later stage. All NDT procedures are to be acceptable to CCS ~~the Society~~.

2.8 Sub-contractors

2.8.1 The NDT Service Supplier shall give information of agreements and arrangements if any part(s) of the services provided are subcontracted, included level 3 NDT Services (as described in section 2.4). The NDT Service Supplier, in the following-up of subcontracts shall give emphasis to the quality management system of the subcontractor.

2.8.2 Subcontractors shall meet the same requirements placed on NDT Service Suppliers for any NDT performed.

2.9 Reporting

2.9.1 All NDT shall be properly documented in such a way that the performed testing and examination can be easily retraced and/or repeated at a later stage. The reports shall identify the defects present in the tested area, and a conclusive statement as to whether the material, weld, component or structure satisfies the acceptance criteria or not.

2.9.2 The report shall include a reference to the applicable standard, NDT procedure and acceptance criteria applied in the applicable NDT method/technique. In general, the acceptance criteria shall comply with the Society Rules. Reports shall be signed by the personnel with the appropriate level of certification, and the appropriate signatory status as defined in the Quality Management System.

CCS Rule Change Notice For:
RULES FOR CLASSIFICATION OF SEA-GOING STEEL SHIPS

PART TWO

CONTENTS

CHAPTER 2 HULL STRUCTURES

Appendix 5 BUCKLING STRENGTH ASSESSMENT OF SHIP STRUCTURAL ELEMENTS

SECTION 1 APPLICATION AND DEFINITIONS

1.1.2 Application of this Appendix

1.1.2.1 Sections of this Appendix and application description The buckling checks are to be performed according to:

(1) Section 1 for general definitions regarding buckling capacity, allowable buckling utilisation factors and buckling check criteria.

(2) Section 2 for the slenderness requirements of longitudinal and transverse stiffeners[①].

(3) Section 3 for the prescriptive buckling requirements of plates, longitudinal and transverse stiffeners, primary supporting members and other structures subject to hull girder stresses[②].

(4) Section 4 for direct strength analysis (usually by finite element method) buckling requirements of hatch cover structural members including plates, stiffeners and primary supporting members.

(5) Section 5 for the determination of buckling capacities of plate panels, stiffeners, primary supporting members and column structures.

1.1.2.2 Buckling assessment with this Appendix For the buckling assessment of a ship hull girder, a hatch cover or other structural components, the slenderness requirements as defined in Section 2 and the buckling requirements as defined in Section 3 or Section 4 are to be checked.

1.1.2.3 Alternative methods

This Appendix contains the general methods for the determination of buckling capacities of plate panels, stiffeners, primary supporting members, and columns. For special cases not covered in this Appendix, such as a whole plate structure with stiffeners in two directions (i.e., a stiffened panel with both primary and secondary stiffeners), other more advanced methods, such as finite element analysis methods, can be used with the consent of CCS.

① The requirements in Section 2 of this Appendix are only applicable to stiffeners in the hatch cover structure.

② The requirements in Section 3 of this Appendix are not mandatory.

CHAPTER 3 EQUIPMENT AND OUTFITS

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

2 The Forces on Rudder–Rudder Stock

2.5 Semi spade rudder with 2-conjugate elastic support

Data for the analysis

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

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

$$\text{~~K_{22}~~}\ K_{12} = 1.3 \times \left[\frac{\lambda^3}{3EJ_{1h}} + \frac{\lambda^2(h-\lambda)}{2EJ_{1h}}\right] + \frac{e^2\lambda}{GJ_{th}}$$

$$\text{~~K_{12}~~}\ K_{22} = 1.3 \times \left[\frac{\lambda^3}{3EJ_{1h}} + \frac{\lambda^2(d-\lambda)}{EJ_{1h}} + \frac{\lambda(h-\lambda)^2}{EJ_{1h}} + \frac{(h-\lambda)^3}{3EJ_{2h}}\right] + \frac{e^2\lambda}{GJ_{th}}$$

CCS Rule Change Notice For:

RULES FOR CLASSIFICATION OF SEA-GOING STEEL SHIPS

PART THREE

CONTENTS

CHAPTER 1 GENERAL

Section 2 GENERAL PROVISIONS

1.2.1 Ambient conditions

1.2.1.1 General requirements

The main and auxiliary engines, shafting and machinery equipment essential to classification are to be so designed, type-selected and arranged as to ensure compliance with the provisions of 1.2.1.2 and 1.2.1.3.~~normal operation under the inclination conditions as shown in Table 1.2.1.1. Considering the type, size and service conditions of the ship, smaller angles of inclination may be permitted.~~

1.2.1.2 Considering the type, size and service conditions of the ship, smaller angles of inclination may be permitted. See Table 1.2.1.2 for specific requirements.

Angle of inclination of ships **Table 1.2.1.~~1~~2**

Installations and equipment	Angle of inclination① (°)			
	Athwartships		Fore-and-aft	
	static	dynamic	static	dynamic
Main and auxiliary machinery	15	22.5	5②	7.5
Safety equipment: e.g. emergency power installations, emergency fire pumps and their device	22.5③	22.5③	10	10

Notes: ① Athwartships and fore-and-aft inclinations may occur simultaneously.

② Where the length of the ship exceeds 100 m, the fore-and-aft static angle of inclination may be taken as 500/L degrees, where L = length of the ship, in m.

③ For ships carrying liquefied gases and chemicals, the emergency source of electrical power is also to remain operable with the ship being flooded to a final athwartship inclination up to a maximum of 30°.

1.2.1.3 Shipboard accelerations

Main propulsion and steering machinery and auxiliary machinery that is essential to the propulsion and steering, and the safety of the ship are to be capable of operation under the effects of acceleration and motions.

Documented evidence of equipment suitability is to be submitted to CCS according to the following requirements.

(1) Documentation

For ships subject to the SOLAS Convention, ship builders are to identify and document the ship accelerations and motions periods to which machinery and equipment might be subjected to. The expected accelerations and ship motions periods are to be within machinery and equipment manufacturers requirements. The estimations are to consider vessel type, machinery or equipment location and expected service conditions.

(2) Evaluation of equipment suitability

Machinery and equipment manufacturers are to submit the following evidence to the Classification Society to demonstrate that their machinery or equipment can operate under the required conditions stated in 1.2.1.2 and at least at the levels of shipboard accelerations as stated in this paragraph:

①Report of testing under representative conditions; or

② Report of theoretical verification using recognised computational techniques accompanied by detailed and relevant validation data: or

③ Historical data which provides relevant demonstration of satisfactory experience in service.

(3) Installation and operation

Machinery and equipment manufacturers are to submit details of the requirements /recommendations for installation of the machinery and equipment onboard to ensure satisfactory operation in service under the required conditions as described in 1.2.1.2 and at least at the levels of shipboard accelerations as stated in 1.2.1.4 .

Note: Consideration is to be given for positioning machinery in order to minimize the dynamic load on bearings due to ship motion.

Shipbuilders are to submit details demonstrating that the installation of the machinery and equipment onboard is in accordance with manufacturer's requirements /recommendations.

1.2.1.~~2~~4 The machinery installations relevant to classification of ships are to be so designed and arranged as to ensure normal operation under the ambient temperature conditions as shown in Table 1.2.1.~~2~~4.

Ambient temperature **Table 1.2.1.~~2~~4**

Environment	Location	Temperature range (℃)
Air	In enclosed spaces	0 to 45
	Within specific space or on machinery installations	According to actual temperature of specific space or equipment
	On the open deck	-25 to 45
Seawater	All positions	32

For ships in restricted service, ambient temperature may be taken according to the actual condition of navigation area.

1.2.1.~~3~~5 For the purpose of determining the rating of main and auxiliary reciprocating internal combustion engines, the following ambient reference conditions apply to ships for unrestricted service:

Total barometric pressure	0.1 MPa
Air temperature	45℃
Relative humidity	60%
Sea water temperature (charge air coolant-inlet)	32℃

The engine manufacturers are not expected to provide simulated ambient reference conditions at a test bed.

1.2.1.~~4~~6 In the case of ships for restricted service, the rating is to be suitable for the temperature conditions associated with the geographical limits of the restricted service.

CHAPTER 2 PUMPING AND PIPING SYSTEMS

Section 1 GENERAL PROVISIONS

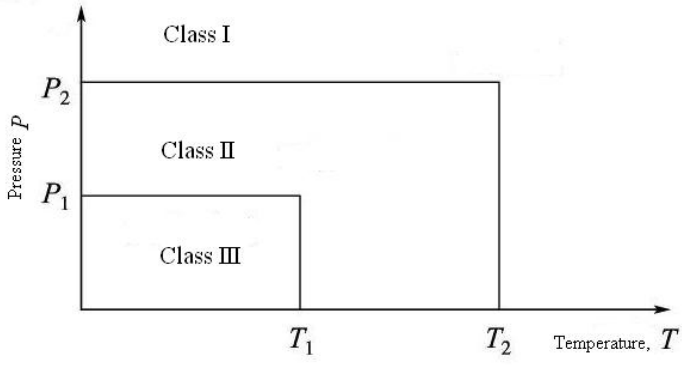
2.1.1 General requirements

2.1.1.1 Unless otherwise stated, this Chapter applies to piping systems of all ships. Chemical cargo piping, chemical process piping, liquefied gases cargo piping, ~~and~~ liquefied gases process piping and fuel piping such as liquefied natural gas, liquefied petroleum gas, ammonia, methanol/ethanol, etc. are to satisfy relevant requirements of applicable CCS rules and guidelines such as ~~comply with relevant requirements in CCS~~ Rules for Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk , ~~and CCS~~ Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk , Rules for Ships Using Natural Gas Fuels, Guidelines for Ships Using Liquefied Petroleum Gas as Fuel, Guidelines for Ships Using Ammonia as Fuel, and Guidelines for Ships Using Methanol/Ethanol as Fuel, respectively.

2.1.5 Classes of pipes

2.1.5.1 For the purpose of assigning appropriate testing requirements, types of joints to be adopted, heat treatment and weld procedure, pressure piping systems are divided into three classes in accordance with their design pressure and design temperature, as indicated in Table 2.1.5.1.

Piping system class **Table 2.1.5.1**



Piping system	Class I		Class II		Class III	
	Design pressure $> P_2$ (MPa)	Design temperature $> T_2$ (°C)	Design pressure $\leq P_2$ (MPa)	Design temperature $\leq T_2$ (°C)	Design pressure $\leq P_1$ (MPa)	Design temperature $\leq T_1$ (°C)
Steam	> 1.6	or > 300	≤ 1.6	and ≤ 300	≤ 0.7	and ≤ 170
Thermal oil	> 1.6	or > 300	≤ 1.6	and ≤ 300	≤ 0.7	and ≤ 150
Fuel oil, lub-oil, flammable hydraulic oil	> 1.6	or > 150	≤ 1.6	and ≤ 150	≤ 0.7	and ≤ 60
Other media	> 4.0	or > 300	≤ 4.0	and ≤ 300	≤ 1.6	and ≤ 200

Notes:

① For Class I piping, one parameter for design pressure and design temperature of Class I specified in the Table is to be met; ~~For Class II piping, one parameter for design pressure and design temperature of Class II specified in the Table is to be met;~~ ~~F~~for Class II or Class III piping, ~~two parameters are not to exceed the provisions of Class III the Table.~~ both the parameters for design pressure and design temperature specified in the Table are to be met.

② Toxic or corrosive media, flammable media heated above flash point or with flash point below 60°C media and liquefied gas belong to class I. If means of special safeguards for preventing leakage and its consequences are provided (e.g. pipes led in positions where leakage of internal fluids will not cause a potential hazard or damage to surrounding areas which may include the use of pipe ducts, shielding, screening etc.), they may also belong to class II, but except toxic media.

③ Cargo pipes belong to class III.

④ Class III pipes may be used for open ended piping, e.g. drains, overflows, vents boiler waste steam pipes, etc.

⑤ Other media mean air, gases, water, and non-flammable hydraulic oil~~.~~ and urea for the selective catalytic reduction (SCR) system (when the piping material is selected according to ISO 18611-3:2014), etc.; in addition, the oxygen and acetylene piping is to be Class I piping (except for discharge pipes with openings).
⑥ Thermal oil means the circulating oil used in the thermal oil system as specified in Section 8, Chapter 4 of this PART.

Section 5 CONNECTION OF PIPE LENGTHS, HEAT TREATMENT AND NON-DESTRUCTIVE TESTING

2.5.1 Connection of pipe lengths

2.5.1.2 The application of the aforesaid types of connection is as follows:
(1) Welded butt-joints and slip-on sleeve welded joints are to comply with the requirements specified in Table 2.5.1.2(1).

Connection of pipe length **Table 2.5.1.2(1)**

Type of connection	Allowed for classes	Allowed for outside diameter
Butt welded joints with special provision for a high quality of root side	I, II, III	No restriction
Butt welded joints without special provision for a high quality of root side	II, III	
Slip-on sleeve welded joints	III	
	I, II, except for piping systems conveying toxic media where fatigue, severe erosion or crevice corrosion is expected to occur	$D \leq 88.9$ mm

(1) Slip-on threaded joints are to comply with requirements of a recognized standard. Slip-on threaded joints may be used for outside diameters as stated below except for piping systems conveying toxic or flammable media or services where fatigue, severe erosion or crevice corrosion is expected to occur. Slip-on threaded joints with outside diameters of maximum 25mm may be used for connecting small bore instrumentation equipment (e.g., pressure/temperature sensors) to piping systems conveying flammable media. Threaded joints in CO_2 systems are to be allowed only inside protected spaces and in CO_2 cylinder rooms.

① Threaded joints for direct connectors of pipe lengths with tapered thread may be allowed for Class I, outside diameter not more than 33.7 mm as well as Class II and Class III, outside diameter not more than 60.3 mm.

② Threaded joints for parallel thread may be allowed for Class III, outside diameter not more than 60.3 mm.

③ In particular cases, sizes in excess of those mentioned above may be accepted if they satisfy the requirements of recognized international or national standards.

2.5.3 Mechanical joints

Application of mechanical joints depending upon the class of piping **Table 2.5.3.1(3)**

Types of joints	Classes of piping system		
	Class I	Class II	Class III
Pipe unions			
Welded and brazed type	× ($D_0 \leq$ 60.3 mm)	× ($D_0 \leq$ 60.3 mm)	×
Compression couplings			
Swage type	×	×	×
Bite typ	× ~~($D_0 \leq$ 60.3 mm)~~	× ~~($D_0 \leq$ 60.3 mm)~~	×
Typical Compression Type	× ~~($D_0 \leq$ 60.3 mm)~~	× ~~($D_0 \leq$ 60.3 mm)~~	×
Flared type	× ~~($D_0 \leq$ 60.3 mm)~~	× ~~($D_0 \leq$ 60.3 mm)~~	×
Press type	–	–	×
Slip-on joints			
Machine grooved type	×	×	×
Grip type	–	×	×

Slip type	–	×	×

Notes:
× Application is allowed.
– Application is not allowed.
D_0 Outside diameter of the pipe.

