

2022

Rules for the Classification of Steel Ships

Part 9 Additional Installations

Rules

2022

Guidance Relating to the Rules for the Classification of Steel ships

Part 9 Additional Installations

Guidance



2022

Rules for the Classification of Steel Ships

Part 9

Additional Installations

APPLICATION OF PART 9 "ADDITIONAL INSTALLATIONS"

1. Unless expressly specified otherwise, the requirements in the Rules apply to ships for which contracts for construction are signed on or after 1 July 2022.
2. The amendments to the Rules for 2021 edition and their effective date are as follows;

Effective Date : 1 July 2022

CHAPTER 2 CARGO HANDLING APPLIANCES

Section 2 Survey

- 203. 1 (4) and 4 (2) have been amended.

Section 3 Derrick Systems

- 302. 1 (F) and 4 have been newly added.
- 303. 3, 4, and 6 (5),(6) have been newly added.
- 304. 6 (3),(4) have been newly added.

Section 4 Cranes

- Table 9.2.17, 9.2.19 have been amended.

Section 7 Machinery, Electrical Installations and Control Engineering Systems

- 702. 2 (2) has been newly added.
- 704. 2 (8) has been newly added.

Section 8 Cargo Lifts and Cargo Ramps

- Table 9.2.28 has been amended.

CHAPTER 8 HIGH VOLTAGE SHORE CONNECTION SYSTEMS

Section 1 General

- 101. 1 has been amended.
- 103. has been amended.
- 104. has been newly added.

Section 2 Requirements of High Voltage Shore Connection (HVSC) systems

- 201. 4 (1) (A) and (B) have been amended.
- 201. 4 (2) (C) and (D) have been amended.
- 202. 1 has been newly added.
- 202. 3 has been amended.

Section 3 Testing and Inspection

- 301. 1 has been amended.
- 302. (10) has been amended.
- 303. 1 and 2 have been amended.

CHAPTER 10 BALLAST WATER MANAGEMENT

Section 1 General

- 102. 5 and 7 have been amended.
- Table 9.10.1, Table 9.10.2 have been newly added.

Section 3 Ballast Water Management Systems

- 301. 2 (1)(2)(4)(5) have been amended.
- 303. to 305 have been entirely amended.

Section 4 Installation of BWMS On-board Ships

- Newly added.

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CHAPTER 1 CARGO REFRIGERATING INSTALLATIONS

Section 1 General

101. General

1. Application [See Guidance]

- (1) The Rules for Cargo Refrigerating Installations apply to the surveys and constructions of cargo refrigerating installations (hereinafter referred to as "refrigerating installations") of ships classed or to be classed with the requirements of **Pt 1, Ch 1** intended to be assigned and registered the class notations in accordance with **Pt 1, Ch 1, Sec 2**.
- (2) For the refrigerating machinery within the refrigerating installations specified in above (1), the requirements in the Rules apply to the refrigerating machinery using the primary refrigerants listed below. The surveys and constructions of the refrigerating machinery using primary refrigerants other than those listed below are to be as deemed appropriate by the Society.

R 22 : CHClF₂

R 134a : CH₂FCF₃

*R 404A : R 125/R 143a/R 134a (44/52/4 wt%)
CHF₂CF₃/CH₃CF₃/CH₂FCF₃*

*R 407C : R 32/R 125/R 134a (23/25/52 wt%)
CH₂F₂/CHF₂CF₃/CH₂FCF₃*

*R 410A : R 32/R 125 (50/50 wt%)
CH₂F₂/CHF₂CF₃*

*R 507A : R 125/R 143a (50/50 wt%)
CHF₂CF₃/CH₃CF₃*

R 717 : NH₃

- (3) For refrigerating installations of ships with restricted area of service or those of small capacity, some of the requirements in the Rules may be modified appropriately provided that the Society considered it acceptable.
- (4) At the request of the shipowner or his representative, the Surveyor may carry out Loading Port Surveys on registered refrigerating installations at the loading port in accordance with the requirements in **Ch 7**. On completion of the survey to the satisfaction of the Surveyor a Certificate on Loading Port Survey will be issued.
- (5) The relevant requirements in the Rules for the Classification of Steel Ships apply to the materials, equipment, installation and workmanship of the systems, unless otherwise specified in the Rules.

2. Equivalency (2020)

"The equivalence of alternative and novel features which deviate from or are not directly applicable to the Rules is to be in accordance with **Pt 1, Ch 1**.

102. Definitions

The definitions of terms which appear in the Rules are to be as specified in the following **Par 1** to **5**, unless otherwise specified elsewhere.

1. **Refrigerating installations** means refrigerating machinery, insulation for refrigerated chambers and other related appliances in refrigerated chambers
2. **Refrigerating machinery** means a set of refrigerating units which compose refrigerating cycle, consisting of compressors, condensers, receivers, evaporators, coolers, piping and fittings, driving motors for the compressors and refrigerant pumps, automatic controllers, and electrical equipments.
3. **Refrigerating units** means in general such machinery as compressors, motors, condensers, evaporators, pumps, etc., necessary to operate refrigerating cycles among the refrigerating machinery.
4. **Brine** is a general term for the secondary refrigerants which is cooled by the primary refrigerants and which is a thermal medium to cool the cargo.
5. **Design pressures** means the maximum working pressure. However, design pressures are not to be less than the values specified in **Table 9.1.1**.

Table 9.1.1 The Lowest Design Pressure

Refrigerants	High Pressure Side ⁽¹⁾ (MPa)	Low Pressure Side ⁽²⁾ (MPa)
<i>R 22</i>	1.9	1.5
<i>R 134a</i>	1.4	1.1
<i>R 404A</i>	2.5	2.0
<i>R 407C</i>	2.4	1.9
<i>R 410A</i>	3.3	2.6
<i>R 507A</i>	2.5	2.0
<i>R 717</i>	2.3	1.8
(NOTES) ⁽¹⁾ High Pressure Side : The pressure part from the compressor delivery side to the expansion valve. ⁽²⁾ Low Pressure Side : The pressure part from the expansion valve to the compressor suction valve. In case where a multistage compression system is adopted, the pressure part from the lower-stage delivery side to the higher-stage suction side is to be included.		

Section 2 Surveys

201. General

1. Kinds of surveys

Kinds of surveys are as follows:

- (1) Surveys for Classification (hereinafter referred to as "Classification Surveys")
 - (A) Classification Surveys during Construction
 - (B) Classification Surveys after Construction
- (2) Surveys for Classification Maintenance
 - (A) Annual Surveys
 - (B) Special Surveys
 - (C) Occasional Surveys

2. Classification Surveys and intervals of Classification Maintenance Surveys

- (1) Classification Surveys
 - (A) Classification Surveys during Construction

For refrigerating installations intended to be constructed and registered with the Society, the construction, materials, scantlings and workmanship of the hull, equipment and machinery are to be undergo the Classification Survey during Construction. The presence of the Surveyor is required at the following stages of the work. However, the requirements may be modified having regard to the actual status of facilities, technical abilities and quality control at the works.