Section 7 TESTS

2.7.3 Testing after assembly on board

2.7.3.1 All piping systems are to be checked for leakage under working conditions.

2.7.3.2 Liquid ~~F~~fuel ~~(oil or gas)~~ piping, heating coils in tanks, bilge pipes in way of double bottom tanks or deep tanks and hydraulic piping are to be tested by hydraulic pressure in accordance with Table 2.7.3.2.

Hydraulic tests after assembly on board **Table 2.7.3.2**

Piping system	Test pressure
Liquid ~~F~~fuel ~~(oil or gas)~~ piping	1.5 times design pressure, but not less than 0.4 MPa
Heating coils in tanks	
Bilge pipes in way of double bottom tanks or deep tanks	Not less than test pressure of the tank
Hydraulic piping	1.25 times design pressure, but no need to exceed design pressure plus 7 MPa

2.7.3.3 Where Classes I and II pipes are butt welded together during assembly on board, they are to be tested by hydraulic pressure in accordance with the requirements of 2.7.1.1 to 2.7.1.4 after welding. During installation and before the hydraulic test is carried out, the pipe lengths may be insulated, except in way of the joints.

2.7.3.4 The hydraulic test required in 2.7.3.3 of this Section may be omitted provided non-destructive tests by ultrasonic or radiographic methods are carried out on the entire circumference of all butt welds with satisfactory results.

2.7.3.5 Pneumatic leak testing may be carried out on water sensitive systems, in lieu of hydrostatic testing. In certain circumstances, a combined hydrostatic – pneumatic strength test may also be applied, where the system is partially filled with water and the free space above is pressurized with a test gas (typically air or nitrogen). When pneumatic tests cannot be avoided, the sufficient safety precautions are to be taken.

Appendix 3 TYPE APPROVAL OF MECHANICAL JOINTS

1.5 Testing, procedures and requirements

Test Procedures of Mechanical Joints **Table 1.5.1**

Tests		Types of Mechanical Joints			Notes and references
		Compression couplings and pipes unions	Slip-on joints		
			Grip type & slip type machined grooved type	Slip type	
1	Tightness test	×	×	×	1.5.5(1)
2	Vibration (fatigue) test	×	×	–	1.5.5(2)
3	Pressure pulsation test①	×	×	–	1.5.5(3)
4	Burst pressure test	×	×	×	1.5.5(4)
5	Pull-out test	×	×	–	1.5.5(5)
6	Fire endurance test	×	×	×	1.5.5(6), if required by 2.5.3.7 of this Chapter
7	Vacuum test	×③	×	×	1.5.5(7), for suction lines only
8	Repeated assembly test	×②	×	–	1.5.5(8)

Abbreviations: × test is required
– test is not required

Notes:

① For use in all Class I and II systems and those Class III systems where pressure pulsation other than water hammer is expected.

② Except permanent joint type (e.g., press and swage type). ~~press type and swage type.~~

③ Except joints with metal-to-metal tightening surface.

CHAPTER 4 MACHINERY PIPING SYSTEMS

Section 9 REQUIREMENTS CONCERNING USE OF CRUDE OIL OR SLOPS AS FUEL FOR TANKER BOILERS

4.9.1 General requirements

4.9.1.1 The requirements of this section apply to tankers where crude oil or slops are used as fuel for boilers.When the flash point of the fuel is lower than 60℃, the relevant provisions in SOLAS II-1/55,56 and 57 are to be complied with as a priority.

4.9.1.~~1~~2 In tankers crude oil or slops may be used as fuel for main or auxiliary boilers according to the following requirements. For this purpose all arrangement drawings of a crude oil installation with pipeline layout and safety equipment are to be submitted for approval in each case.

4.9.1.~~2~~3 Crude oil or slops may be taken directly from cargo tanks or flow slop tanks or from other suitable tanks. These tanks are to be fitted in the cargo tank area and are to be separated from non-gas-dangerous areas by means of cofferdams with gas-tight bulkheads.

4.9.1.~~3~~4 The construction and workmanship of the boilers and burners are to be proved to be satisfactory in operation with crude oil.

The whole surface of the boilers is to be gas-tight separated from the engine room. The boilers are to be tested for gas-tightness before being used. The whole system of pumps, strainers, separators and heaters, if any, is to be fitted in the cargo pump room or in another room, to be considered as dangerous, and separated from engine and boiler room by gas-tight bulkheads. When crude oil is heated by steam or hot water the outlet of the heating coils is to be led to a separate observation tank installed together with above mentioned components. This closed tank is to be fitted with a venting pipe led to the atmosphere in a safe position according to the provisions for tankers and with the outlet fitted with a suitable flameproof wire gauze of corrosion resistant material which is to be easily removable for cleaning.

4.9.1.~~4~~5 Electric, internal combustion and steam (when the steam temperature is higher than 220℃) prime movers of driving pumps, of separators (if any) are to be fitted in the engine room or in another non-dangerous room.

Where drive shafts pass through pump room bulkhead or deck plating, gas-tight glands are to be fitted. The glands are to be efficiently lubricated from outside the pump room.

4.9.1.~~5~~6 Pumps are to be fitted with a pressure relief by-pass from delivery to suction side and it is to be possible to stop them by a remote control placed in a position near the boiler fronts or machinery control room and from outside the engine room.

4.9.1.~~6~~7 When it is necessary to preheat crude oil or slops, their temperature is to be automatically controlled and a high temperature alarm is to be fitted.

CHAPTER 9 DIESEL ENGINES

Section 5 STARTING ARRANGEMENTS

9.5.1.2 Where the main engine is arranged for starting by compressed air, two or more air compressors are to be fitted. At least one of the compressors is to be driven independent of the main propulsion unit. The capacity of one of the said independently driven compressors or the combined capacity of independently driven compressors is not to be less than 50% of the total required. ~~and is to have the capacity not less than 50% of the total required.~~

The total capacity of air compressors is to be sufficient to supply within one hour the quantity of air needed to satisfy 9.5.1.6 by charging the receivers from atmospheric pressure. The capacity is to be approximately equally divided between the number of compressors fitted, excluding an emergency compressor which may be installed to satisfy the requirements of 9.5.1.1.

Appendix 1 SAFETY OF ~~LOW PRESSURE~~ GAS FUEL ENGINES

[]

1 General Requirements

1.1 Application and scope

1.1.1 This Appendix applies to ~~trunk piston~~ marine reciprocating ~~low pressure gas fuel~~ engines supplied with natural gas as fuel. This appendix also applies to engines using similar fuels with main component methane such as bio-methane or synthetic methane. This Appendix only specifies relevant requirements for the use of natural gas fuel, and in addition, gas fuel engines are to comply with relevant provisions of this Chapter. It is to be ensured by the gas supply system that the gas supplied to the engine is always in gaseous state. This Appendix does not cover requirements for liquid or cryogenic gas. The engines can be dual fuel engines (hereinafter referred to as DF engines), gas fuel only engines (hereinafter referred to as GF engines), or any variations thereof including fuel sharing capability. DF engines and GF engines may not be permitted for emergency applications.

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

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

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

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

~~(2) mixed with air before the turbo-charger ("pre-mixed engines").~~

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

~~1.1.5 This Appendix covers the following applications, but is not limited to:~~

~~(1) mechanical propulsion;~~

~~(2) generating sets intended for main propulsion and auxiliary applications;~~
~~(3) single engine or multi-engine installations.~~

1.2 Definitions

(1) Certified safe type means electrical equipment that is certified by an independent national testing institution or a competent authority and complies with the recognized standards for electrical equipment in hazardous areas. ~~in accordance with the recommendation published by the International Electrotechnical Commission (IEC), in particular publication IEC 60092-502, or with recognized standards at least equivalent. The certification of electrical equipment is to correspond to the category and group for methane gas.~~

Note: Refer to IEC 60079 series, Explosive gases; IEC 60092-502:1999 Electrical installations in ships -Part 502: Tankers - Special features.

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

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

~~(4) Engine room is a machinery space or enclosure containing gas fuelled engine(s).~~Explosion relief device means a device to protect personnel and component against a determined overpressure in the event of a gas explosion. The device may be a valve, a rupture disc or other, as applicable.

(5) Gas means natural gas used as fuel consisting primarily of methane. ~~a fluid having a vapour pressure exceeding 0.28MPa absolute at a temperature of 37.8°C.~~

Note: Gas may also be bio-methane or synthetic methane etc. with methane as main component.

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

(7) Gas fuel engine means ~~either~~ a gas fuel only engine, ~~or~~ a dual fuel engine~~.~~ or any variations thereof.

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

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

(10) ~~Gas Valve Unit (GVU) is a set of manual shutoff valves, actuated shut-off and venting valves, gas pressure sensors and transmitters, gas temperature sensors and transmitters, gas pressure control valve and gas filter used to control the gas supply to each gas consumer. It also includes a connection for inert gas purging.~~High pressure gas means gas with a maximum working pressure greater than 1.0MPa.

(11) IGC Code means the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, ~~(~~as amended~~. by IMO Resolutions MSC.370(93), MSC.411(97) and MSC.411(99)).~~

(12) IMO means the International Maritime Organisation.

(13) IGF Code means the International Code of Safety for Ships Using Gases or other Low-Flashpoint Fuels (IMO Resolution MSC.391(95), as amended~~ by IMO Resolution MSC.422(98)~~).

(14) Low pressure gas means gas with a maximum working pressure lower or equal ~~up~~ to 1.0 MPa.

(15) Lower Heating Value ("LHV") means the amount of heat produced from the complete combustion of a specific amount of fuel, excluding latent heat of vaporization of water.

(16) Methane Number is a measure of resistance of a gas fuel to knock, which is assigned to a test fuel based upon operation in knock testing unit at the same standard knock intensity.

Note: Pure methane is used as the knock resistant reference fuel, that is, methane number of pure methane is 100, and pure hydrogen is used as the knock sensitive reference fuel, methane number of pure hydrogen is 0.

(17) Pilot fuel means the fuel oil that is injected into the cylinder to ignite the main gas-air mixture on DF engines.

(18) Pre-mixed engine means an engine where gas is supplied in a mixture with air through a common manifold for all cylinders, e.g. mixed before or after the turbocharger.

(19) Recognized standards means applicable international or national standards acceptable to CCS or standards laid down and maintained by an organisation which complies with the standards

adopted by IMO and which are recognized by the Classification Society.
(20) Safety Concept is a document describing the safety philosophy with regard to gas as fuel. It describes how risks associated with this type of fuel are controlled under reasonably foreseeable abnormal conditions as well as possible failure scenarios and their control measures. The results of the risk analysis, see 1.4, are to be reflected in the safety concept.
Note: A detailed evaluation regarding the hazard potential of injury from a possible explosion is to be carried out and reflected in the safety concept of the engine.

1.3 Plans and documents

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

No.	Plans and documents
(1)	Schematic layout or other equivalent documents of gas system on the engine
(2)	Gas piping system (including double-walled arrangement where applicable)
(3)	Parts for gas admission system②
(4)	Arrangement of explosion relief valves (crankcase①, charge air manifold, exhaust gas manifold and exhaust gas system on the engine) 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~~ (only for DF engine)
(7)	Shielding of high pressure fuel pipes for pilot fuel system, assembly (only for DF engine)
(8)	High pressure parts for pilot fuel oil injection system②(only for DF engine)
(9)	Schematic layout or other equivalent documents of the i~~I~~gnition system (only for GF engine)
Note: ① If required by 9.1.12 of this Chapter and 2.2.5.1 of this Appendix~~, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships~~. ② The documentation to contain specification of design pressures, working pressure, pipe dimensions and materials.	

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

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

1.4 Risk analysis

1.4.1 The risk analysis is to address:
(1) a failure or malfunction of any system or component involved in the gas operation of the engine;
(2) a gas leakage downstream of the double block and bleed valves ~~gas valve unit~~;
(3) the safety of the engine in case of emergency shutdown or blackout, when running on gas;
(4) the inter-actions between the gas fuel system and the engine.
Note: With regard to the scope of the risk analysis it shall 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~~ IEC 31010: 2019 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 gas in components or locations not designed for such purpose, and/or
② to ignition, fire or explosion.
(2) Evaluate the consequences (see 2.1.2 of this Appendix).
(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 gas-related systems or components, in particular gas piping and its enclosure, where provided and gas admission valves ~~cylinder gas supply valves~~. Failures of the gas supply components not located directly on the engine, such as block-and-bleed valves and other components of the gas supply system ~~Gas Valve Unit (GVU)~~, are not to be considered in the analysis;
(2) failure of the ignition system (oil fuel pilot injection for DF engines, ~~or~~ sparking plugs, glow plugs for GF engines);
(3) failure of the air to fuel ratio control system (charge air by-pass, gas pressure control valve, etc.);
(4) for engines where gas is supplied ~~injected~~ upstream of the turbocharger compressor, failure of a component likely to result in a source of ignition (hot spots);
(5) failure of the gas combustion or abnormal combustion (misfiring, knocking);
(6) failure of the engine monitoring, control and safety systems;
Note: Where engines incorporate electronic control systems, a failure mode and effects analysis (FMEA) is to be carried out in accordance with 9.1.12.2(23) and Note 5 of this Chapter~~, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships~~.
(7) ~~abnormal~~ presence of gas in engine components (e.g. air inlet manifold or scavenge space and exhaust manifold ~~of DF or GF engines~~) and in the external systems connected to the engines (e.g. exhaust duct,cooling water system, hydraulic oil system, etc.);
(8) changes of operating modes for DF engines, including fuel oil mode, gas fuel mode and other working mode;
(9) hazard potential for crankcase fuel gas accumulation, for ~~engines where the space below the piston is in direct communication with the crankcase~~ trunk piston engines, refer to 7.2.1.6 of CCS Rules for Ships Using Natural Gas Fuels and Section 7 of this Chapter.
(10) risk of crankcase explosion in connection with active crankcase ventilation which produces a flow of external air into the crankcase.

2 Design Requirements

2.1 General principles

2.1.1 The manufacturer is to declare the allowable gas composition limits for the engine and the minimum and (if applicable) maximum methane number.
2.1.2 Components containing or likely to contain gas are to be designed to:
(1) minimise the risk of fire and explosion so as to demonstrate an appropriate level of safety commensurate with that of an oil-fuelled engine;
(2) mitigate the consequences of a possible explosion to a level providing a tolerable degree of residual risk, due to the strength of the component(s) to withstand the overpressure due to the ignition of leaked gas in the most severe condition or the fitting of suitable ~~pressure~~ explosion relief devices of an approved type.
The strength of the component(s) of arrangement of explosion relief devices is to be documented (e.g., as part of risk analysis) or otherwise demonstrated to be sufficient for a worst-case explosion.
Also refer to ~~7.1.2~~Section 1 and Section 2, Chapter 7 of CCS Rules for Ships Using Natural Gas Fuels.
~~Note:~~

①2.1.3 Discharge from ~~pressure~~ explosion relief devices is to prevent the passage of flame to the machinery space and be arranged such that the discharge does not endanger personnel or damage other engine components or systems.
②2.1.4 Relief devices are to be fitted with a flame arrester.