 - (a) When the tests of materials in accordance with the requirements in **Pt 2** of the Rules and other tests necessary for the approval or acceptance described in **301. 3 (4)**, **502. 1 (1)** and **502. 5** of the Rules are carried out.
 - (b) When the tests specified in **Ch 6** are carried out.
 - (c) When considered necessary by the Surveyor
 - (B) Classification Surveys after Construction

Refrigerating installations intended to be registered in a way other than that described in above (A) are to undergo the Classification Survey after Construction
- (2) Classification Maintenance Surveys

Refrigerating installations which have been registered are to undergo surveys in accordance with

the following intervals to maintain their Classification.

- (A) Annual Surveys are to be carried out at intervals specified in **Pt 1, Ch 2, 201.**
- (B) Special Surveys are to be carried out at intervals specified in **Pt 1, Ch 2, 401.**
- (C) Occasional Surveys are to be carried out at a time falling on any of (a) to (c) mentioned below, independently of Special Surveys and Annual Surveys.
 - (a) When main parts of the installations have been damaged, repaired or renewed.
 - (b) When the installations are modified or altered.
 - (c) When a survey is needed for a reason other than the above.
- (D) Continuous Surveys **[See Guidance]**
 - (a) At the request of the Owner, and upon approval of the proposed arrangements by this Society, a system of Continuous Survey may be undertaken for all the items of machinery installations to be surveyed at the Special Survey. When such a system is adopted, all the requirements of the Special Survey are to be surveyed in regular rotation, as far as practicable, with uniform annual share within 5 year period and to be completed.
 - (b) The survey in such way as specified in above (a) is referred to as a Continuous Survey.

3. Preparation for surveys and others

- (1) All such preparations as required for the Survey to be carried out as well as those which may be required by the Surveyor as necessary in accordance with the requirements in the Rules are to be made by the applicant of the survey. The preparations are to include provisions of an easy and safe access, necessary facilities, certificates and records for the execution of the survey, opening up of equipment, removal of obstacle and cleaning. Inspection, measuring and test equipment, which Surveyors rely on to make decisions affecting classification are to be individually identified and calibrated to a standard deemed appropriate by the Society. However, the Surveyor may accept simple measuring equipment(e.g. rulers, measuring tapes, micrometers, etc.) and gauge fitted on machinery(e.g. pressure gauges, temperature gauges, rpm gauges, etc.) without individual identification or confirmation of calibration, provided they are properly maintained and periodically compared with other similar equipment.
- (2) The applicant for survey is to arrange a supervisor who is well conversant with the survey items intended for the preparation of the survey to provide the necessary assistance to the Surveyor according to his requests during the survey.
- (3) The survey may be suspended where necessary preparations have not been made, any appropriate attendant mentioned in the previous (2) is not present, or the Surveyor considers that the safety for execution of the survey is not ensured.
- (4) Where repairs are deemed necessary as a result of the survey, the Surveyor will notify his recommendations to the applicant of survey. Upon this notification, the repair is to be made to the satisfaction of the Surveyor.

202. Classification Surveys

1. Classification Surveys during Construction

- (1) In a Classification Survey during construction, the construction, materials, scantlings and workmanship of the refrigerating installations are to be examined in detail in order to ascertain that they meet the full requirements of each chapter concerned of the Rules.
- (2) For the refrigerating installations intended to undergo a Classification Survey during construction, the following plans and information in triplicate are to be submitted to the Society before the work is commenced.
 - (A) Specifications of the refrigerating installations(including particulars of refrigerating units)
 - (B) General arrangements of the refrigerating units(including detailed ventilating arrangements of the relevant compartment)
 - (C) Sectional assembly of refrigerant compressors for each type
 - (D) Detailed plans of pressure vessels subject to the primary refrigerant pressure
 - (E) Piping arrangements of primary refrigerants, brine and cooling water(materials, diameter and thickness of pipes are to be indicated)
 - (F) Arrangements of refrigerated chambers(including details of ductings for air circulation and ventilation)
 - (G) Wiring diagram for the refrigerating installations and arrangements of electric appliances
 - (H) Wiring diagram for detail construction of penetration of the insulation in refrigerated chambers

- (I) Kind of insulation on all surfaces, physical properties, thickness and methods of attachment of the insulation and linings (including detailed construction and insulating methods of hatch covers, access doors, ventilating ducts, scupper and bilges)
- (J) Drainage arrangements and defrosting arrangements in refrigerated chambers and spaces in which the air coolers are installed
- (K) Arrangements of thermometers or sensors in refrigerated chambers and air coolers, and the name of manufacturer and the type of the sensors
- (L) Explanatory documents to show the function of automatic temperature controls

2. Classification Surveys after Construction

(1) General

In an Classification Survey after Construction, the refrigerating installations are to be examined on their construction, materials, workmanship and actual conditions as required for the Special Survey corresponding to their age, in order to ascertain their effectiveness.

(2) Tests

(A) In the Classification Survey after Construction, operation tests and other various tests are to be carried out as required for the Special Survey.

(B) Where deemed necessary by the Surveyor, the tests and examination items may be added or omitted according to their age, service career and actual condition.

(3) Plans and documents for submission

When the refrigerating installations are intended to undergo the Classification Survey after Construction, plans and documents are to be submitted as may be required by the requirements in 1 (2).

203. Classification Maintenance Surveys

1. Annual Surveys

At an Annual Survey, an external examination is to be carried out on the following items. Examination may also be made on the items which are prepared to be examined in detail or which are opened up by the Owners' option. If any defects are observed at such examinations, the Surveyor may require open-up examination of the suspected items.

- (1) At examination of the refrigerating installation, log book is to be made to trace the operating condition of the installation during navigation.
- (2) Insulation linings of refrigerated chambers and their fastening are to be examined. Any indication of dampness or deterioration of the insulation is to be investigated.
- (3) Air circulation ducts, hatch covers and their seal, access doors in refrigerated chambers and their fastening, ventilating system and their closing means are to be examined. Care is to be given to the condition of penetrating parts where ducting or ventilating pipes pass through the deck plating.
- (4) Bilge ways, bilge wells, strainers, non-return valves and water sealed traps of scupper pipes, suction and sounding pipes are to be cleaned and examined. The drainage arrangements of refrigerated chambers and the defrosting arrangements of air coolers are also to be examined.
- (5) Condition of the cooling coils of air coolers and the cooling grids (including brine) in refrigerated chambers is to be examined.
- (6) Shells of condensers, receivers, evaporators, separators, dryers, filters and other pressure vessels and their connections and piping are to be examined externally as far as possible.
- (7) Insulation on the surfaces of pressure vessels, pipe connections and piping is to be examined for any indication of dampness or deterioration.
- (8) Randomly selected thermometers and apparatus used for measuring the temperature in the suction and delivery side of cooling air in refrigerated chambers and air coolers are to be checked for their accuracy. However, the Surveyor may at the discretion accept the checking records made by some reliable persons.
- (9) Condition of compressors, condenser cooling water pumps, primary refrigerant pumps, brine pumps, air circulation fans and their driving motors is to be examined externally.
- (10) Water end covers of condenser selected by Surveyor are to be examined externally for their corrosion through inspection holes or other suitable openings.
- (11) Tests for insulation resistance are to be made on the motors and controls of compressors, pumps, fans, etc. and their wiring, and the resistance is to be not less than 1 MΩ between insulated circuits and earth. However, when correct records are maintained, the above tests may

be omitted at the discretion of the Surveyor.

(12) All automatic controls, safety devices and alarms are to be tested for their satisfactory function.

2. Special Surveys

At a Special Survey, items specified in (1) to (8) of **1** are to be examined. In addition, the examinations required by the followings are to be carried out.

- (1) Compressors and their lubricating systems are to be opened up and examined. In the case of screwed-type compressors or compressors deemed appropriate by the Society, the interval of opened-up may be modified by the Society, provided their working condition is found satisfactory.
- (2) Condenser cooling water pumps, primary refrigerant pumps and brine pumps are to be opened up and examined. **[See Guidance]**
- (3) Insulated pipes carrying the refrigerant are to be examined both outside and inside the insulated chambers, removing the insulation to the extent necessary for checking their condition, especially the locations which pipes are connected by butt welding in place.
- (4) All pressure relief valves throughout the refrigerating plant are to be adjusted on their relieving pressure.
- (5) All automatic controls, safety devices and alarms are to be tested for their satisfactory function.
- (6) The insulation in refrigerated chambers is to be carefully examined, and bored where considered necessary in order to determine the integrity and dryness. These test holes are subsequently filled carefully.
- (7) Brine pipe system is to be tested to the pressure of 1.5 times the design pressure or 0.4 MPa whichever is the greater.
- (8) Pressure vessels are to be opened up for examination, and afterward pressure tested in accordance with the following procedures :
 - (A) The coils of gas condensers of the coil-in-casing type are to be examined and tested to the pressure of 1.5 times the high pressure side design pressure. Where it is impracticable to remove the coils, they may be examined through inspection holes.
 - (B) The coils of evaporators of the coil-in-casing type are to be examined and tested to the pressure of 1.5 times the low pressure side design pressure. Where it is impracticable to remove the coils, they may be examined through inspection holes.
 - (C) The water end covers of the shell-and-tube type condensers and the shell-and-tube type evaporators in which the primary refrigerant is in the shell are to be removed and the tube plates, tube ends and inside the end covers are to be examined. Afterwards, the shells are to be tested to the pressure equal to the high pressure side design pressure.
 - (D) The primary refrigerant end covers of the shell-and-tube type evaporators in which the brine is in the shell are to be removed and the tube ends and inside the end covers are to be examined. The shells are to be tested to the pressure of 1.5 times the design pressure or 0.4 MPa whichever is the greater. After refitting the end covers, the primary refrigerant side is to be tested to the pressure equal to the low pressure side design pressure.
 - (E) Receivers are to be hydrostatically tested to the design pressure. However, when the receivers are designed to use such primary refrigerant as *R 22*, *R 134a*, *R 404A*, *R 407C*, *R 410A* or *R 507A*, or when they are proved to have no harmful defects such as erosions or cracks on the inner surface of the vessels by means of ultrasonic test or other effective non-destructive examinations, the above mentioned pressure test may be omitted.
 - (F) For pressure vessels for the refrigerant of *R 22*, *R 134a*, *R 404A*, *R 407C*, *R 410A* or *R 507A*, pressure tests specified in through above may be omitted at the first Special Survey provided that the vessels are found to be in good order.
- (9) Current condition of the electrical equipment and electric cables are to be examined. It is to be ascertained that their insulation resistance is not less than 1 M Ω between all insulated circuits and earth. When correct records are maintained, the above examination may be omitted at the discretion of the Surveyor.
- (10) Operation tests of the refrigerating installation are to be carried out. **[See Guidance]**

3. Occasional Surveys

At an Occasional Survey, examinations or tests on items required are to be carried out in accordance with the requirements in **201. 2 (2) (C)** to the satisfaction of the Surveyor.

Section 3 Refrigerating Machinery

301. General

1. General requirements

- (1) Refrigerating machinery are to be designed taking into account their purpose and service conditions, etc.
- (2) All components of the refrigerating machinery are to be so constructed and arranged that they can be easily maintained and readily opened up for repair or renewal.
- (3) Where *R 717* is used as refrigerant, the refrigerating machinery are to comply with the requirements in this section and in addition, they are to comply with the requirements in **Sec 4**.
- (4) Primary refrigerant pipes for *R 22*, *R 134a*, *R 404A*, *R 407C*, *R 410A* or *R 507A* are to be classified into Class III specified in **Pt 5, Ch 6, 101. 4**.
- (5) Pressure vessels for the refrigerant of *R 22*, *R 134a*, *R 404A*, *R 407C*, *R 410A* or *R 507A* are to be classified in accordance with the requirements in **Pt 5, Ch 5, 302**, according to the design pressure specified in **102. 5**.
- (6) Refrigerating machinery are to be provided with the following equipment.
 - (A) Standard thermometer : 2 sets
 - (B) Hydrometer : 1 set (in the case of brine-cooling)
 - (C) Refrigerant leakage detector : 1 set

2. Capacity and number of refrigerating machinery

- (1) At least two refrigerating units are to be provided and so arranged as to be readily interchanged with each other.
- (2) The refrigerating capacity of the installation is to be sufficient to maintain the temperatures of the refrigerated chambers even though any one unit suspended.

3. Materials and welding

- (1) Materials used for the refrigerating machinery are to be suitable for refrigerant, the design pressure, the minimum working temperature, etc.
- (2) Materials used for the primary refrigerant pipes, valves and their fittings are to comply with the requirements in **301. 1 (4)** and **402. 1 (1)**, according to the classes of pipes specified in **Pt 5, Ch 6, 102**.
- (3) Materials used for the pressure vessels exposed to the refrigerant pressure (condensers, receivers and other pressure vessels) are to comply with the requirements in **301. 1 (5)** and **402. 1 (1)**, according to the classes of pressure vessels specified in **Pt 5, Ch 5, 303**.
- (4) Materials listed below are not to be used:
 - (A) For parts exposed to fluorine-substituted hydrocarbons:
aluminium alloys containing more than 2% of magnesium
 - (B) For parts always exposed to water:
aluminium of which purity is less than 99.7% (except corrosion protection treated materials)
- (5) The use of cast-iron valves is to be in accordance with the requirements in **Table 9.1.2**. Even when the use of cast-iron valves is allowed in **Table 9.1.2**, such valves are not to be used where the design temperature is lower than 0°C or higher than 220°C. In this case, such valves may be used at temperatures down to -50°C even if the design temperature is lower than 0°C, provided that they are used under a pressure up to 1/2.5 of the design pressure.
- (6) Refrigerating machinery using specific materials such as rubber hoses, plastic tubes, vinyl pipes or aluminium alloys, etc. is to be approved or accepted by the Society, considering the refrigerant used or service conditions.