2.2 Design requirements

2.2.1 For gas carriers, engine-mounted gas piping is to be designed and manufactured in accordance with 5.1 to 5.9 of Chapter 5 and Chapter 16 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk. For ships other than gas carriers, the piping is to be designed in accordance with the criteria for gas piping (design pressure, wall thickness, materials, piping fabrication and joining details etc.) as given in Chapter 3 of CCS Rules for Ships Using Natural Gas Fuels. Requirements for pipe class are as follows:
(1)All single walled or high-pressure gas pipes are to be considered as Class I.
(2)Low pressure double walled gas pipes are to be considered as Class II.
(3)All secondary enclosures for gas pipes are to be considered as Class II.
(4)Single walled gas vent pipes, if permitted, are to be considered as Class I, except it is justified that the maximum built up pressure is less than 5 bar gauge, in which case it is to be considered as Class II.
(5)Gas vent pipes protected by a secondary enclosure are to be considered as Class II.
(6)Secondary enclosure for vent pipes is to be considered as Class III.

Design pressure for gas pipes Table 1

	Design pressure	
Gas pipe, low pressure	See 3.2.3.1 of CCS Rules for Ships Using Natural Gas Fuels	See 5.4.1 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk
Gas pipe, high pressure	See 3.2.3.1 of CCS Rules for Ships Using Natural Gas Fuels	See 5.4.1 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk
Out pipe, low pressure	See 6.4.1.3 of CCS Rules for Ships Using Natural Gas Fuels	See 5.4.4 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk
Out pipe, high pressure	See 6.4.1.3 of CCS Rules for Ships Using Natural Gas Fuels	See 5.4.4 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk
Open ended pipes	See 3.2.3.2 of CCS Rules for Ships Using Natural Gas Fuels	See 5.4.1 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk

Flexible bellows used in the fuel gas system on the engine are to be approved based on the requirements of 13.7.2 of CCS Rules for Ships Using Natural Gas Fuels, and 5.13.1.2 of Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, as applicable.
The number of cycles, pressure, temperature, axial movement, rotational movement and transverse movement which the bellow will encounter in actual service on the engine are to be specified by the engine designer.
Endurance against high cycle fatigue due to vibration loads is to be verified by testing or alternatively be documented by the Expansion Joint Manufacturers Association, Inc. (EJMA) calculation or equivalent (i.e., more than 10^7 cycles).
Note: The fatigue test due to ship deformations in 13.7.2.4 of CCS Rules for Ships Using Natural Gas Fuels is considered not relevant for bellows which are an integral part of the engine.

2.2.2 Arrangement of the gas piping system on the engine
(1) Pipes and equipment containing fuel gas are defined as hazardous area Zone 0 (refer to 9.2.2.1 of CCS Rules for Ships Using Natural Gas Fuels).

(2) The space between the gas fuel piping and the wall of the outer pipe or duct is defined as hazardous area Zone 1 (refer to 9.2.2.2(6) of CCS Rules for Ships Using Natural Gas Fuels).
(3) For gas carriers, the gas fuel piping system on the engine is to be arranged in accordance with 16.4.3 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk. For ships other than gas carriers, the piping is to be arranged in accordance with the principles and requirements of 6.4.1.1 and 6.4.1.2 of CCS Rules for Ships Using Natural Gas Fuels.
The double pipe or duct is to be designed in accordance with 3.3.1.4, 6.4.1.3 and 6.4.1.4 of CCS Rules for Ships Using Natural Gas Fuels.
In case of a ventilated double wall, for gas carriers, the ventilation inlet is to be arranged in accordance with 16.4.3.2 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk. For ships other than gas carriers, the ventilation inlet is to be arranged in accordance with 10.6.1.3 of CCS Rules for Ships Using Natural Gas Fuels.
The pipe or duct is to be pressure tested at 1.5 × design pressure ~~in accordance with 2.7.1, Chapter 2, PART THREE of CCS Rules for Classification of Sea-going Steel Ships~~ to ensure gas tight integrity and to show that it can withstand the expected maximum pressure at gas pipe rupture.
(4) Single walled gas piping is only acceptable:
① for engines supplied with low pressure gas and installed in ESD protected machinery spaces, as defined in 2.3.1.1(2) of CCS Rules for Ships Using Natural Gas Fuels and in compliance with other relevant requirements of CCS Rules for Ships Using Natural Gas Fuels (e.g. 2.3.3);
② in the case as per 6.4.1.2(1) of CCS Rules for Ships Using Natural Gas Fuels.
For gas carriers, the requirements of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk apply.
In case of gas leakage in an ESD-protected machinery space, which would result in the shutdown of the engine(s) in that space, a sufficient propulsion and manoeuvring capability including essential and safety systems is to be maintained. Therefore the safety concept of the engine is to clearly indicate application of the “double wall” or “alternative” arrangement.
Note: The minimum power to be maintained is to be assessed on a case-by-case basis from the operational characteristics of the ship.

2.2.3 Charge air system and exhaust gas system on the engine

(1) The charge air system and exhaust gas system on the engine are ~~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 explosion ~~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 rupture ~~bursting~~ disk).

2.2.4 ~~Exhaust system on the engine~~

~~(1) The exhaust gas system on the engine is to be designed in accordance with 2.1.2 above.~~
~~(2) In case of a single engine installation, the engine is to be capable of operating at sufficient load to maintain power to essential consumers after opening of the pressure relief devices caused by an explosion event. Sufficient power for propulsion capability is to be maintained.~~ Continuous relief of exhaust gas (through open rupture disc) into the engine room or other enclosed spaces is not acceptable.
Suitable explosion relief system for air inlet manifolds, scavenge spaces and exhaust system is to be provided unless designed to accommodate the worst-case overpressure due to ignited gas leaks or justified by the safety concept of the engine. A detailed evaluation regarding the hazard potential of overpressure in air inlet manifolds, scavenge spaces and exhaust system is to be carried out and reflected in the safety concept of the engine.
Explosion relief devices for air inlet and exhaust manifold are to be type approved.
The necessary total relief area and the arrangement of the explosion relief devices are to be determined taking into account:
- The worst-case explosion pressure depending on initial pressure and gas concentration,
- the volume and geometry of the component, and
- the strength of the component.
The arrangement is to be determined in the risk analysis (see 1.4.4(7)) and reflected in the safety concept.

2.2.5 Protection of crankcase

(1) Crankcase explosion relief valves are to be installed in accordance with 9.7.4 of this Chapter~~, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships~~. Refer also to 7.2.1.6 of CCS Rules for Ships Using Natural Gas Fuels. For engines not covered by 9.7.4 of this Chapter, the detailed evaluation as required in 1.4.4(7) of this Appendix is to determine if crankcase explosion relief valves are necessary.

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

(3) Ventilation of crankcase (either supply or extraction), if arranged, is to comply with 10.3.1 of CCS Rules for Ships Using Natural Gas Fuels. Relevant evidence is to be documented in Safety Concept. The ventilation systems for crankcase, sump and other similar engine spaces are to be independent from the systems on the other engines.

2.2.6 With regard to gas ignition in the cylinder, for gas carriers, the requirements of 16.7 of CCS Rules for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk apply; for ships other than gas carriers, the requirements of Section 2 of Chapter 7 of CCS Rules for Ships Using Natural Gas Fuels apply.

2.2.7 Control, monitoring, alarm and safety systems

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

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

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

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

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

(6) Unless the risk analysis required by 1.4 of this Appendix proves otherwise, the monitoring and safety system functions for DF or GF engines are to be provided in accordance with Table ~~1~~2 of this Appendix in addition to the general monitoring and safety system functions given by the ~~CCS~~ Rules ~~for Classification of Sea-going Steel Ships~~.

Note: For DF engines, Table 2 ~~1~~ applies only to the gas mode.

Monitoring and Safety System Functions for Gas Fuel Engines Table 2 ~~1~~

Parameter	Alarm	Automatic activation of the double block-and bleed valves	Automatic switching over to oil fuel mode①	Engine shutdown
Abnormal pressures in the gas fuel supply line	×	×	×	×⑤
Gas fuel supply systems - malfunction	×	×	×	×⑤
Pilot fuel injection or spark ignition systems - malfunction	×	×②	×	×②⑤
Exhaust gas temperature after each cylinder - high	×	×②	×	×②⑤
Exhaust gas temperature after each cylinder, deviation from average – low③	×	×②	×	×②⑤
Cylinder pressure or ignition - failure, including misfiring, knocking and unstable combustion	×	×②④	×④	×②④⑤
Oil mist concentration in crankcase or bearing temperature⑥ - high	×	×		×⑨
Pressure in the crankcase – high ~~④~~⑧	×	×	×	
Engine stops - any cause	×	×		
Failure of the control-actuating medium of the block and bleed	×	×	×	

valves				
Failure of crankcase ventilation system, if applicable	×	×⑦	×⑦	

Symbol: × Applicable

Note:

① DF engine only, when running in gas mode.

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

③ Required only if necessary for the detection of misfiring.

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

⑤ GF engine only.

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

⑦ Automatic safety actions to be activated as specified by the engine manufacturer, see 9.7.6 of this Chapter.

⑧ Only for trunk piston engines. This pressure sensor cannot replace or substitute a gas detector.

⑨ Only for trunk piston engines. For crosshead engines slow down is to apply (see Table 3.10.1.1, Chapter 3, PART SEVEN of the Rules).

2.2.8 Electrically operated g~~G~~as admission valves are to be certified safe as follows:

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

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

(3) When the valve is arranged without enclosure in accordance with the "ESD-protected machinery space" (see 2.2.2(4)) concept, no certification is required for the outside of the valve, provided that the valve is de-energized upon gas detection in the space.

However, if they are not rated for the zone they are intended for, it is to be documented that they are suitable for that zone. Documentation and analysis are ~~is~~ to be based on IEC 60079-10-1 or IEC 60092-502.

Gas admission valves operated by hydraulic oil system are to be provided with sealing arrangement to prevent gas from entering the hydraulic oil system.

3 Specific Design Requirements

3.1 DF Engines

3.1.1 The maximum continuous power that a DF engine can develop in gas mode may be lower than the approved MCR of the engine (i.e. in oil fuel mode), depending in particular on the gas composition and its quality or the engine design. This maximum continuous power available in gas 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 gas mode of DF 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, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships~~.

3.1.2 DF engines are to be arranged to be started using ~~use~~ either oil fuel or gas fuel ~~for the main fuel charge and~~ with pilot oil fuel for ignition. The engines are to be arranged for rapid changeover from gas use to fuel oil use. In the case of changeover to either fuel supply, the engines are to be capable of continuous operation using the alternative fuel supply without interruption to the power supply.

Changeover to gas fuel operation is to be only possible at a power level and under conditions where it can be done with acceptable reliability and safety as demonstrated through testing.

Changeover from gas fuel operation mode to oil fuel operation mode is to be possible at all situations and power levels.

The changeover process itself from and to gas operation is to be automatic but manual interruption is to be possible in all cases.

If the power level or other conditions do not allow safe and reliable gas operation, changeover to oil fuel mode is to be automatically performed.

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

3.1.3 Gas supply to the combustion chamber is not to be possible without operation of the pilot oil injection.
Note: Pilot injection is to be monitored for example by fuel oil pressure and combustion parameters.

3.2 GF Engines

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

3.3 Pre-Mixed Engines

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

3.4 Two-stroke engines

3.4.1 The risk analysis required in 1.4 is to cover the possible gas accumulation in a scavenge space.
3.4.2 The risk analysis required in 1.4 is to cover the possible failure of a piston rod stuffing box.

4 Type Testing, Factory Acceptance Tests and Shipboard Trials

4.1 Type Testing

4.1.1 Type approval of DF and GF engines is to be carried out in accordance with 9.10.1 and 9.10.2 of this Chapter~~, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships~~, taking into account the additional requirements below.
4.1.2 In addition to the criteria given in 9.1.2.1(1) of this Chapter~~, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships~~, the type of engine is defined by the following:
(1) gas admission method (~~direct~~ cylinder injection after compression stroke, cylinder individual injection before compression stroke ~~charge air space~~ or pre-mixed);
(2) gas admission ~~supply~~ valve operation (mechanical or electronically controlled);
(3) ignition system (pilot injection, spark ignition, glow plug or gas self-ignition);
(4) ignition system (mechanical or electronically controlled).
Note: Cylinder-individual injection before compression stroke may be port injection into the air inlet channel before the cylinder inlet valve, injection into the cylinder before or during compression stroke, or similar arrangements.
4.1.3 In addition to the safety precautions mentioned in 1.2, Appendix 4 of this Chapter~~, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships~~, measures to verify that gas fuel piping on engine is gas tight are to be carried out prior to start-up of the engine.
4.1.4 The type testing of the engine is to be carried out in accordance with 1.3, Appendix 4 of this Chapter~~, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships~~, taking into account the additional requirements of this section.
~~For DF engines, the load tests are to be carried out in gas mode at the different percentages of the maximum power available in gas mode (see 3.1.1 of this Appendix).~~
The influence of the methane number and LHV of the fuel gas is not required to be verified during the Stage B type tests. It is however to be justified by the engine designer through internal tests or calculations and documented in the type approval test report.
4.1.5 In addition to the measurements and records required in 1.4, Appendix 4 of this Chapter~~, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships~~, the following engine data are to be measured and recorded:
(1) Each fuel index for gas and diesel as applicable (or equivalent reading).
(2) Gas pressure and temperature at the inlet of the gas manifold.
(3) Pilot fuel temperature and pressure (supply or common rail as appropriate).
(~~3~~4) Gas concentration in the crankcase.

Note: The gas concentration in the crankcase is normally to be measured inside the crankcase or at the crankcase outlet (crankcase vent pipe).

Gas concentration measurements may be carried out as part of Stage A if the method and the results are properly documented.

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

4.1.6 Stage A – internal tests. In addition to internal tests required in 2.1, Appendix 4 of this Chapter~~, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships~~, the following conditions are to be tested:

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

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

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

(4)The influence of the methane number and LHV of the fuel gas on the engine's maximum continuous power available in gas mode is to be verified.

4.1.7 Stage B – witnessed tests. Witnessed tests are to be carried out in accordance with 2.2, Appendix 4 of this Chapter~~, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships~~. The following requirements are to be considered:

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

① All load points must be run in both gas and diesel modes that apply for the engine type as defined by the engine designer. ~~This also applies to the overspeed test.~~ The independent overspeed protection device has to be tested both in gas and diesel mode.

② ~~In case of DF~~ For engines with variable liquid / gas ratio, selected ~~the~~ load tests are to be carried out at different ratios between the minimum and the maximum allowable value~~s~~.(most relevant and critical loads and ratios should be selected for the test)

The maximum continuous power available in gas mode (see 3.1.1) is to be demonstrated. Overload testing is not required in gas mode for DF engines, provided that changeover to oil fuel mode is automatically performed in case of overload. For load tests of DF engines in gas mode, the test loads are taken as the different percentages of maximum continuous power in gas mode.

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

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

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

③ For DF engines, verification of automatic changeover to diesel mode when the load demand exceeds the maximum continuous power available in gas mode (see 3.1.1 and 3.1.2).

~~③~~④ The efficiency of the ventilation arrangement or other approved principal of the double walled gas piping system is to be verified.

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

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

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

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

Notes:

1. For DF engines, switchover to oil fuel during the test is acceptable.
2. Application of electrical load in more than 2 load steps can be permitted in the conditions stated in 9.7.10.1 of this Chapter~~, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships~~.

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

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

common system failure;

② Failure of a ~~cylinder~~ gas admission ~~supply~~ valve;

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

④ Abnormal gas pressure;

⑤ Abnormal gas temperature*.

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

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

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

(2) spark igniter (for GF engines);

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

4.1.9 Engine type approval certificate

For DF engines, the maximum continuous power available in gas mode is to be specified on the type approval certificate in addition to the maximum continuous rating in diesel mode if differing.

4.2 Factory acceptance test

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

For DF engines, the load tests referred to in 2.3, Appendix 6 of this Chapter~~, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships~~ are to be carried out in diesel mode and in gas mode at the different percentages of the engine's MCR.

Maximum continuous power available in gas mode is to be demonstrated (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~~, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships~~, measures to verify that gas fuel piping on engine is gas tight are to be carried out prior to start-up of the engine.

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

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

(2) Gas pressure and temperature;

(3) Pilot fuel temperature and pressure (supply or common rail as appropriate).

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

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

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

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

② Failure of a ~~cylinder~~ gas admission ~~supply~~ valve;

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

④ Abnormal gas pressure;

⑤ Abnormal gas temperature.

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

4.3 Shipboard trials

4.3.1 A leak test is to be carried out for the gas piping system after assembly on board.

4.3.~~1~~2 Shipboard trials are to be carried out in accordance with the provisions of Appendix 6 of this Chapter~~, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships~~, considering the additional requirements below.

(1) For DF engines, the test loads are to be carried out in all operating modes (gas mode, diesel mode, etc.), as applicable (see 3.1.1). The maximum continuous power available in gas mode is to be demonstrated.

Note: If a test load is performed in all applicable operation modes without interruption (direct changeover at same power and speed), the duration may be considered as the total duration demonstrated in all fuel modes. However, demonstration at each mode shall not be less than one hour.

(2)The starting maneuvers are to be carried out in diesel mode and gas mode, if applicable.

(3) For DF engines, automatic switching over to oil fuel mode is to be tested. Further, manual change over from diesel to gas mode and vice versa is to be tested.

(4) The efficiency of the ventilation arrangement, or other approved principle, of the double walled gas piping system is to be verified.

~~For DF engines, when load tests specified in 3.4, Appendix 6, Chapter 9, PART THREE of CCS Rules for Classification of Sea-going Steel Ships are carried out in gas mode, test loads are taken as each percentage of the maximum output power in gas mode (see 3.1.1 of this Appendix).~~

5 Certification of Engine Components

5.1 General requirements

5.1.1 Section 2 of this Chapter applies. In addition to those components specified in Table 9.2.2.1, the engine components listed in Table 3 are to be documented as listed in the table.

Required documentation for engine components Table 3

No.	Part	Material properties	Non destructive examination	Pressure testing	Visual inspection of welds	
1	Gas pipe Low-pressure double walled	W(CC+M)	W ②, ⑥	W④	VT	
2	Single walled Gas pipes	W(CC+M)	W ①	W④	VT	C
3	High-pressure gas pipes	W(CC+M)	W①	W④	VT	C
4	Secondary enclosure for gas pipes	W(CC+M)	W ②	W③	VT	
5	Gas pipe Low-pressure, Flanges *	W(CC+M)	W ②, ⑥		VT	
6	Gas pipe High-pressure, Flanges *	W(CC+M)	W ①		VT	C
7	Gas pipe Low-pressure, Fittings and other components	W(CC+M)		W④	VT	
8	Gas pipe High-pressure, Fittings and other components	W(CC+M)		W④	VT	C
9	Gas pipe Low-pressure Bodies of valves⑦	W(CC+M)		W④		
10	Gas pipe High-pressure Bodies of valves⑦	W(CC+M)		W④		C
11	Gas venting pipes and flanges*, build up pressure less than 5.0bar	TR(CC+M)	W②	W④	VT	

No.	Part	Material properties	Non destructive examination	Pressure testing	Visual inspection of welds	
12	Gas venting pipes and flanges*, build up pressure at 5.0bar or more with secondary enclosure	TR(CC+M)	W②	W④	VT	
12	Gas venting pipes and flanges*, build up pressure at 5.0bar or more	W(CC+M)	W①	W④	VT	C
13	Gas venting pipes Secondary enclosure			W⑤	VT	

Footnotes:
① 100 % radiographic or ultrasonic inspection of all butt-welded joints in accordance with CCS Rules for Materials and Welding
② 10 % radiographic or ultrasonic inspection of butt-welded joints in accordance with CCS Rules for Materials and Welding
③ Pressure test at 1.5 × design pressure to ensure gas tight integrity, not less than the expected maximum pressure at gas pipe rupture
④ Pressure test at 1.5 × design pressure
⑤ Leak test.
⑥ If inside diameter > 75 mm or wall thickness > 10 mm: 100 % radiographic or ultrasonic inspection of all butt-welded joints in accordance with CCS Rules for Materials and Welding
⑦ If nominal diameter > 25 mm
⑧ (*) “Flanges” limited to the final connection to the engine.

CHAPTER 11 SHAFTING AND PROPELLERS

Section 3 SHAFT TRANSMISSION UNITS

11.3.6 Transmission devices for controllable pitch propeller

11.3.6.17 The pitch control system of CP propellers for main propulsion is to be tested and recorded in accordance with the following requirements, in order to demonstrate that the propelling thrust is not significantly altered when transferring control from one location to another and in case of failures in the control system, and that the pitch response times measured during the test do not exceed the maximum value.

(1) A full range of pitch response tests is to be carried out to get the pitch response and verify that it coincides with the combinator curve of the propeller. The tests are to be carried out for at least three positions of the control lever in ahead and astern directions (e.g., dead slow ahead / astern, half ahead / astern, full ahead / astern). The tests are to be carried out in normal and emergency operating conditions. Tests that are not affected by the control position may be carried out from one control position only.

(2) A test of the fail-to-safe characteristics of the propeller pitch control system is to be carried out to demonstrate that failures in the pitch command and control or feedback signals are alarmed and do not cause any change of thrust. Such failures are to be clearly identified and included in the test procedure.

(3) The test is to record: Position of the control handle; Actual pitch indication (local indication, remote indications); Rotational speed of the propeller; Response time between the pitch change order (modification of the lever position) and the instant when the pitch and propeller speed have reached their final position; Propelling thrust variation during the transfer of the control from one location to another one.

(4) The test procedure, including the list of the parameters to be recorded and the maximum pitch response time, is to be prepared and submitted by the pitch control system manufacturer or integrator and agreed with CCS.

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PART FOUR

CONTENTS

APPENDIX 2 TYPE APPROVAL PROCEDURE FOR CABLE TRAYS/PROTECTIVE CASINGS MADE OF PLASTIC MATERIALS

2.4.1 Resistivity test

Cable trays/protective casings of plastic materials passing through a hazardous area are not to be electrically non-conductive and are to ensure satisfactory earthing between any point in these appliances and the ship's hull.

The volume resistivity level of the cable trays/protective casings and fittings is to be below $10^5 \Omega m$ and the surface resistivity is to be below ~~10^6~~$10^8 \Omega$. The cable trays/protective casings are to be tested in accordance with IEC62631-3-1 and IEC62631-3-2.

~~The resistance to earth from any point in these appliances is not to exceed 10^6 Ω.~~

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PART SIX

CONTENTS

CHAPTER 3 FIRE SAFETY MEASURES

Section 4 MISCELLANEOUS

3.4.5 Reinforced thickness of ballast and cargo oil piping

3.4.5.1 Ballast piping passing through cargo tanks and cargo oil pipes passing through segregated ballast tanks, as defined by regulation 19.3.6 of MARPOL Annex I, are to comply with the following requirements:

(1) The pipes are to be of heavy gauge steel of minimum wall thickness according to Table 3.4.5.1 hereunder with welded or heavy flanged joints① the number of which is to be kept to a minimum.

(2) Expansion bends② only ~~(not glands)~~ are permitted in these lines within cargo tanks for serving the ballast tanks and within the ballast tanks for serving the cargo tanks.

Minimum Wall Thickness of Pipes **Table 3.4.5.1**

Nominal diameter (mm)	Minimum wall thickness (mm)
50	6.3
100	8.6
125	9.5
150	11.0
200 and above	12.5

① Heavy flanges joints means welded flange joints rated at least PN10 or one pressure rating higher than required design pressure, whichever is greater.

② Expansion bends means expansion loops such as an omega bend ('Ω') in piping system to counteract excessive stresses or displacement caused by thermal expansion or hull deformation which could be fabricated from straight lengths of pipe.

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PART SEVEN

CONTENTS

CHAPTER 2 BASIC REQUIREMENTS

Section 8 MAIN PROPULSION MACHINERY REMOTELY CONTROLLED FROM NAVIGATION BRIDGE

2.8.1.13 The bridge control of main steam turbines is to comply with the requirements in 3.2.3.2(1) of this PART. For attended machinery spaces, the slow turning device may be arranged to be operated manually.

CHAPTER 4 REQUIREMENTS FOR MACHINERY NOTATIONS OF CONSTANTLY ATTENDED MACHINERY SPACES

Section 3 REQUIREMENTS FOR AUTOMATION OF SHIPS WITH CLASS NOTATION BRC

4.3.2.5 ~~The bridge control of main steam turbines is to comply with the requirements in 3.2.3.2 of this PART. If the slow-turning device is arranged to be operated manually, automatic operation will not be required.~~

~~4.3.2.6~~ Alarms at the BCS:

(1) For the items to be alarmed at the BCS and the mode of alarms, see column 5 of Table 4.3.4.1 of this Section. Alarms indicating the faults in the machinery and electrical equipment as well as the automated control and monitoring systems are, in general, to be relayed to the BCS in the following modes: group alarms for the protective actions of safety systems; separate alarms; group alarms for serious faults and group alarms for general faults.

(2) The audible alarms at the BCS are permitted to be silenced after acknowledgment, but the visual alarms are to be extinguished only after the rectification of faults, and furthermore, the visual signals are to be capable of being clearly distinguishable before and after acknowledgment.

4.3.2.6~~7~~ If the main engine is remotely started from the bridge control station, the indicator is to be fitted on the bridge control station for the starting air pressure or voltage of starting storage batteries of main engines.

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PART EIGHT

CONTENTS

CHAPTER 2 ADDITIONAL REQUIREMENTS FOR LIVESTOCK CARRIERS

Section 1 GENERAL PROVISIONS

2.1.1 Application

2.1.1.1 This Chapter applies to livestock carriers.

2.1.1.2 Livestock carriers complying with the requirements of this Chapter are eligible for the assignment of the notation: Livestock Carrier.

2.1.1.3 In addition to the provisions of this Chapter, livestock carriers are to comply with the applicable requirements for livestock carriers in other chapters of the Rules, CCS Rules for Materials and Welding and relevant requirements of the flag State Administration (if any).

2.1.1.4 The corresponding requirements of this Chapter may be relaxed or waived with the consent of CCS for livestock carriers which are expected to operate for not more than 24 hours.

2.1.2 Definitions

2.1.2.1 Livestock carrier refers to a sea-going steel ship constructed or adapted and used solely for the carriage of livestock cargoes. Livestock includes sheep, cattle, horses(mules or donkeys), ~~and~~ pigs and camels, etc.

2.1.2.2 Secondary power source refers to the source of power which may supply independent power for livestock service systems if the main source of power is out of action.

2.1.3 Plans and documents

2.1.3.1 In addition to the plans and documents as specified in relevant chapters of the Rules, the following plans and documents are to be submitted for approval:

(1) Arrangement of access for people to livestock spaces;

(2~~1~~) Arrangement of livestock pens and passageways;

(3~~2~~) Constructions of livestock pens and passageways;

(4~~3~~) Diagram of storage and distribution systems for fodder and water;

(5~~4~~) Diagram of the water washing system;

(6~~5~~) Diagram of the sewage drainage and discharge system;

(7~~6~~) Arrangement of fire-fighting appliances in livestock spaces;

(8~~7~~) Diagram of secondary power source system;

(9~~8~~) Arrangement of secondary power sources spaces;

(10~~9~~) Piping diagram related to secondary power sources;

(11) Cargo securing manual (if applicable).

2.1.3.2 The following plans and documents are to be submitted for information in addition to the plans and documents provided in the relevant chapters of the Rules:

(1) Diagram of the ventilation system, with indication of the gross volume and calculations of air change rates of the enclosed spaces;

(2) Specifications of fire-fighting appliances;

(3) Estimation of fuel consumption of secondary source of power and estimation of time for restarting (restoration) of secondary source of power (if applicable).

Section 2 HULL STRUCTURE AND ARRANGEMENT

2.2.1 Hull structure

2.2.1.1 The structure of livestock carriers is to comply with the relevant requirements of Chapter 2, PART TWO of the Rules.

2.2.1.2 Where superstructure deck is strength deck (contributing to the longitudinal strength), the thickness of deck plating, excluding that of the forecastle, is to comply with the requirements of 2.17.5.4 in Chapter 2 of PART TWO and the buckling strength requirements in respect to longitudinal strength of Section 2, Chapter 2 of PART TWO, but not less than 6 mm.

2.2.1.3 Where superstructure deck is strength deck (contributing to the longitudinal strength), the

framing of superstructure deck is to comply with the relevant requirements of Section 8, Chapter 2 of PART TWO and the buckling strength requirements in respect to longitudinal strength of Section 2, Chapter 2 of PART TWO.

2.2.2 Livestock arrangement and protection of livestock

2.2.2.1 The livestock is to be kept in pens. The dimensions of these pens are to be suitable for the livestock carried and are to comply with the requirements in this Section ~~Table 2.2.3.5~~.

2.2.2.2 Arrangements for livestock are to protect livestock from injury, avoidable suffering and exposure to weather and sea.~~Arrangements for protecting the livestock from injury, avoidable suffering and exposure to weather, sea or heat source are to be provided.~~

2.2.2.3 On a ship, livestock, livestock structures, livestock equipment and arrangements for the carriage of livestock are not to: ~~Livestock may not be carried or loaded for carriage on or in any part of a ship where the livestock, livestock fittings, livestock equipment or arrangements may:~~

(1) obstruct access to any accommodation space or working space necessary for the safe operation ~~running~~ of the ship, or the means of egress from any hold or underdeck space;

(2) interfere with operation and running of life-saving or fire-fighting appliances;

(3) interfere with arrangement and operation of the tank or bilge sounding equipment ~~or bilge pumping~~;

(4) interfere with the operation of closing appliances;

(5) interfere with the operation of freeing ports;

(6) interfere with the lighting or ventilation of other parts of the ships;

(7) interfere with the proper navigation of the ship.

2.2.2.4 If the casing or bulkhead of an engine room, boiler room or heated fuel tank forms the boundary of a space in which livestock is to be carried, appropriate heat insulation is to be provided.