Table 9.1.2 Service limitation of valves made of iron casting

Kind of valves	Materials	Application
Stop valves	JL100, JL 150 and JL 200 in ISO 185 or equivalent thereto	Not to be used
	JL 250, JL 300 and JL 350 in ISO 1083 or equivalent thereto	1) May be used for design pressure not exceeding 1.6 MPa
Relief valves	ISO 185, ISO 1083 or equivalent thereto	Not to be used
Automatic control valves	JL100, JL 150 and JL 200 in ISO 185 or equivalent thereto	Not to be used
	JL 250, JL 300 and JL 350 in ISO 185 or equivalent thereto	1) May be used for design pressure not exceeding 1.6 MPa 2) May be used for design pressure exceeding 1.6 MPa but not exceeding 2.6 MPa, provided nominal diameter does not exceed 100mm and design temperature is 150°C or below.
	ISO 1083 or equivalent thereto	Not to be used for design pressure exceeding 3.2 MPa

302. Construction, etc. of refrigerating machinery

1. Refrigerant compressors

- (1) Compressor components subject to the refrigerant pressure(including crankcases in the case of reciprocating compressors) are to be so designed to withstand the design pressure for HP side. However, when a relief valve is fitted to the crankcase integral with compressor cylinder, the components mentioned above may be designed for the design pressure for the relief valve.
- (2) Where the compressor is lubricated by pressure oil, the compressor is to be stopped automatically when the oil pressure falls below a preset value.
- (3) The compressor is to be provided with an alarm or automatic cut off device which operates where condenser cooling water pressure falls below a predetermined value. **【See Guidance】**

2. Driving machines and gearing

Prime movers and step-up gearing for compressors are to be in accordance with the relevant requirements in Pt 5.

3. Pressure vessels exposed to the refrigerant pressure

Design, construction and strength of pressure vessels exposed to the refrigerant pressure(condensers, receivers, and other pressure vessels) are to be in accordance with the requirements in 304. to 316. of Pt 5, Ch 5, Sec 3.

4. Oil separators

Suitable oil separators with drainage are to be provided to the discharge side of the compressor, except when a unit integrated with evaporator is provided to ensure oil recovery.

5. Filters

Suitable filters are to be provided in the refrigerant gas lines to the compressors and in the liquid lines to the automatic regulators. Filters may be omitted provided oil separators fitted have filtrating capability.

6. Refrigerating dryers

Dryers are to be provided to the refrigerant pipes for R22, R134a, R404A, R407C, R410A or R507A. Driers are to be so arranged that they can be by-passed or changed over to a stand-by unit without interrupting the operation of the plant in case of failure. However, such arrangement is not required when the change over to the stand-by unit is ensured by a unit integrated with the evaporator.

7. Refrigerant pumps

Where the primary and/or secondary refrigerants are circulated round the system by pumps, a stand-by pump so arranged as to be easily interchangeable with pumps for normal operation is to be provided. Its capacity is not to be less than that of the largest pump for normal operation.

8. Condenser cooling water pumps

- (1) At least two separate condenser cooling water pumps are to be provided and so arranged as to be interchangeable with each other. In this case, one of the pumps may be used for other purposes, provided that it is of adequate capacity and its use on other services does not interfere with the supply of cooling water to the condenser.
- (2) Condenser cooling water is to be taken from at least two sea connections (suctions). One of the sea connections is to be provided on the port side and the other on the starboard side.

9. Piping systems

Design, construction, strength, fabrication and outfitting of piping systems are to be in accordance with the requirements in **Pt 5, Ch 6, 102. to 107.**

10. Safety devices against excessive pressure

- (1) A high pressure cut out switch and a relief valve are to be fitted between each compressor (except turbo compressors) and its delivery stop valve. The gas discharged from the relief valve is to be led to the open air or the low pressure side of the refrigerant system.
- (2) The refrigerant side of the condenser, the receiver and parts containing liquid refrigerant, which may be isolated and exposed to a pressure exceeding their design pressure, are to be provided with relief valves or other suitable pressure relieving devices.
- (3) Pressure vessels used for low pressure side containing liquid refrigerants (including brine coolers and closed type brine tanks) and isolated by stop valves are to be provided with pressure relief valves or other suitable pressure relieving devices.
- (4) All pumps and piping systems which may be exposed to a pressure exceeding their design pressure are to be provided with relief valves or other suitable pressure relieving devices.
- (5) Where gas discharged from the relief valve on the high pressure side of the primary refrigerant is led to the low pressure side, the arrangement is to be made so that the operation of the relief valve is not affected by back pressure accumulation.
- (6) Where gas discharged from relief valves or other pressure relieving devices are led to the open air, the openings are to be located at safe places above the weather deck.
- (7) Pressure relieving devices are to be capable of preventing the pressure accumulation exceeding 1.1 times the design pressure of the parts to which the devices are fitted.

11. Automatic control

Automatic control is to be in accordance with the requirements in **Pt 6, Ch 2, 201.**

12. Electrical equipment

- (1) The electric power supply to the refrigerating installation is to be fed by at least two sets of generating units.
- (2) The capacity of the generating units mentioned above (1) is to be such that in the event of any one generating unit being stopped the remaining generating units are capable of maintaining the temperature of the refrigerated chambers.
- (3) The construction of electrical equipment arranged in the refrigerating installation is to comply with the requirements in **Pt 6, Ch 1.**

303. Cooling appliances in refrigerated chambers

1. Cooling grids

Brine cooling grids or direct expansion cooling grids in each refrigerated chamber are to be divided in at least two sections so arranged that each section can be shut off, where necessary.

2. Air cooler

Cooling coils of each air cooler are to be arranged in not less than two sections, each of which can be shut off where necessary. Alternatively, at least two independent air coolers are to be provided.

3. Refrigerated air circulating fans

Where circulation of air is dependent on a single fan and motor, access arrangements are to be such that the fan and motor can be readily removed for repair or renewal even when the chamber is loaded with refrigerated cargo. Where the chamber temperature can be maintained in an allowable range even if one unit is out of use, the above requirement is not applied.

4. Automatic temperature regulating devices

Where automatic regulating devices for controlling the temperatures in the refrigerated chambers are provided, a manually operated regulating valve or system is to be provided as stand-by service. Alternatively, two sets of automatic regulating systems so arranged that each system can be readily operated by changing over may be provided.

5. Temperature difference [See Guidance]

The temperature difference between the refrigerated chamber and the refrigerant is to be controlled so that the dehydration of cargo and frosting of the cooling appliances in each chamber can be minimized.

6. Galvanizing of brine tanks and pipes

Internal surfaces(brine side) of brine tanks and pipes exposed to brine are not to be galvanized. However, this requirement is not applied where brine tanks are closed type and they are provided with a ventilating pipe or pipes led to the open air in a location where no damage will arise from the gas discharged and their open ends are fitted with non corrosive metallic wire gauze diaphragms, or where the tanks are open type and the compartments in which they are situated are efficiently ventilated.

7. Corrosion protection of refrigerant pipes in refrigerated chambers

External surfaces of primary refrigerant or brine pipes of steel within refrigerated chambers or embedded in insulation thereof are to be suitably protected from corrosion by galvanizing, coating of any corrosion protective paint or other methods. Where pipes are connected by screwed couplings or by welding, ungalvanized or uncoated portions of the pipes are to be coated with an efficient corrosion resisting material after pressure testing.