2.2.2.5 The following measures are to be taken to avoid hurt to livestock from exposed steel structure during the movement of livestock:

(1) protective boards are to be fitted on both sides of upper and lower passageways;

(2) protective boards are to be fitted on pens adjacent to the bulkhead with stiffeners or similar structures.

~~**2.2.3 Livestock pen, means of access for livestock and livestock deck**~~

~~2.2.3.1 A ramp or other suitable means of access appropriate to the species, is to be provided for the loading or unloading of livestock. It is to be so erected as to prevent any gap occurring between it and the ship and is to be set at a gradient suitable for the species to be loaded or unloaded.~~

~~2.2.3.2 A means of access is to be fitted with:~~

~~(1) side panels free of protrusions and of sufficient strength and height to prevent escape of livestock;~~

~~(2) a walking surface of battens suitable for the species; and~~

~~(3) a closing arrangement.~~

~~2.2.3.3 If a means of access is part of the ship's equipment, it is to be designed to support a uniformly distributed load over the walking surface not less than the values specified in Table 2.2.3.3.~~

~~**Table 2.2.3.3**~~

~~**Species**~~	~~**Load (N/m^2)**~~
~~Cattle and horses~~	~~4700~~
~~Sheep, goats and pigs~~	~~2400~~

~~2.2.3.4 The permissible tensile stress for material used in the construction of a means of access is specified in Table 2.2.3.4.~~

~~**Table 2.2.3.4**~~

~~**Material**~~	~~**Permissible tensile strength**~~
~~Steel~~	~~$R_{eH}/2$~~
~~Aluminum~~	~~$R_{p0.2}/2$~~
~~Other~~	~~To be specially considered by CCS~~

2.2.3.5 Livestock pen and means of access for livestock are to comply with the requirements of Table 2.2.3.5.

Limits for pens and passageways of sheep and pigs Table 2.2.3.5(1)

Maximum breadth	4.5 m
Minimum breadth	2.0 m
Maximum length	Not more than twice the breadth
Minimum length	Not less than the breadth
Maximum clear floor area within pen	40.5 m^2
Minimum clear height within pen	1.1 m
Maximum clear vertical distance between rails	0.3 m
Maximum clear vertical distance below bottom edge of lowest rail of pen installed at deck level	0.2 m
Maximum clear vertical distance below bottom edge of lowest rail of pen not installed at deck level	0.05 m
Minimum height of top edge of uppermost rail above pen floor	0.9 m
Minimum width of adjacent passageway clear of receptacles and any other obstructions	0.55 m

Limits for pens and passageways of cattle Table 2.2.3.5(2)

Maximum breadth	4.5 m
Minimum breadth	2.1 m
Minimum length	2.3 m
Maximum clear floor area within pen	21 m^2
Maximum height of top edge of lowest rail above pen floor between pens	0.6 m
Minimum clear height within pen	1.8 m if a mechanical ventilation system is provided 2.3 m in any other case
Minimum width of adjacent passageway, measured clear between rails, when pens are on both sides of the passageway and cattle are loaded and discharged through the pens	1.0 m
Minimum width of adjacent passageway, measured clear of any fixed structure, fittings, receptacles or obstruction (eg pillars, feed chutes, fixed fodder or water troughs), when pens are on both sides of the passageway and cattle are loaded and discharged through the pens	0.7 m
Minimum width of adjacent passageway, measured clear of any fixed obstructions, when pens are on both sides of the passageway and cattle are loaded and discharged through the passageway	1.0 m
Minimum width of adjacent passageway measured clear from rails, when pens are on one side only of the passageway	0.75 m

Limits for stalls, pens and passageways of horses Table 2.2.3.5(3)

Maximum clear length within stall		2.5 m
Minimum clear length within stall		2.3 m
Minimum clear passage	(1) between 2 rows of stalls and bounded by the front rails	1.7 m
	(2) between 2 rows of stalls and bounded by front and back rails	1.2 m
	(3) in any other case	1.0 m
Minimum clear breadth within stall	(1) if the stall is aligned athwartships	0.7 m
	(2) if the stall is aligned fore and aft	0.9 m
Height of uppermost front, back and side rail from floor to top edge		1.15 m
Height of lowest front, back and side rail from floor to top edge		0.75 m

Note: Pens dedicated for the carriage of other livestock are to be submitted to CCS for special consideration.

2.2.3.6 Livestock pens are to be designed based on the load determined by the application of the following formula:

$$F = \alpha b\left[0.574 + 0.0252\left(Z + \gamma\right)\right] \text{ N/m}$$

where: α = coefficient, taken as 1668 for sheep or pigs and 3336 for cattle or horses;
b = maximum breadth of pen, in m;

~~*Z* — the vertical distance from the ship's minimum draught water-line to the pen floor;~~
~~*y* — coefficient, taken as 0.5 for sheep or pigs and 0.75 for cattle or horses.~~
~~Load bearing areas are:~~
~~for sheep and pigs: uniformly distributed up to the rail the centre of which is at a height of not more than 0.9 m above the pen floor;~~
~~for cattle and horses: uniformly distributed up to the rail the centre of which is at a height of not more than 1.40 m above the pen floor.~~
~~2.2.3.7 Livestock pen floors or platforms are to be designed according to the following formula with the load uniformly distributed in any two-thirds of the area of the pen:~~

$$P = \beta\left[1 + ((0.094 - 0.00035L)y + (7.4 - 0.016L))/d\right]$$ ~~N/m²~~

~~where: β — coefficient, taken as 2500 for sheep or pigs and 5000 for cattle or horses;~~
~~*d* — minimum draught of the ship, in m;~~
~~*y* — longitudinal distance from the midpoint of the pen to amidships, in m;~~
~~*L* — length between the perpendiculars of the ship, in m.~~

~~2.2.4 Means of egress and access for persons~~

~~2.2.4.1 Each space in which livestock is carried is to be provided with no fewer than two means of egress widely separated and giving access to an open deck.~~
~~2.2.4.2 Access to a livestock space for persons is to be safe and, if combined with a ramp used for moving livestock between decks, is to be separated from the livestock ramp by protective fencing.~~
~~2.2.4.3 A pen, stall or similar fitting is to be provided with a means of access for persons with a secure closing arrangement having a structural strength equivalent to the strength of that part of the pen, stall or fitting.~~
~~2.2.4.4 If access is required between a vessel's side and a pen, stall or similar fitting for the purposes of the safe and proper operation of the vessel, a passageway is to be provided that has a clear width of not less than 750 mm between the vessel's rail or bulwark and the rails or receptacles of the pen, stall or fitting, except that obstructions outside the pen rails may reduce the passageway measured from the vessel's rail to 550 mm.~~
~~2.2.4.5 Where it is necessary for persons to be on a means of access during the movement of livestock, a passage of not less than 550 mm width is to be provided, which is to be:~~
~~(1) fenced to a height of not less than 1 m and with an intermediate horizontal rail approximately 550 mm above the walking surface; and~~
~~(2) fitted with treads at suitable stepping distances.~~
~~2.2.4.6 The passageways in spaces for the carriage of livestock are to have a minimum clear height of 2.0 m.~~

2.2.3 Means of egress and access for people to livestock spaces

2.2.3.1 In a ship, there are to be at least 2 exits from each space where livestock is carried. The exits are to be widely separated and give access to an open deck.
2.2.3.2 If a person uses access on a ramp that is used for loading livestock onto the ship:
(1) there is to be protective fencing separating the person access from the livestock access that :
① is at least 1 m high; and
② has an intermediate horizontal rail at least 500 mm and not more than 600 mm above the walking surface; and
(2) the passageway is to be at least 550 mm wide and be fitted with treads at a suitable stepping distance.
2.2.3.3 A pen, stall or similar structure for the containment of livestock is to have a means of access for people, with a secure closing arrangement. The closing arrangement is to have a structural strength that corresponds to the strength of the part of the pen, stall or structure to which it connects.
2.2.3.4 The passageway between the ship's rail or bulwark and the rails of the pen, stall or structure is to be at least 750 mm wide . However, the passageway width may be reduced to less than 750 mm, but no less than 550 mm, by obstructions outside the pen rails such as receptacles, pipework or other objects for the provision of livestock services.
2.2.3.5 A passageway or walkway in a livestock area is to have a clear height of at least 2m.

2.2.4 Access for livestock to and from the ship

2.2.4.1 For loading livestock onto the ship or unloading livestock from the ship, there is to be a ramp or other means of access suitable for the species. Downward sloping ramps are not considered suitable for camels when loading into a livestock space.

2.2.4.2 The ramp or other means of access is to:

(1) be load tested every 5 years and such tests are to comply with the requirements of 2.2.13;

(2) be set up so that there is no gap between it and the ship at any time the ramp is in use; and

(3) have an arrangement to close it off either at the top or the bottom:

① for livestock such as sheep, pigs or goats, the closing arrangement is to be a gate capable of being quickly closed;

② for cattle, horses or camels, the closing arrangement is to be a sliding gate capable of being quickly closed; and

③ for all species, the closing arrangement is to be positioned close to or at the entry point to the ship.

(4) for the species mentioned in Table 2.2.5.1, the ramp is to meet the requirements of this table;

(5) for species other than those mentioned in Table 2.2.5.1, the ramp is to:

① be set at a gradient suitable for the species to be loaded or unloaded;

② be fitted with side panels that are free of protrusions and strong and high enough to prevent escape of livestock; and

③ be fitted with a non-slip walking surface with battens suitable for the species.

2.2.4.3 A camel may be loaded onto a ship or unloaded from a ship with a camel harness. There is to be a clear height of no less than 2.4 m in any area of a ship that is used for access for camels.

2.2.4.4 Any ramp or other means of access that is part of the ship's equipment is to be designed to support a uniformly distributed load as given in Table 2.2.4.4.

Table 2.2.4.4

Species	Load(N/m^2)
Cattle, horses and camels	4700
Sheep, goats and pigs	2400

2.2.4.5 The permissible stress for material used in the construction of a ramp or other means of access is given in Table 2.2.4.5.

Table 2.2.4.5

Material	Permissible stress
Steel	$0.5R_{eH}$
Aluminium	$0.5R_{p0.2}$
Other	Subject to special consideration of CCS

Notes: R_{eH} — yield strength;

$R_{p0.2}$ — strength at the non-proportional elongation being 0.2% of the original gauge length.

2.2.5 Ramp for moving livestock between decks, pens or stalls

2.2.5.1 Any ramp on which livestock is moved between decks is to comply with the requirements of Table 2.2.5.1:

Table 2.2.5.1

Item	Requirement	Sheep, pigs and goats	Cattle	Horses
1	Gradient	≤1:2	≤1:2	≤1:2
2	Clear width	≥550mm	≥750mm	≥750mm
3	Height of sides measured perpendicular to ramp floor	≥900mm	≥1.4m	≥2m
4	Sides panelled or sheathed —	—	≥1.2m	≥2m

	height of sides measured perpendicular to ramp floor			
5	Sides free from protrusions	Yes	Yes	Yes
6	Foot battens	Yes	Yes	Yes
7	Foot battens — height	≥25mm	≥50mm	≥50mm
8	Foot battens — width	≥10mm	≥25mm	≥25mm
9	Foot battens — well rounded edges	Yes	Yes	Yes
10	Spacing between foot battens	≤300mm	≤300mm	≤300mm
11	Distance from top or bottom end of ramp to first foot batten	≤100mm	≤200mm	≤200mm

2.2.5.2 A ramp for moving cattle between decks is to have a personnel ramp beside it that:
(1) is at least 500mm wide;
(2) has a guard rail 1m high on the side away from the cattle ramp;
(3) has access at each deck to avoid personnel having to cross the cattle race; and
(4) has foot battens or a non-skid surface.

2.2.5.3 The means of closing livestock access to a pen or stall could be a sliding or swinging gate or portable rails. The means is to:
(1) maintain continuity of strength and the alignment of the adjoining boundary; and
(2) be secured against accidental lifting or removal.
2.2.5.4 If pens or stalls are on an exposed deck, the uppermost pens or stalls on each deck are to be fitted with a roof that:
(1) ensures compliance with the minimum clear height requirement of pens or stalls for the species to be carried;
(2) is waterproof; and
(3) extends at least 450 mm beyond the deck area occupied by the pens or stalls.
2.2.5.5 Any pens or stalls for livestock that are at the forward end of a livestock structure, on or above the uppermost continuous deck, and their feeding and watering equipment, are to be screened effectively from sea spray, and protected, in any sea condition, from seawater entering any part of the pens, stalls or feeding and watering equipment.

2.2.6 Construction of pens for sheep, pigs and goats

2.2.6.1 The construction of pens for sheep, pigs and goats is to comply with the requirements in Table 2.2.6.1.

Table 2.2.6.1

Item	Detail of design	Dimension
1	Maximum breadth of pen	4.5m
2	Minimum breadth of pen	2.0m
3	Maximum length of pen	Not more than twice the breadth
4	Minimum length of pen	Not less than the breadth
5	Maximum clear floor area within pen	40.5m^2
6	Minimum clear height within pen	If a mechanical ventilation system is provided: 1.8m In any other case: 2.3m
7	Maximum clear vertical distance between rails	300mm
8	Maximum clear vertical distance between bottom edge of lowest rail of pen and deck level	200mm
9	Maximum clear vertical distance between bottom edge of lowest rail of upper pen and bottom of pen, unless a vertical plate or board is fitted in accordance with 2.2.7.2	50mm
10	Minimum height of top edge of uppermost rail above pen floor for sheep and pigs (900 mm, or less if the clear height above the uppermost rail is less than 300 mm)	900mm

11	Minimum width of adjacent passageway clear of receptacles and any other obstructions	550mm

Notes:
(1) For item 5, the clear floor area is the area of the pen excluding fixed receptacles, other objects or structures in the pen, but including fodder storage area that meets storage requirement.
(2) For an open structure above the weather deck, if pen rails or gates form the outer perimeter containment:
① the space between the bottom edge of the lowest rail and the deck is not to be more than 100 mm;
② the space between the rails above the bottom rail is not to be more than 200 mm; and
③ the railing is to continue to a height that is no more than 200 mm below the overhead structure of the ship.
(3) The decks for pens, passageways and ramps between decks are to have a surface that provides a non-slip foothold for sheep.

2.2.6.2 Rails and stanchions that form the boundary of a sheep, pig or goat pen is to be able to withstand a load calculated using the following formula:

$$F = 1668\ B\ (0.574 + 0.0252\ Z) \quad \text{N/m}$$

where: F —boundary load, in N/m;
B—maximum breadth of the pen, in m;
Z—vertical distance from a point 0.5 m above the pen floor to the ship's waterline corresponding to the anticipated lightest load, in m.

Notes: (1) The approved stability booklet for the ship contains the information for the load calculation
(2) A rail the centre of which is more than 900 mm above the pen floor is not to be included in the load calculations.