304. Other arrangements in refrigerated chambers

1. Defrosting arrangements

Where refrigerated chambers are operated below 0°C, means for effectively defrosting air cooler coils in refrigerated chambers are to be provided.

2. Ventilating arrangements in refrigerated chambers

Where chambers are intended for the carriage of refrigerated cargoes requiring controlled ventilation, air refreshing arrangements are to be provided. In this case, each chamber is to be provided with its own separate inlet and exhaust vent, and each vent is to be provided with an airtight closing appliance. The positions of the air inlet and exhaust vent are to be selected to minimize the possibility of contaminated air entering into the chambers.

3. Heating arrangements for fruit cargoes

Where it is intended to carry fruit cargoes which may be adversely affected by low temperatures into areas where the ambient temperature may become below the carrying temperature, arrangements for heating the chambers are to be provided.

305. Refrigerating machinery compartments

Refrigerating machinery compartments are to be provided with efficient arrangements of drainage and ventilation, and separated by gastight bulkheads from the adjacent refrigerated chambers.

Section 4 Special Requirements for Refrigerating Machinery Using Ammonia as Refrigerant

401. General

1. General requirements

Refrigerating machinery using ammonia as refrigerant is to be of an indirect refrigerating system using brine, and to use R717 refrigerant as the primary refrigerant only.

2. Definition

The definitions of terms which appear in this chapter are to be as specified in the following (1) to (4), unless otherwise specified specially in other chapter.

- (1) **Gas** means ammonia gas used as the refrigerant.
- (2) **Gas purging** means the discharge of non-condensing gases from the condenser.
- (3) **Storage container** means a vessel used for storing gas for replenishment.
- (4) **Gas expulsion system** means the system for excluding gas quickly from a compartment, and consists of ventilation system, gas absorption system, water screening system, gas absorption water tanks, etc.

3. Drawings and data

Drawings and data to be submitted in addition to those specified in other chapters, are generally as follows:

- (1) Gas Detector Arrangement
- (2) General Arrangement of Refrigerating Machinery Compartment

402. Design

1. General requirements

- (1) Pressure vessels used in the refrigerating machinery are to be in accordance with the requirements of Class I specified in **Pt 5, Ch 5**, and the primary refrigerant pipes(hereinafter referred to as "refrigerant pipes".) are to be classified into Class I piping specified in **Pt 5, Ch 6**.
- (2) Refrigerating machinery is to be provided with auxiliary receivers of adequate capacity so that repairs and maintenance may be carried out without discharging the gas to the atmosphere. However, the auxiliary receivers can be dispensed with, if at least the refrigerant in the receiver with the largest capacity can be stored in some other receiver.

2. Materials

- (1) Materials capable of highly corrosion(copper, zinc, cadmium, or their alloys) and materials containing mercury are to be not used at locations where ammonia comes in contact.
- (2) Nickel steel is not to be used in pressure vessels and piping systems.
- (3) Cast-iron valves are not to be used in the refrigerant piping system.
- (4) Material for sea-water cooled condensers is to be selected considering the corrosion due to sea water.

403. Refrigerating machinery

1. Refrigerant compressors

Refrigerant compressors are to be provided with means for automatically stopping the compressor when the pressure on the high pressure side of the refrigerant piping system becomes excessively high. Also, an alarm system which generates visible and audible alarms when this means are in operation is to be installed in the refrigerating machinery compartment and monitoring position.

2. Piping joints

Piping joints for the refrigerant piping system are to be butt welded as far as practicable.

3. Pressure relieving devices

The refrigerant gas discharged from a pressure relief valve is to be absorbed in water, except when leading the gas to the low pressure side.

4. Liquid level gauge

If liquid level gauges made of glass are used at locations where pressure exists permanently, they are to comply with the requirements given below.

- (1) Flat type glass is to be used in the liquid level gauge, and the construction is to be such that the gauge is adequately protected against external impacts.
- (2) The construction of the stop valve for the liquid level gauge is to be such that the flow of liquid is automatically cut off if the glass breaks.

5. Gas purging

Gas discharged from the purging valve is to be not discharged directly to the atmosphere, but absorbed in water.

6. Condenser

Independent piping for discharge of cooling sea water for the condenser is to be used. The piping is to be led directly overboard without passing through accommodation spaces.

404. Refrigerating machinery compartment

1. Construction and arrangement

- (1) The compartment where the refrigerating machinery and storage vessels are installed(hereinafter referred to as "refrigerating machinery compartment".) is to be a special compartment isolated by gastight bulkheads and decks from all other compartments so that leaked ammonia does not enter other compartments. The refrigerating machinery compartment is to be provided with access doors which comply with the following requirements:
 - (A) At least two access doors are to be provided in the refrigerating machinery compartment as far apart as possible from each other. At least one access door is to lead directly to the weather deck. However, if it is not possible to provide access door directly to the weather deck, then at least one access is to have airlock type doors.
 - (B) Access doors not leading to weather deck are to be of high tightly and self-closing type.
 - (C) Access doors are to be capable of being operated easily and are to open outward.
- (2) The refrigerating machinery compartment is to be not adjacent to accommodation spaces, hospital room or control room.
- (3) Passages leading to the refrigerating machinery compartment are to comply with the following requirements:
 - (A) If a passage is adjacent to accommodation spaces, hospital room or control room, it is to be isolated by gastight bulkheads and decks.
 - (B) The passage is to be isolated from passages to accommodation spaces, and led directly to the weather deck.
- (4) Penetrations on gastight bulkheads and decks where cables and piping from the refrigerating machinery compartment pass through, are to be of gastight construction.
- (5) Drain pans of adequate size are to be provided at a position which is lower than the refrigerating machinery and storage vessels in the refrigerating machinery compartment so that liquid ammonia does not leak outside the compartment.
- (6) An independent drainage system is to be provided in the refrigerating machinery compartment so that the drainage of this compartment is not discharged into open bilge wells or bilge ways of other compartments.

405. Gas expulsion system

1. General

A gas expulsion system consisting of ventilation system, gas absorption system, water screening system, and gas absorption water tanks is to be installed in the refrigerating machinery compartment so that the gas leaked out accidentally can be expelled quickly from the refrigerating machinery compartment.

2. Ventilation system

- (1) A mechanical ventilation system, which complies with the following requirements as a rule, is to be installed in the refrigerating machinery compartment so that this space can be ventilated all the time.

- (A) The ventilation system is to have adequate capacity to ensure at least 30 air changes per hour in the refrigerating machinery compartment.
 - (B) The ventilation system is to be independent of other ventilation systems on board the ship, and is to be capable of being operated from outside the refrigerating machinery compartment.
 - (C) Exhaust outlets are to be installed at a horizontal distance of more than 10 m from the nearest air intake opening, openings of accommodation spaces, service spaces and control stations, and at a vertical distance of more than 4 m from the weather decks.
 - (D) The air intake opening is to be provided at a low position and the exhaust opening is to be provided at a high position in the refrigerating machinery compartment so that the gas does not accumulate in the compartment and the exhaust ducts.
 - (E) Ventilation fan of non-sparking type is to be provided and complied with the requirements specified in **Pt 8, Ch 3, 104. of the Rules.**
- (2) Independent ventilation systems are to be installed in passages leading to the refrigerating machinery compartment. However, if the ventilation system specified in above (1) is provided with ducts so that it can be used for exhausting air in the passages, then an independent ventilation system need not be installed.

3. Gas absorption system

A gas absorption system satisfying any of the requirements given below, capable of excluding leaked gases quickly from the refrigerating machinery compartment, and capable of being operated from outside the compartment, is to be installed.

(1) Scrubber

- (A) The scrubber is to be designed with an adequate processing capacity which restricts the gas concentration at the exhaust fan to well below 25 ppm, and absorbs ammonia in the largest receiver within 30 minutes.
- (B) The pump for the scrubber is to start automatically when the gas concentration in the refrigerating machinery compartment exceeds 300 ppm.

(2) Water sprinkler system

- (A) The quantity of sprinkled water is to be such that the leaked gas can be satisfactorily absorbed.
- (B) Nozzles are to be of type approved by the Society. As a rule, nozzles are to be positioned so that their range covers all the refrigerating machinery in the compartment.
- (C) When the gas concentration in the refrigerating machinery compartment exceeds 300 ppm, the pump for sprinkling water is to start automatically.

4. Water screening system

All doors of the refrigerating machinery compartment are to be provided with water screening system which can be operated from outside the compartment.

5. Gas absorption water tanks

Gas absorption water tanks complying with the requirements given below, are to be installed at a position lower than the refrigerating machinery compartment so that the leaked liquid ammonia can be recovered quickly.

- (1) The tank is to have such a capacity that the water which can absorb the refrigerant filled in at least one refrigerating machinery can be fully recovered.
- (2) An automatic water supply system is to be installed in the tank so that the fully-filled condition of the tank is always maintained.
- (3) Overflow from the tank is to be diluted or neutralized and then discharged overboard directly, without leading the discharge pipes through accommodation spaces.
- (4) Means are to be provided in the tank to recover the drain of the liquid ammonia generated in the refrigerating machinery compartment. An appropriate drain trap is to be provided to prevent reverse flow of the gas from the tank.
- (5) All the vent pipe of the tank is to be connected to the exhaust pipe of the ventilation system of **405. 2.**

406. Gas detection and alarm system

1. Installation requirements

- (1) Gas detection and alarm systems are to be provided in the refrigerating machinery compartment complying with the following requirements:
 - (A) At least one gas detector complying with the requirements given below, is to be installed above each refrigerating machinery.
 - (a) The detectors are to activate an alarm when the gas concentration exceeds 25 ppm.
 - (b) When the gas concentration exceeds 300 ppm, the detector is to automatically stop the refrigerating machinery, automatically activate the gas expulsion, and activate the alarm.
 - (B) An adequate number of flammable gas detectors are to be provided so that when the gas concentration reaches up to 4.5%, the power supply to the electrical equipment in the refrigerating machinery compartment is cut off and the alarm systems are activated.
 - (C) The alarm systems are to generate visible and audible alarms near the doors, within and outside the refrigerating machinery compartment and at monitoring locations.
 - (D) A manually-operated transmitter for leakage warnings is to be provided, near the doors and outside the refrigerating machinery compartment.
- (2) Gas detection and alarm system complying with the following requirements are to be provided in passages leading to the refrigerating machinery compartment:
 - (A) The gas detectors are to activate the alarm system when the gas concentration exceeds 25 ppm
 - (B) The alarm systems are to generate visible and audible alarms in the passage and near the doors of the refrigerating machinery compartment.
- (3) Detectors are to be capable of continuous detection and considered to be appropriate by the Society.

407. Electrical equipment

1. General

- (1) Electrical equipment in the refrigerating machinery compartment required to be operated in the event of leakage accidents, gas detection and alarm system, and emergency lights are to be of certified safety types for use in the flammable atmosphere concerned. **【See Guidance】**
- (2) Electrical equipment in the refrigerating machinery compartment other than mentioned in above (1), are required to switch off automatically, by means of circuit breakers installed outside the refrigerating machinery compartment when the flammable gas detector specified in **406. 1 (1) (B)** activates.
- (3) If a water sprinkler system is installed in the refrigerating machinery compartment as the gas absorption system, all electrical machinery and equipment in the refrigerating machinery compartment are to be of the waterproof type.

408. Safety and protective equipment

1. General

As a rule, safety and protective equipment as given below are to be provided, and are to be stored at locations outside the refrigerating machinery compartment so that they can be easily retrieved in the event of leakage of the refrigerant. Storage locations are to be marked with signs so that they can be identified easily.

- (1) Protective clothing(helmet, safety boots, gloves, etc.) × 2
- (2) Self-contained breathing apparatus(capable of functioning for at least 30 minutes) × 2
- (3) Protective goggles × 2
- (4) Eye washer × 1
- (5) Boric acid
- (6) Emergency electric torch × 2
- (7) Electric insulation resistance meter × 1

Section 5 Refrigerated Chambers

501. Construction of refrigerated chambers

1. Materials used for refrigerated chambers

Decks, floors and boundary bulkheads of refrigerated chambers are to be constructed of materials confirmed to be airtight. However, divisional bulkheads between refrigerated chambers, where the chambers concerned are intended for cargo which will not taint or adversely affect the cargo in any other chamber, may be constructed of appropriate materials subject to the approval of the Society.

2. Airtightness of closing appliances

Closing appliances such as hatch covers, access doors, bilge and manhole covers forming part of the insulated envelope of independently refrigerated chambers, are to be made airtight. Where hatch covers or plugs are exposed to the ambient conditions, they are to be provided with a double seal.

3. Welding and materials of steelworks in refrigerated chambers

Special attention is to be paid to welding and materials of members which are directly welded to the main structural hull members, and structural discontinuities and/or defects in welded joint are to be avoided.

4. Coamings of manholes, etc.

Tank top insulation in way of manholes and bilge hats is to be provided with a liquidtight coaming with a suitable height to prevent seepage into the insulation.

5. Penetration of ventilation ducts and pipes through decks, bulkheads, etc.

- (1) Ventilation ducts are not to pass through the collision bulkheads below the freeboard deck. Ducts passing through the other watertight bulkheads are to be provided with an efficient closing appliance which can be operated from a position above the freeboard deck accessible at all times. In the operating position, an indicator is to be provided to show whether the duct is opened or closed.
- (2) Refrigerating pipes passing through bulkheads or decks of refrigerated chambers are not to be in direct contact with the steelwork. Airtightness of the bulkheads or decks is to be maintained. Where these pipes pass through deck plating or watertight bulkheads, the fittings and packing of the glands are to be both fireresisting and watertight.
- (3) Ventilators, air ducts or pipes passing through refrigerated chambers to other compartments are to be made airtight in way of penetrating parts of insulation, and they are to be effectively insulated in the refrigerated chamber.
- (4) Air pipes, sounding pipes, bilge suction pipes and other pipes led from the outside of refrigerated chambers and passing through refrigerated chambers are to be effectively insulated and special consideration is to be given to the arrangement of these pipe lines to prevent freezing of liquid in these pipes.