2.2.6.3 Any two-thirds of the area of the floor of a sheep, pig or goat pen is to be able to withstand 100% of the floor load uniformly distributed over the area. The floor load is to be calculated according to the following formula:

$$F = 2500\ [1 + ((0.094 - 0.00035\ L)y + (7.4 - 0.016\ L))/d] \quad \text{N/m}^2$$

where: F—floor load, in N/m^2;
d—draught of the ship corresponding to the anticipated lightest loaded waterline, in m;
L—length between the perpendiculars of the ship, in m;
y— longitudinal distance from the midpoint of the pen to amidships, in m.
Note: The approved stability booklet for the ship contains the information for the load calculation.

~~2.2.3.8~~2.2.6.4 The permissible stress for a pen and pen area deck material is to meet the requirements in Table 2.2.6.4. ~~The permissible stresses of livestock pens and floors are given in Table 2.2.3.8.~~

Table ~~2.2.3.8~~2.2.6.4

Material	Permissible tensile stress	Permissible shear stress
Steel	$0.75R_{eH}$	$0.375R_{eH}$
Aluminium	$0.75R_{p0.2}$	$0.375R_{p0.2}$
Other	To be specially considered by CCS	To be specially considered by CCS

Notes: R_{eH} — yield strength;
$R_{p0.2}$ — strength at the non-proportional elongation being 0.2% of the original gauge length.

2.2.7 Additional requirements for pens, walkways and passageways for sheep, pigs and goats

2.2.7.1 There is to be a passageway on at least one side of each pen.
2.2.7.2 If a lower tiered pen has a water or food receptacle beside a passageway, the upper tiered pen above it is to have, fitted to the side adjoining the passageway, to prevent the fouling of food and water of livestock in lower tiers, a vertical plate or board which is at least 225 mm high.
2.2.7.3 If pens are constructed in more than 1 tier on a deck, walkways are to be provided so that

no pen floor is more than 1.5m above the deck or a walkway.

2.2.7.4 The following additional requirements apply to pens used for the carriage of goats:

(1)There are to be pen rails to a height of at least 1.5 m above the pen floor, or to a height where the clear height above the uppermost rail is less than 300mm;

(2) For any goat pen that is not on the upper tier of a 2 tier structure:

① the space between the rails is to be closed off to contain goats in the pen, and for example, wire mesh is considered to be an effective means of containment; and

② food and water receptacles are to be located inside the pen.

2.2.8 Design of pens and passageways for cattle

2.2.8.1 The dimensions of a pen for cattle and adjacent passageways are to comply with Table 2.2.8.1.

Table 2.2.8.1

Item	Detail of design	Dimension
1	Maximum breadth of pen	4.5m
2	Minimum breadth of pen	2.1m
3	Minimum length of pen	2.3m
4	Maximum clear floor area within pen	21m^2
5	Maximum height of top edge of lowest rail above pen floor between pens	600mm
6	Maximum height of top edge of lowest rail above pen floor in boundaries of pen other than between pens	300mm
7	Maximum distance between 2 adjacent rails of pen	300mm
8	Maximum distance between top rail and overhead structure of the ship in open structures above the weather deck, where pen rails form the outer perimeter containment	300mm
9	Minimum clear height within pen:	If a mechanical ventilation system is provided: 1.8m In any other case: 2.3m
10	Minimum width of adjacent passageway, measured clear between rails, if pens are on both sides of the passageway and cattle are loaded and discharged through the pens	1.0m
11	Minimum width of adjacent passageway, measured clear of any fixed structures, receptacles or other obstructions, if pens are on both sides of the passageway and cattle are loaded and discharged through the pens	0.7m
12	Minimum width of adjacent passageway, measured clear of any fixed structures, receptacles or other obstructions, if pens are on both sides of the passageway and cattle are loaded and discharged through the passageway	1.0m

Note: For item 4, the clear floor area is the area of the pen excluding fixed receptacles, other objects or structures in the pen, but including fixed fodder file.

2.2.8.2 If a water or food receptacle is fitted to the outside of a pen, or fodder is distributed on the floor outside a pen, a clear vertical space of not more than 500 mm may be provided between adjacent pen rails on the side of the pen adjoining the passageway, for watering or feeding livestock in the pen.

2.2.8.3 The deck for cattle pens, passageways and ramps between decks are to have a surface that provides a non-slip foothold for cattle.

2.2.8.4 Rails and stanchions that form boundary of a cattle pen or stall are to be able to withstand a load calculated using the following formula:

$$F = 3336\ B\ (0.574 + 0.0252\ Z) \quad \text{N/m}$$

where: F—boundary load, in N/m;

B—maximum breadth of pen, in m;

Z—vertical distance from a point 0.75 m above the pen or stall floor to the ship's waterline corresponding to the anticipated lightest load, in m.

Notes: (1) The approved stability booklet for the ship contains the information for the load calculation.
(2)A rail the centre of which is more than 1.4 m above the pen or stall floor is not to be included in the load calculations.

2.2.8.5 Any two-thirds of the area of the floor of a cattle pen is to be able to withstand 100% of the floor load uniformly distributed over the area.The floor load is determined according to the following formula:

$$F = 5000\,[1 + ((0.094 - 0.00035\,L)y + (7.4 - 0.016\,L))/d] \quad N/m^2$$

where: *F*—floor load, in N/m^2 ;
d—draught of the ship corresponding to the anticipated lightest loaded waterline, in m;
L—length between the perpendiculars of the ship, in m;
y—longitudinal distance from the midpoint of the pen to amidships, in m.
Note: the approved stability booklet for the ship contains the information for the load calculation.

2.2.8.6 The above 2.2.8.4 and 2.2.8.5 apply to the floor support of a cattle pen whether or not it also forms the top boundary of a pen on a lower deck.
2.2.8.7 The floor of a cattle stall is to be of substantially the same method of construction and of substantially the same scantlings as required for a cattle pen.
2.2.8.8 The stresses for materials used in the construction of boundaries and floors of a cattle pen are to comply with the requirements of Table 2.2.6.4.
2.2.8.9 There is to be a passageway and a means of access to cattle pens for the care and removal of cattle.
2.2.8.10 There is to be a means of access at the rear of each stall.

2.2.9 Design of horse stalls and passageways

2.2.9.1 The dimensions of a stall for horses and adjacent passageways are to comply with Table 2.2.9.1.

Table 2.2.9.1

Item	Detail of design	Category	Dimension
1	Maximum clear length within stall		Horses, 2.5m; Mules or donkeys, 2.3m
2	Minimum clear length within stall		2.3m
3	Minimum clear width of passage:	Between 2 rows of stalls and bounded by the front rails	Horses, 1.7m; Mules or donkeys, 1.5m
		Between 2 rows of stalls and bounded by front and back rails	1.2m
		In any other case	1.0m
4	Minimum clear width within stall	If the stall is aligned athwartships	0.7m
		If the stall is aligned fore and aft	0.9m
5	Height of uppermost front, back and side rail from floor to top edge		1.15m
6	Height of lowest front, back and side rail from floor to top edge		0.75m

2.2.9.2 The rails and stanchions of a horse stall are to be constructed of materials that have a strength of at least that of heavy gauge tubular steel pipe with a 50 mm nominal bore.
2.2.9.3 The floor of a horse stall is to have the strength to withstand a load calculated in

accordance with 2.2.8.5.
2.2.9.4 A horse on a ship is to be in a separate stall.
2.2.9.5 There is to be a passageway at the front of each horse stall. There is to be a means of access to the rear of each horse.
2.2.9.6 The floor of a horse stall is to be constructed to facilitate drainage and cleaning.
2.2.9.7 If constructed of wood, the floor of a horse stall is to:
(1) have boards that are:
① close fitting at the front of the stall;
② spaced between 20 and 30 mm apart at the rear; and
③ secured against lifting
(2) have foot battens at the front and rear of the stall that:
① are at least 50 mm high;
② are at least 50 mm wide; and
③ have well rounded edges.
2.2.9.8 If constructed of concrete, the floor of a horse stall is to:
(1) have concrete that is finished off to provide a non-slip surface; and
(2) provide suitable standings.
2.2.9.9 If constructed of metal mesh, the floor of a horse stall is to:
(1) be made with rods with a diameter of between 8 and 10 mm;
(2) the rods are placed to provide openings of no more than 50 mm by 50 mm; and
(3) provide suitable standings.
2.2.9.10 A horse stall on an exposed deck is to:
(1) for a stall on an outer edge of the ship — have protective sheathing fitted on its outboard side; and
(2) for a stall the forward end of which is exposed — have protective sheathing fitted on its forward end.
2.2.9.11 The requirements for sheathing:
(1) may be portable if it can be fitted from outside a stall; and
(2) is to effectively screen the stall and its feeding and watering arrangements from sea spray; and
(3) is not to exclude natural ventilation.
2.2.9.12 If the back of a stall forms a boundary of a passageway or another stall, a kick rail or board is to be fitted to that end of the stall so that the clear space between rails, or rail and board, is not more than 150 mm.
2.2.9.13 The following measures are to be taken for restraint of a horse:
(1) The horse is to be fitted with a collar made of leather or other suitable material;
(2) Each stall is to have cross ties and suitable fastenings for use with the collar; and
(3) If the cross ties are made of chain, a set of bolt cutters that can cut the chain is to be carried onboard and kept readily available.

2.2.10 Design of camel pens and passageways

2.2.10.1 The dimensions of a pen for camels and adjacent passageways are to, in addition to the requirements of Table 2.2.8.1, also comply with the following requirements :
(1) the minimum clear height within the pen is to be at least 2.4 m; and
(2) if a water or food receptacle is fitted to the outside of the pen or feed is distributed on the floor outside the pen, there is to be a clear vertical space of at least 450mm and no more than 500 mm between 2 adjacent pen rails on the side of the pen adjoining the passageway.
2.2.10.2 If a camel pen has kickboards or is sheathed in mesh, the kickboards or mesh are to extend for at least 1 m above the pen floor to prevent camels from attacking people or chew parts of the ship, e.g. cabling or piping.
2.2.10.3 The structural strength requirements for camel pens are equivalent to those for cattle pens.
2.2.10.4 As camels are difficult to move around a ship, camel pens are to be located close to the entry point onto the ship.
2.2.10.5 Camel pens are tot be non-contiguous with pens carrying other livestock.
2.2.10.6 The camels in a pen are to be of a similar size and the same gender.

2.2.11 Requirements for carriage of other species of livestock

2.2.11.1 If livestock other than sheep, pigs, goats, cattle, horses or camels is to be carried:
(1) there are to be stalls or pens;
(2) the stalls or pens are to safely contain the livestock for the time of the voyage;
(3) the stalls or pens are to be constructed appropriately for the size, other characteristics and needs of the livestock and have arrangements to adequately feed, water and tend the livestock;
(4) other measures for the safety of the livestock, and of people near the livestock, are to be taken, in equivalence to the requirements of this Chapter; and
(5) there are to be appropriate hospital pens or stalls.

2.2.12 Hospital pens

2.2.12.1 A hospital pen is to comply with the following requirements:
(1) A hospital pen is to be clearly identified as a hospital pen;
(2) A hospital pen is to be constructed to the same standard as a pen for the species of livestock for which it is provided;
(3) Animals that are individually penned or stalled may be disregarded when calculating the number or area of hospital pens; and
(4) If a deck is divided into separate compartments by watertight doors, a hospital pen is to be provided in each compartment of the deck for each species carried in the compartment.
2.2.12.2 Hospital pens for sheep, pigs and goats:
(1) There are to be hospital pens equal in area to at least 0.25% of the pen area used for the carriage of sheep, pigs or goats;
(2) There is to be a hospital pen on each deck on which sheep, pigs or goats is carried; and
(3) If a hospital pen has a length and width not in accordance with Table 2.2.6.1, no side of the pen is to be less than 1.5 m long.
2.2.12.3 Hospital pens for cattle:
(1) There are to be hospital pens equal in area to at least 1% of the pen area used for the carriage of cattle;
(2) There is to be a hospital pen on each deck on which cattle are carried;
(3) However, if the pen area for the carriage of cattle on a deck is less than $500m^2$, the hospital pens may be sited on an adjacent deck above or below if they are easily accessible to cattle transferred from the other deck, and the transfer is not through a watertight opening; and
(4) If a hospital pen has a length and breadth not in accordance with Table 2.2.8.1, no side of the pen is to be less than 1.5 m long.

2.2.13 Testing of ramps for livestock

2.2.13.1 Ramps are to be tested in compliance with the designed operating requirements and according to the test loads specified in Table 2.2.13.1. The test procedures are to be subject to consent.

Table 2.2.13.1

Safe working load (kN)	Proof load (kN)
SWL≤196	1.25×SWL
196＜SWL≤490	SWL+49
SWL＞490	1.1×SWL

2.2.13.2 After testing, the ramp and its accessory gear are to be thoroughly examined for damage or permanent deformities.

Section 3 STABILITY

2.3.1 General requirements

2.3.1.1 The stability of livestock carriers is to comply with the requirements of this Section or relevant requirements of the flag State Administration.
2.3.1.2 The stability of livestock carriers is to comply with the requirements for cargo ships in Sections 9 and 10 of Chapter 1, PART TWO of the Rules.

2.3.2 Additional requirements for stability

2.3.2.1 The effects of the shift of livestock and fodder in pellet form (if any) and the effect of wind are to be taken into account for intact stability of livestock carriers. The following criteria are to be complied with for livestock carriers under intact condition:

(1) The angle of heel is not to exceed 10 degrees due to the effect of wind.

(2) The residual area A is to comply with the following requirements, taking into account the effects of the shift of livestock and fodder in pellet form and the effect of wind, as illustrated in Figure 2.3.2.1 below:

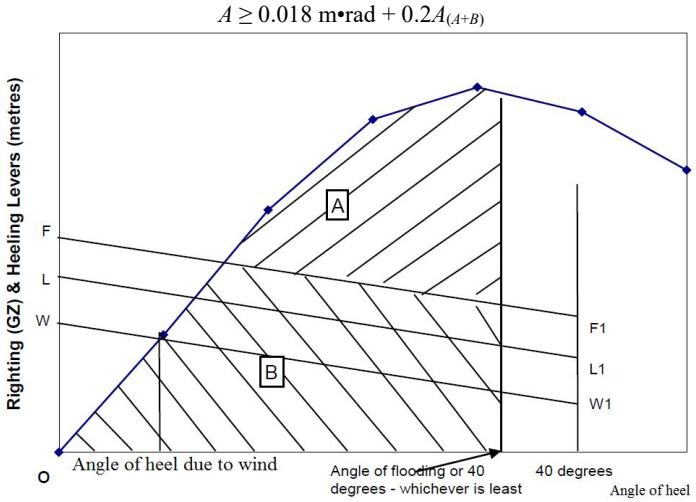

Figure 2.3.2.1 Rolling Criteria

where: $A_{(A+B)}$ is the sum of area A and area B under the righting lever curve, as illustrated in Figure 2.3.2.1.

Definitions in Figure 2.3.2.1 are as follows:

OW — the heeling lever at 0° due to wind;
WW_1 — the heeling lever curve due to wind;
WL — the heeling lever at 0° due to the shift of livestock;
LL_1 — the heeling lever curve due to the combined effects of wind and the shift of livestock;
LF — the heeling lever at 0° due to the effect of shift of fodder;
FF_1 — the heeling lever curve due to the combined effects of wind and the shift of livestock and fodder;
θ — the angle of heel due to wind.