6. Insulating linings, etc.

Insulation linings, bilge limbers and their covers, hatch covers and access doors to refrigerated chambers are to be constructed of water-vapour-resisting material or covered with such material.

7. Cargo battens

Cargo battens are to be fitted and so arranged on all vertical walls of refrigerated chambers as to provide sufficient space for air circulation and prevent the cargo from coming to contact with the insulation or cooling grids. However, where the form of insulation lining, storage method of cargo, etc. are adequate, and need not provided battens, they may not be required.

8. Gratings

Gratings of suitable form and strength are to be provided on floors of refrigerated chambers so as to provide sufficient space between floors and cargo for free air circulation and prevent the floor insulation from mechanical damage by cargo handling. However, where the floor insulation lining meets the above requirements or cargoes to be loaded are supported on suitable pallets, gratings are not required.

502. Insulation and insulation materials

1. Insulation materials

- (1) Insulation materials approved or accepted by the Society are to be used.
- (2) If slab formed insulant is used, it is to have suitable strength. Where a binder is used to join slabs each other, it is to be odourless and not to absorb any of the odours from the cargo.

2. Protective coatings

- (1) Steelworks to be insulated are to be thoroughly cleaned and coated with an anti-corrosive composition before they are insulated.
- (2) All steel bolts, nuts and other fixtures which support or secure insulation materials, joints, coverings, etc. are to be galvanized or protected against corrosion with suitable means.

3. Insulation

- (1) The thickness of insulation over all surfaces and the manner in which it is supported are to be in accordance with the approved specification and plans. The insulation is to be strongly fixed so as not to be loose. Where the insulation is of slab form, the joints are to be butted closely together and staggered so as not to be made a gap between the slab forms. Unavoidable crevices between insulations or insulation and structural member are to be filled with suitable insulating material.
- (2) Structural members which extend into refrigerated chambers are to be effectively insulated over a sufficient length in the refrigerated chambers to prevent heat penetration into the chambers and supercooling of each member at the place of penetration.

4. Removal of insulation

- (1) The insulation of such places that easy access to bilge hats, bilge ways and tank manhole lids is required is to be of plug type and removable.
- (2) The insulation in way of bilge suction pipes, air and sounding pipes and other pipe lines is to be removable to the extent necessary for access for inspection.

5. Insulation of oil tank plating

Where the tank top and bulkhead of the oil storage tank form part of the refrigerated chamber walls, air space of sufficient width is to be provided between the tank plating and the insulation, or the surface of the tank plating is to be coated with an oil-proof and oil-tight composition of sufficient thickness approved by the Society, before the insulation is fitted. Where air space is provided between the tank plating and the insulation, free drainage of oil seepage to the gutter way and bilges is to be ensured. Furthermore, such air spaces are to be provided with ventilating pipes led to the open air, and corrosion resisting metallic wire gauze diaphragms are to be fitted at the outlet.

503. Temperature measuring arrangements

1. Number of thermometers and sensors

- (1) Two sets of thermometers are to be provided in each refrigerated chamber. At least two sensors are to be connected to each set of thermometer for each chamber.
- (2) Unless otherwise required, at least the following number of sensors are to be provided in each chamber, depending upon the volume of the chamber.
 - (A) Volume up to 300 m³ : 4
 - (B) Volume up to 600 m³ : 5
 - (C) Volume above 600 m³ : 5 plus one for above 400 m³ or fraction thereof.
- (3) In addition to those specified in above (2), one sensor is to be fitted in each main stream of air in the suction and delivery sides of each air cooler.

2. Electric thermometers

- (1) Electric power supply to each instrument in refrigerated chambers is to be fed by a separate final sub-circuit.
- (2) Sensors connected to thermometers in refrigerated chambers are to be properly protected from mechanical damage.
- (3) The readings of thermometers in refrigerated chambers are to be accurate to the true temperature within $\pm 0.5^{\circ}\text{C}$ in the range of below 0°C , and $\pm 0.3^{\circ}\text{C}$ in the range of 0°C and above.

504. Drainage arrangements

1. General

- (1) Drainage arrangements are to be in accordance with the relevant requirements in **Pt 5, Ch 6, Sec 4** in addition to the requirements in this chapter.
- (2) All refrigerated chambers and air coolers are to have ample continuous drainage.
- (3) Compartments outside the refrigerated chambers are not to drain into the refrigerated chambers.

2. Non-return valves and sealed traps in scupper pipes

- (1) Scupper pipes led from refrigerated chambers and air cooler trays are to be provided with non-return valves and liquid sealed traps. However, the pipes led from between deck chambers and air cooler trays may be not provided with non-return valves.
- (2) Where scupper pipes from refrigerated chambers and air cooler trays are connected to a common header, each branch pipe is to be provided with a liquid sealed trap, and those from lower hold spaces are to be fitted, in addition, with non-return valves.
- (3) Where the chamber temperature contemplated is 0°C or below, scupper pipes together with non-return valves and liquid sealed traps specified in above (1) and (2) are, if necessary, to be well insulated.
- (4) Liquid sealed traps are to have an adequate depth and arranged so as to be accessible for cleaning and refilling with liquid.

Section 6 Tests

601. Tests at the manufacturers works

1. Pressure tests and leak Tests

- (1) Machinery components, pressure vessels and pressure piping exposed to a primary refrigerant pressure are to be subjected to hydrostatic tests to the pressure of 1.5 times the design pressure. After hydrostatic tests, they are to be leak tested to a pressure equal to the design pressure.
- (2) Machinery components, pressure vessels and pressure piping intended for use with brine are to be subjected to hydrostatic tests to a pressure of 1.5 times the design pressure or 0.4 MPa whichever is the greater.
- (3) In general, pressure tests are to be carried out with water or oil and leak tests are to be carried out with air or suitable inert gases or any inert gas with a small amount of the refrigerant added to it.

2. Performance tests

- (1) Compressors, fans, primary refrigerant or brine pumps and their prime movers are to be tested for their performance.
- (2) Welded parts in pressure vessels and piping are to be tested in accordance with the relevant requirements in **Pt 5, Ch 5, Sec 4** and **Pt 5, Ch 6, Sec 13**.
- (3) Electrical equipment is to be tested in accordance with the requirements in **Pt 6, Ch 1**.

602. Shop tests

1. Leak tests

- (1) The primary refrigerant system is to be leak tested after the piping arrangement is completed on board the ship, generally with inert gases or inert gases with a small amount of refrigerant added, to a pressure of 90% of the respective design pressures.
- (2) The brine system is to be leak tested after the piping arrangement is completed on board the ship to a pressure of 1.5 times the maximum working pressure of the brine pump or 0.4 MPa whichever is the greater.

2. Calibration of thermometers

Thermometers are to be checked for accuracy at the freezing point of water, after they are set up on board the ship, and their accuracy is to comply with the required specification. The records of checking are to be submitted to the Surveyor.

3. Air circulation tests

Where air circulating fans are provided in refrigerated chambers, it is to be ascertained that the velocity of circulating air and the state of air circulation are satisfactory.

4. Functional tests

Automatic control devices, safety devices and alarms are to be ascertained that they operate satisfactorily.