Note: If fodder is not pellet feed carried in bulk, the heeling lever due to shift of fodder will be zero.

(3) The heeling lever due to the effect of wind is to be determined according to the following requirements:

① The heeling lever due to the effect of wind at 0° is to be given by $OW = \frac{PAH}{\Delta}$,

where: Δ — displacement, in t;
P — wind pressure, 504 pa;
A — lateral area of the vessel above the waterline, in m^2;
H —vertical distance between the centroid of the lateral area of the vessel above the waterline and the centroid of the vessel's underwater lateral area. For most vessels the vertical position of the centroid of the underwater lateral area may be taken as half the draft to the underside of the keel at amidships.

② The heeling lever due to the effect of wind at 40° is to be given by 0.8 (heeling lever due to the effect of wind at 0°).

③ The heeling lever curve is to be taken as a straight line joining the heeling lever at 0° and the heeling lever at 40°.

(4) The heeling lever due to the shift of livestock is to be determined according to the following requirements:

① The heeling lever due to the shift of livestock at 0ºis to be given by $\frac{m \cdot C}{f \cdot \Delta}$,

where: m — average mass of livestock to be carried on the intended voyage, in t;

f — floor area required per head of average mass of the livestock to be carried on the intended voyage, in m^2;

C — livestock shift constant, $C = \frac{1}{6}\sum lb^2$, where l is length of each pen, in m; b is breadth of each pen, in m. For vessels with uniform breadth of pens, the livestock vessel constant becomes: 1/6 (breadth of pen × total floor area of pens). For vessels with varying breadths of pens, the largest breadth may be used and the livestock shift constant becomes: 1/6 (maximum breadth of pen × total floor area of pens).

② The heeling lever due to the shift of livestock at 40° is to be given by 0.8 (heeling lever due to the shift of livestock at 0°).

③ The heeling lever curve is to be taken as a straight line joining the heeling lever at 0° and the heeling lever at 40°.

(5) The heeling lever due to the shift of fodder is to be determined according to the following requirements:

① The heeling lever due to the shift of fodder at 0° is to be given by $\frac{M_f}{s \cdot \Delta}$,

where: M_f — the sum of the shift moment of each compartment, where the shift moment of each compartment is to be given by 0.044 lb^3, where: l is the maximum length of the compartment; and b is the maximum breadth of the compartment, in m. The use of volumetric shift moments for the fodder, where the surface is assumed to take up an angle of slope of 15° to the horizontal for full compartments and 25° to the horizontal for partly filled compartments, is an acceptable alternative method to obtain the total shift moment of fodder;

s — stowage factor (the volume of fodder in pellet form per unit weight).

② The heeling lever due to the shift of fodder in pellet form carried in bulk at 40° is to be given by 0.8 (heeling lever due to the shift of fodder at 0°).

③ The heeling lever curve is to be taken as a straight line joining the heeling lever at 0° and the heeling lever at 40°.

Section 4 PROVISION OF LIVESTOCK SERVICES

2.4.1 General requirements

2.4.1.1 Facilities or systems providing daily services for livestock are to be fitted in livestock spaces and these facilities or systems intended for:

(1) the supply of food, water and fresh air to the livestock;

(2) the cleaning of the livestock spaces and accesses;

(3) the ~~draining~~ internal collection, disposal, storage and satisfactory outside discharging of the sewage ~~effluents~~ produced by the livestock.

2.4.1.2 In addition to the provisions of this Section, the piping is to comply with the applicable requirements of Chapter 2 and Chapter 3, PART THREE of the Rules.

2.4.2 Ventilation system

2.4.2.1 All spaces ~~An enclosed space~~ for the carriage of livestock, whether enclosed or not, are ~~is~~ to be provided with a mechanical ventilation system ~~of sufficient capacity to~~ that can change the total volume of air ~~of~~ in those ~~that~~ spaces in ~~its entire volume as follows~~ accordance with the requirements of Table 2.4.2.1.~~:~~

~~(1) if the minimum clear height of the space is 2.30 m or more, not less than 20 changes per hour;~~

~~(2) if the minimum clear height of the space is 1.80 m, not less than 30 changes per hour; and~~

~~(3) if the minimum clear height of the space is between 2.30 m and 1.80 m, at a rate proportional to~~

~~those specified above. This may be obtained by linear interpolation.~~
~~For the purposes of this paragraph, the volume of an enclosed space includes all that space contained between the vessel's side plating, bulkheads, tank top or decks enclosing the space, less the volume of any tanks or trunks that are airtight within the space and no deduction is to be made in respect of space occupied by livestock, pens or other livestock fittings.~~

Total volume of air Table 2.4.2.1

Item	Minimum clear height of the space (x)	Time within which complete air change must occur
1	x≤1.8m	at least every 2 minutes
2	x≥2.3m	at least every 3 minutes
3	1.8m<x<2.3m	proportionately between 2 and 3 minutes, specific time can be calculated by linear interpolation

~~2.4.2.2 A space for the carriage of livestock that is not enclosed is to be provided with a mechanical ventilation system if:~~
~~(1) the space, being a structure having an arrangement of pens on more than one deck level, has a breadth greater than 20 m; or~~
~~(2) because of a partial enclosure of the space, the natural ventilation is restricted.~~
~~The capacity of ventilation system is to comply with the requirements in paragraph 2.4.2.1.~~
~~The volume of a space that is not enclosed referred to in this paragraph includes all that space contained between the extremities of a pen structure including passageways on the outboard sides or ends of the structure, less the volume of any tanks or trunks that are airtight within the pen structure and no deduction is to be made in respect of space occupied by livestock, pens or other livestock fittings.~~

2.4.2.~~3~~2 A mechanical ventilation system is to distribute air so as to ensure that the whole of each livestock space is efficiently ventilated.

(1) For a livestock space, the following is to be ensured:

① the air is as clean and fresh as practicable; and

② there is minimal recirculation of intake and exhaust air.

Note: A vertical high velocity exhaust system may help prevent recirculation of exhaust and intake air.

(2) Exhaust air outlets are not to be sited near accommodation spaces, offices or air intakes on the ship.

(3) Ventilators serving livestock spaces are to remain in operation in all weather conditions.

~~2.4.2.4 Ventilation circuits are to be supplied by at least two independent fans of such a capacity as to maintain the ventilation of all the spaces as required by 2.4.2.1 and 2.4.2.2 with one fan out of action.~~
~~Notwithstanding the above provisions, if a mechanical ventilation system is provided with adequate spare parts, the provision of only one fan is acceptable. Adequate spare parts are to be interpreted as including for each type of fan: one set of bearings; one rotor or impeller; and one complete motor.~~

2.4.2.3 The redundancy of the mechanical ventilation system is to comply with the following requirements:

(1) If a mechanical ventilation system is fitted, the ship is to carry, for each type of fan in the system, either:

① spare fans; or

② spare parts, including:

(a) a complete electrical motor;

(b) a complete rotor or impeller;

(c) any other parts required for repair.

(2) If a mechanical ventilation system is fitted on a ship, fan starters should have at least 2 group starter panels.

(3) Each group starter panel is to be:

① located in a space that is not adjacent to a space where another group starter panel is located;

② supplied with power from both the main and secondary sources of power; and

③ interlocked to prevent simultaneous supply of power from both main and secondary sources.

2.4.2.~~5~~4 The ~~Electrical supplies from both~~ main and secondary sources of power are to be ~~supplied to each group starter panel, with both supplies being~~ as widely separated as practicable and neither passing through any space containing any part of the other source of power. ~~Interlocks~~

~~at each group starter are to prevent simultaneous supply by both sources of power.~~
~~2.4.2.6 If two or more independent fans are fitted in the ventilation piping of each space, fan group starter panels are to be located in at least two locations, with the operation of fans from either panel being able to effectively ventilate the required livestock spaces.~~
2.4.2.5 A ship is to have visual and audible alarms on the bridge to provide a warning as soon as there is a failure of any part of the ventilation system.

2.4.3 Fodder and ~~W~~water arrangements
2.4.3.1 Spaces intended for livestock (including pens, stalls or similar fittings) are to be provided with receptacles for feeding and watering the animals concerned.
2.4.3.2 The receptacles are to be capable of containing at least 33 per cent of the daily allowance of fodder and water for the number of animals contained in the space (pen, stall or similar fitting) except where the fodder or water is provided by an automatic system.
~~2.4.3.3 A receptacle provided in accordance with 2.4.3.1 and 2.4.3.2 above is to be:~~
~~(1) suitable for the species of livestock;~~
~~(2) readily accessible to the livestock;~~
~~(3) capable of being serviced from outside the pen, stall or other fitting;~~
~~(4) so installed as to not impede ventilation; and~~
~~(5) so constructed and positioned, that fodder dust is not disturbed by the flow of ventilation.~~
~~2.4.3.4 If the fodder distribution system is dependent on electric power, the system is to be capable of being powered by both the main and secondary sources of supply.~~
2.4.3.3 An animal's daily allowance for water and fodder is as follows:
(1) An animal's daily water allowance is:
① for cattle — 36 L per m^2 of pen area; and
② for sheep, pigs and goats — 6 L per head.
(2) An animal's daily fodder allowance is:
① for cattle — 5.7 kg per m^2 of pen area; and
② for sheep, pigs and goats — 4.8 kg per m^2 of pen area.
Note: Where not dry fodder is supplied, the allowance for water and fodder is to be estimated by the moisture content of the fodder.
2.4.3.4 The availability of water and fodder is to comply with the following requirements:
(1) Before livestock is loaded, automatic feeding and watering systems are to be turned on and capable of supplying water and fodder in accordance with 2.4.3.3.
(2) Water and fodder are to be provided to livestock within 12 hours after loading has commenced.
2.4.3.5 The distribution system for fodder is to be set up and comply with the following requirements:
(1) A ship is to have a storage and distribution system to provide fodder to livestock;
(2) If a fodder distribution system is powered electrically, it is to be able:
① to be powered by both the main and secondary sources of power; and
② to operate if a fire or other emergency occurs in the space containing the main source of power.
(3) Fodder stored in bulk on the ship is to be contained in at least 2 separate spaces.
(4) Fodder may be stored in an enclosed livestock space only if:
① the storage is consistent with the standards for ventilation, lighting and drainage; and
② it does not prevent compliance with the passageway requirements of Section 2 in this Chapter.
(5) The fodder, as a cargo unit, is to be loaded, stowed and secured in accordance with the Cargo Securing Manual.
2.4.3.6 Receptacles for fodder and water are to comply with the following requirements:
(1) Each pen is to have a receptacle for feeding livestock and a receptacle for watering livestock.
(2) However, a fodder receptacle is not required for a pen containing cattle if:
① the pen adjoins a passageway and the cattle can easily consume hay distributed on the floor of the passageway; and
② urine and faeces, or water used to wash pens, is prevented from fouling the passageway.
(3) A receptacle mentioned in (1) is to:
① be suitable for the species of livestock;

② be readily accessible to livestock;
③ be serviceable from outside the pen;
④ be installed so that it does not impede ventilation;
⑤ for adult sheep — be no more than 550 mm above the pen floor at the highest part of the receptacle; and
⑥ be constructed and positioned so that fodder dust is not disturbed by the ventilation flow.

(4) If a receptacle for water or fodder is inside a pen and is not portable, to minimise fouling of the receptacle, there is to be fitted a pipe or bar that:
① has an appropriate height for the species carried in the pen; and
② is at a horizontal distance from the edge of the receptacle of at least:
(a) for sheep — 75 mm; and
(b) for cattle — 150 mm.

2.4.4 Fresh water system

2.4.4.1 All livestock spaces are to be provided with fresh water service to provide fresh drinking water to livestock on board at all times. The water storage system is to have capacity for intended voyages. The water tanks for storage of drinking water for livestock are to maintain a sound condition to avoid water contamination.

2.4.4.2 The fresh water system is to include one main supply pump and one standby pump, of a capacity sufficient to continuously supply fresh water to the livestock.

When the water supply system is not automatic, the standby pump may be replaced by a portable pump ready to be connected to at least one fresh water tank.

The pumps are to comply with the following requirements:

(1) These pumps and the supply systems to which they connect are not to be configured for any purpose other than servicing the livestock water distribution system;

(2) At least 1 of the pumps is to be:
① located outside the space occupied by the main source of power; and
② able to maintain the distribution of water if there is any interruption to the main source of power

2.4.4.3 If the fresh water system is dependent on electric power, it is to be powered by both the main and secondary sources of power and can continue to operate by secondary sources of power if ~~despite~~ a fire or other casualty occurs in the space containing the main source of power. ~~One pump may be located in the space occupied by the main source of power and supplied by that source of power. The other is to be able to maintain supply despite a fire or other casualty affecting the space occupied by the main source of power.~~

2.4.4.4 When the water supply is automatic, water receptacles are to be fitted with means of automatic water level control and devices to avoid the return of water from the receptacle to the fresh water tank.

~~2.4.4.5 The fresh water system serving the livestock spaces is to be totally independent from the fresh water system serving the spaces intended for the crew.~~

2.4.4.5 Emergency water reserve is to comply with the following requirements:

(1) The ships that are undertaking a voyage of not more than 14 days are to have capacity for 3 days supply of emergency drinking water for livestock:

(2) The ships that are undertaking a voyage of more than 14 days are to have capacity for 7 days supply of emergency drinking water for livestock.

Note: Capacity is assessed based on the daily water allowance for the number and kinds of livestock on a voyage.

2.4.5 Water washing system

2.4.5.1 A water washing system is to be provided with appropriate connections to wash the livestock spaces and accesses (including ramps).

2.4.5.2 Livestock spaces and accesses (including ramps) are to be provided necessary auxiliary disinfection measures which can be used in conjunction with the water washing system.

2.4.5.3 Necessary auxiliary drying measures for the areas mentioned in 2.4.5.1 above are to be considered.

2.4.6 Drainage and discharge of sewage

2.4.6.1 Each space intended for the livestock is to be fitted with a pipe or gutter of sufficient size to drain the sewage and the washing effluents. The drainage system for livestock sewage is to be kept separate from, and not connected in any way to, the livestock drinking water system.

2.4.6.2 Drainage arrangements are to be such that fluids drained from a pen are as far as practicable kept clear of other pens and associated working and access spaces.

Where necessary, drainage gutters and upper parts of the draining pipes are to be covered by a strainer plate.

In addition, drainage pipelines are to be so arranged that the drainage system can still be used with the ship's trim by bow or stern.

~~2.4.6.3 The drainage system serving the livestock spaces is to be independent from any piping system serving the other spaces of the ship, and in particular from the bilge system.~~

2.4.6.~~4~~3 The pipes and other components of the draining system are to be made of a material resistant to the corrosion due to the effluents.

~~2.4.6.5 Essential drainage tanks, wells and the top of drainage pipes in a vessel are to be accessible from outside livestock pens for the purpose of inspection and cleaning.~~

2.4.6.~~6~~4 Pumps and ejectors serving the drainage tanks or wells are to be capable of conveying semi-solid matter~~.~~ and evacuating the tank or well by lines other than the ship's bilge lines.

2.4.6.~~7~~5 All electrical equipment involved in ~~fitted to meet the requirements of 2.4.6~~ the sewage drainage and discharge system of sewage are to be capable of being operated by both the primary and the secondary sources of power.

2.4.6.6 A ship is to have a means of effectively draining fluids from a pen where livestock is carried, under any expected conditions of trim by the head or by the stern, or of angle of heel to either side.

2.4.6.7 Drains are to comply with the following requirements:

(1) The ship is to have drains at each corner of a pen or group of pens as follows:

① for a ship with a beam of more than 20 m:

(a) at least 3 drains fitted athwartships; and

(b) for every 5 m that the beam of the ship exceeds 20 m — an additional drain.

② no more than 20 m apart longitudinally in each hold or livestock space;

③ for a drain that consists of pipes to the deck below, on a ship that carries livestock other than sheep or goats:

(a) pipes with an internal diameter of at least 300 mm; and

(b) an outlet that is at least 250 mm above the deck or well below.

(2) If a drain is inside a pen, it is to be protected so that:

① livestock cannot get their feet caught in the drain; and

② any protection does not prevent the flow of effluent.

2.4.6.8 For inspection and cleaning, the following things are to be accessible from outside livestock pens:

(1) drainage tanks;

(2) wells;

(3) the tops of drainage pipes.

2.4.7 Provision of humane killing device

2.4.7.1 For a ship carrying livestock, there is to be on board a humane killing device that is suitable for each species carried.

2.4.8 Additional requirements for the automatic system

2.4.8.1 If any part of the normal means of feeding and watering livestock on the ship is by an automatic system, there is to be an alternative arrangement for feeding and watering in case there is a malfunction of the automatic system.

Section 5 FIRE-FIGHTING APPLIANCES

2.5.1 Fire hydrants and fire hoses

2.5.1.1 The number and position of the hydrants are to be such that at least two jets of water not emanating from the same hydrant may reach any part of the spaces intended for the livestock. At least one of these jets is to be from a single length of hose without the necessity for hoses to pass over or through pens.
2.5.1.2 A fire hose is to be provided in an enclosed space for each hydrant and in any other space or on a deck for each 50 m length, or part thereof, of space or deck.
2.5.1.3 Each fire hose is to be provided with the necessary connections and a nozzle capable of directing water in the form of a spray and a jet.
2.5.1.4 Each hose is to be capable of being connected to any hydrant and to any other hose (other than hydrants and hoses within the engine room or accommodation spaces).
2.5.1.5 Fire hoses are to be located in conspicuous locations, near the hydrants and close to the entrances or access to the spaces.
2.5.1.6 The hydrants are to be connected to the ship's fire main.

2.5.2 Additional fire-fighting means
2.5.2.1 Livestock structures, including livestock decks and containment structures but excluding livestock services such as water pipes and feed troughs, are to be constructed of non-combustible materials.
2.5.2.2 If hay ~~or,~~ straw or bhusa is carried or used in a livestock space, one of the following fire-fighting means is to be provided:
(1) ~~a fixed water fire-fighting system, or~~ portable fire extinguishers:
① that use water as the extinguishing medium;
② with 1 extinguisher placed adjacent to an entrance to the space; and
③ with 1 extinguisher placed at least every 18 m of the space.
(2) ~~portable water extinguishers spaced not more than 18 m apart, one of which being positioned at the entrance of the space concerned.~~ an approved fire-fighting arrangement that uses water as the extinguishing medium.
2.5.2.3 Where electrical equipment other than that referred to in Section 6 of this Chapter is located in an enclosed livestock space, suitable fire-fighting means are to be provided in this respect~~.~~ as follows:
(1) portable fire extinguishers in sufficient numbers; or
(2) a fixed fire-fighting installation.
2.5.2.4 Notices are to be prominently displayed prohibiting smoking or the use of naked lights in livestock spaces and spaces used for storage of fodder, hay, straw, bhusa, bedding or other flammable material.

Section 6 ELECTRICAL EQUIPMENT

2.6.1 General requirements
2.6.1.1 In addition to the applicable requirements of PART FOUR of the Rules, electrical equipment of livestock carriers is to comply with the provisions of this Section.

2.6.2 Sources of electrical power for livestock carriers
2.6.2.1 The main source of power is to meet the following:
The main source of power as specified in 2.1.1.1 of Chapter 2, PART FOUR of the Rules is to be provided and all electrical ~~auxiliary~~ services (including livestock services) necessary for maintaining the livestock carrier in normal operational and habitable conditions will be ensured without recourse to the emergency source of electrical power.
2.6.2.2 The secondary source of power is to meet the following requirements:
(1) The secondary source of power is to be located in a space that is not contiguous with any space containing the main source of power or part thereof, and be independent of any services provided from or through any such space. In case of a fire or other casualty in any space containing the main source of power or any part thereof, the secondary source of power must be capable of supplying power to livestock services for a period of 72 h.
(2) The prime mover of secondary source of power is to be capable of supplying power to the system within 30 min in the failure of main source of power. The prime mover may be started by

an effective arrangement powered by an independent source of energy or the emergency source of power complying with the requirements of paragraphs 1.1, 1.4 and 2 of SOLAS regulation II-1/43.
(3) Instructions are to be provided for the changeover between main and secondary sources of power and vice-versa. A copy of such instructions is to be posted in the space containing the livestock source of power, and is to be readable under the emergency lighting required by SOLAS regulation II-1/43.2.2. The instructions are to detail, among other things, starting method, switchboard changeover and electrical supply changeover to livestock services.
(4) Cables of secondary source of power are to be kept away from cables of main source of power in so far as practicable and generally they do not pass through the same space.

2.6.3 Lighting

2.6.3.1 Livestock spaces, passageways between pens and access routes between or to those spaces are to be adequately lit.
2.6.3.2 An emergency lighting system that is automatically activated on the failure of the main electrical installation is to be provided in all parts of a vessel where livestock is carried, passageways between pens and access routes between or from those parts, and is to be capable of giving a level of illumination in all passageways and access routes for a continuous period of not less than 15 min. The lamp casings on light fittings for the emergency lighting system are to be painted red for ease of identification.
2.6.3.3 If fixed lighting is provided in a part of a vessel above the uppermost continuous deck, that lighting is to be capable of being controlled from the navigating bridge.
2.6.3.4 Light fittings is to be of sufficient strength and fitted with protective sheathing outside to resist damage by livestock and placed beyond possible contact by livestock.

2.6.4 Electrical equipment for use in dust laden atmospheres

2.6.4.1 Electrical equipment and cables installed in areas where flammable dusts may be present (such as spaces used for the storage or handling of bulk fodder) are to comply with the requirements of 2.18.3.2 of Chapter 2, PART FOUR of the Rules.
2.6.4.2 Lighting, or power points for portable lighting, in a space used for carriage of fodder in bulk, are to be controlled by switches situated on the navigating bridge or at the fodder-handling machinery control station and indicator lights are to be provided to show when power is supplied to the lighting or power points.

CHAPTER 38 ADDITIONAL REQUIREMENTS FOR WINDFARM SERVICE VESSELS

Section 1 GENERAL PROVISIONS

38.1.1 Scope of Application

38.1.1.1 This Chapter applies to vessels that provide support and guarantee services for the operation and maintenance of offshore wind farms.

38.1.1.2 In addition to the provisions of this Chapter, the design, construction and survey of windfarm service vessels are also to comply with other applicable chapters and PARTs of the Rules, the relevant provisions of CCS Rules for Materials and Welding, and the relevant requirements of the flag State Administrations (if any).

38.1.2 Class Notation

38.1.2.1 The class notation " Windfarm Service Vessel" may be assigned to the vessel that meets the provisions of this Chapter.

38.1.3 Personnel Transportation Methods and Functions

38.1.3.1 Windfarm service vessels are to adopt at least one of the following methods to transport the operation and maintenance personnel:

(1) Bow docking method

According to Section 2 of this Chapter, the bow of the vessel is to be equipped with fenders or the bow structure is to meet the strength check requirements, the operation and maintenance personnel are to be transported by the bow docking method.

(2) Gangway method

The vessel is to be equipped with a gangway that meets the requirements of Section 4 of this Chapter, and the gangway is to be used to transport operation and maintenance personnel.

38.1.3.2 The windfarm service vessels are to have the following functions:

(1) Amphibious functions in tidal flats

The bottom structure of the vessel is to meet the sitting requirements of Section 2 of this Chapter, and be able of conducting amphibious operations in tidal flats.

38.1.4 Definitions

38.1.4.1 Windfarm service vessel means a vessel engaged in offshore windfarm operation and maintenance, with the functions of carrying operation and maintenance personnel, operation and maintenance tools, operation and maintenance spare parts, etc.

38.1.4.2 Operation and maintenance personnel means the personnel engaged in offshore windfarm services, except the crew members serving the vessel.

38.1.5 Drawings and information

38.1.5.1 In addition to the drawing and information specified in the relevant chapters and PARTs of the Rules, the following applicable drawing and information are also to be submitted to CCS for approval:

(1) Arrangement of fenders;

(2) Foundation of gangway and the structure of connection to the hull;

(3) Electrical control system of gangway;

(4) Drawings including the field of view or video monitoring system in bridge room/dynamic positioning (DP) control room.

38.1.5.2 The following applicable drawings and information are to be submitted to CCS for information:

(1) Arrangement of gangway;

(2) Failure Mode and Failure Analysis (FMEA) report of gangway.

38.1.5.3 Special structures and arrangements, if CCS deems it necessary, may be required to increase the scope of submitted drawings and information for approval.

38.1.5.4 The operation manual for gangway is to be kept onboard for the use of the crew members, and the manual is to include the sufficient safety operational and technical requirements.

Section 2 HULL STRUCTURES

38.2.1 General Requirements

38.2.1.1 The hull structures are to comply with the applicable requirements of PART TWO of the Rules or other rules.

38.2.2 Bow docking

38.2.2.1 Where a vessel transfers personnel or equipment by a method of bow docking against wind turbine foundation, it is appropriate to install rubber fenders or equivalent energy absorbing fenders in the berthing area of the vessel.

38.2.2.2 The vessel is to be so docked against the wind turbine foundation to be able to safely contact and detach. The energy absorbed by the fenders under the working environmental load is to meet the following requirements:

$$E_f \le 0.6 \cdot E_{allow}$$

Where: $E_f = 0.5\Delta V_i^2 C_s C_m$, in kJ;

Δ —— displacement of vessel, in t;

V_i —— instantaneous relative velocity between the vessel and the wind turbine foundation during the docking operation, in m/s, not to be less than 0.6;

C_s ——hardness coefficient of fenders, to be taken as 1 for soft fenders and 0.9 for hard fenders;

C_m —— coefficient considering of added mass for ship motion, taken as 1.1;

E_{allow} —— allowable absorbing energy provided by the fender manufacturer, in kJ.

38.2.2.3 Where the vessel is not equipped with fenders or is intended to operate in sea conditions of level 4 or above, direct calculation method is to be used for hydrodynamic motion analysis and hull structural strength check.

38.2.3 Operating aground

38.2.3.1 Where the vessel carries out amphibious operation in tidal flats by way of grounding, it is to meet the relevant requirements of 14.7.2 bottom structure strengthening in Section 7, Chapter 14, PART TWO of the Rules.

Section 3 SUBDIVISION AND STABILITY

38.3.1 Subdivision and Stability

38.3.1.1 The vessel is to be so designed to have watertightness and weathertightness boundaries that can provide sufficient stability criterion in both intact and damaged conditions.

38.3.1.2 Where the number of windfarm service personnel on board exceeds 12, the subdivision and stability requirements of Regulation 2, Part IV in the IMO resolution MSC. 527 (106) on the International Code of Safety for Ships Carrying Industrial Personnel are to be in compliance with.

Section 4 SYSTEMS AND EQUIPMENT

38.4.1 Gangway

38.4.1.1 Where the gangway transferring system is installed, it is to comply with the applicable requirements of CCS “Guidelines for Marine Telescope Gangway”.

38.4.1.2 In order to ensure the safety of the linkage between the vessel and gangway, the bridge room/dynamic positioning (DP) control room and the gangway are to meet the following requirements:

(1) The bridge room/DP control room is to be able to observe the gangway conditions in real time through visual or video monitoring systems;
(2) The gangway control room (station) and the bridge room/DP control room are to be equipped with a real-time communication system;
(3) The failure alarm of the gangway is to be extended to the bridge room/DP control room at least in the form of a group alarm;
(4) Sufficient illumination is required for the gangway area, if there is a need for night boarding operation.

Section 5 SURVEYS

38.5.1 General Requirements

38.5.1.1 The surveys during construction and surveys after construction for windfarm service vessels are to be carried out in accordance with the requirements of 38.5.2~38.5.5, in addition to the PART ONE of the Rules.
38.5.1.2 Where the gangway transferring system is installed, the survey of gangway is to be carried out in accordance with the requirements of the CCS Guidelines for Marine Telescope Gangway (2023) (hereinafter referred to as the Guidelines for Gangway).

38.5.2 Initial Classification

38.5.2.1 According to the functional categories described in 38.1.3 of the vessel, the following applicable items are to be surveyed:
(1) Check that the bow docking fenders are correctly manufactured and installed according to the approved drawings;
(2) Inspect the gangway in accordance with the requirements of Chapter 7 in the Guidelines for Gangway;
(3) Check the communication and alarm between the gangway control room (station) and bridge room/DP control room, and functions of video monitoring systems for the gangway (if any) ;
(4) Check the external lighting system of the gangway (if any).

38.5.3 Annual Survey

38.5.3.1 The following applicable items are to be carried out:
(1) For the vessel using the bow docking method, inspect the bow fenders and bow structures to confirm without any defects such as damage, crack, distortion, corrosion, etc.. If necessary, NDE (Non-Destructive Examining) is to be conducted;
(2) For the vessel using gangway, conduct inspection in accordance with the requirements of 8.1.2, Chapter 8 of the Guidelines for Gangway and the requirements of 38.5.2.1 (3) to (4) of this Section;
(3) For the vessel with amphibious functions in tidal flats, check the bottom structure from the inner of hull to ensure that the bottom plating and internal structural members are free of depression, buckling and cracking.

38.5.4 Intermediate Survey

38.5.4.1 The following applicable items are to be carried out:
(1) For the vessel using the bow docking method, the inspection scope is the same as that of annual survey;
(2) For the vessel using gangway, conduct inspection in accordance with the requirements of 8.1.3, Chapter 8 of the Guidelines for Gangway and the requirements of 38.5.2.1 (3) to (4) of this Section;
(3) For the vessel with amphibious functions in tidal flats, the inspection scope is the same as that of annual survey.

38.5.5 Special Survey

38.5.5.1 The following applicable items are to be carried out:
(1) For the vessel using the bow docking method, the inspection scope is the same as that of annual survey;

(2) For the vessel using gangway, conduct inspection in accordance with the requirements of 8.1.4, Chapter 8 of the Guidelines for Gangway and the requirements of 38.5.2.1 (3) to (4) of this Section;

(3) For the vessel with amphibious functions in tidal flats, the inspection scope is the same as that of annual survey.