5. Tests after installation

All components of the refrigerating machinery are to be operated under full load condition as far as possible, and changing over to stand-by units is smooth.

6. Defrosting tests

The defrosting arrangement for air coolers are to be tested for satisfactory operation.

Section 7 Loading Port Surveys

701. General

1. General

- (1) At the request of the shipowner or his representative, the Surveyor may carry out Loading Port Surveys on a registered refrigerating installation at a loading port in accordance with the requirements in **701. 2**. On completion of the survey to the satisfaction of the Surveyor, Certificate on Loading Port Survey will be issued.
- (2) A Loading Port Survey may be carried out concurrently with other surveys of the refrigerating installations such as Annual Surveys.
- (3) If there is no Surveyor available at the loading port, the Society may accept the report of a survey held at the loading port by a reliable competent person as considered appropriate by the Society, provided that all requirements of Loading Port Surveys are fulfilled.

2. Items to be Examined

At the Loading Port Survey, the following items are to be confirmed or examined.

- (1) The refrigerating installation is to be examined under working condition to confirm that it operates in good order, and the temperatures at that time in the refrigerated chambers are to be noted.
- (2) The Surveyor is to ascertain that there is ample generating capacity available for the ships essential services and maximum required power to the refrigerating installation, even when one generator is out of use. Where the electric power source is also used as the ships main power supply, it is to be ascertained that the chamber temperature can be maintained at the specified value with the remaining generators used.
- (3) The refrigerated chambers are to be examined in an empty state to ascertain that:
 - (A) They are clean and free from odour which may adversely affect the cargo to be loaded.
 - (B) Brine or refrigerant pipe grids, coils of air coolers and connections are free from leakage.
 - (C) Cargo battens, where fitted to the vertical walls, are in good order.
 - (D) Cargo gratings or dunnages are available as necessary for the floors or decks.
 - (E) There is no damage sustained to the insulation or its linings in the refrigerated cargo holds.
 - (F) All scuppers and bilge suctions for draining the refrigerated cargo holds are in good working order, and water sealed traps are provided. ⚓

CHAPTER 2 CARGO HANDLING APPLIANCES

Section 1 General

101. General

1. Application

- (1) The Rules apply to the cargo handling appliances which are installed on the ships classed with the Society, and which are intended to be registered under the Society. **【See Guidance】**
- (2) The relevant requirements in the Rules apply to the materials, equipment, installation and workmanship of the cargo handling appliances, unless otherwise specified in the Rules.
- (3) Personnel lifting is to comply with the requirements of **Annex 9-2** of the Guidance. (2017)

2. Equivalency

The equivalency of alternative and novel features which deviate from or are not directly applicable to the Rules is to be in accordance with **Pt 1, Ch 1** of the Rules for the Classification of Steel Ships. (2020) **【See Guidance】**

3. Precautions in Application

- (1) As for the cargo gear, cargo ramps and loose gear, precautions are to be taken to any manners of their treatment different from the requirements of the Rules in the flag state of the ship or state of call.
- (2) The Society may carry out inspection and issue necessary certificates for the cargo handling appliances according to the designated rules in the capacity of the government of the state concerned or other organization under the authorization by such state or organization.

102. Definitions

For the purpose of the Rules, the terms are defined as following below unless otherwise defined

1. **Cargo handling appliances** are lifting appliances and loose gear.
2. **Lifting appliances** are cargo gears and cargo ramps include their installations of driving systems and cargo fittings.
3. **Cargo gears** are derrick systems, cranes, cargo lifts and other machinery(e.g. engine room overhead crane, provision crane etc.) used for the loading and unloading of cargo and other articles permanently installed in the hull structures, etc except cargo ramps, and include their installations of driving systems and cargo fittings. (2017)
4. **Personnel lifting** are cranes used for embarkation and disembarkation or transfer of personnel. (2017)
5. **Structural members** are those of cargo handling appliances carrying the safe working load, including cargo fittings and cargo blocks permanently incorporated in the cargo gear and the cargo ramps.
6. **Cargo fittings** are goose neck brackets, topping brackets, fittings at the derrick boom head, derrick heel lugs, guy cleats, eye fittings, etc. which are permanently fitted to the structural members or the hull structure for the purpose of cargo handling.
7. **Loose gears** are blocks, ropes, chains, rings, hooks, shackles, swivels, clamps, grabs, lifting magnets, spreaders, etc. which are removable parts used for transmitting the loads of cargo to the structural members.
8. **Safe working load** is the maximum allowable mass of cargoes specified by the Rules with which the cargo gear and the cargo ramp can be safely operated. It is abbreviated to "SWL" and expressed in tons (t).
9. **Allowable minimum angle** is the angle to horizontal of a derrick boom at which the derrick system is permitted to operate under the safe working load, and expressed in degrees (°).
10. **Maximum slewing radius** is the radius at which a jib crane is permitted to operate under the safe working load, and expressed in meters (m).

11. **Safe working load, etc.** are safe working load, allowable minimum angle and other restrictive conditions in case of the derrick systems, safe working load, maximum slewing radius and other restrictive conditions in case of the jib cranes, safe working load and other restrictive conditions deemed necessary by the Society in case of other machinery used for the loading and unloading of cargo, and safe working load and other restrictive conditions deemed necessary by the Society in case of the cargo ramps. **【See Guidance】**
12. **Safe working load of a loose gear** is the maximum allowable mass of cargoes specified by the Rules with which the loose gear can be used safely. It is abbreviated to "*SWL*" and expressed in tons (t). For cargo blocks, the safe working load is defined according to (1) or (2) below:
- (1) The safe working load of a single sheave block is the maximum mass of cargoes that can be safely lifted by that block when it is suspended by its head fitting and the mass is secured to a wire rope passing round its sheave.
 - (2) The safe working load of a multiple sheave block is the maximum mass of cargoes that may be applied to its head fitting of the block.
13. **Derrick systems** are installations for handling cargo by suspending the cargo from the top of the derrick boom fitted to derrick post or mast, including those specified in (1), (2) and (3) below:
- 【See Guidance】**
- (1) The end of topping lift being fixed, two guy ropes fitted at the top of the derrick boom are wound by independent winches respectively to swing the boom horizontally(hereinafter referred to as "swinging derrick system").
 - (2) Two derrick booms, on port and starboard sides, in pair are fixed at predetermined positions. The cargo falls of two derricks are connected to load or unload the cargo(hereinafter referred to as "union-purchase derrick system").
 - (3) The cargo fall can be paid out or heaved in and luffing and slewing of derrick boom can be carried out singly or simultaneously while the cargo is suspended(hereinafter referred to as "derrick crane system").
14. **Cranes** cover jib cranes, gantry cranes, overhead cranes and hoists, cargo davits, etc. and are capable of performing the works of cargo loading and unloading, slewing and/or horizontal movement simultaneously or separately.
15. **Cargo lifts** are the installations designed to contain the cargo in their structure to loading and unloading the cargo.
16. **Cargo ramps** are the installation mounted on the shell or provided in the ship, and arranged to permit passage of vehicles as cargo or vehicles loaded with cargo on themselves and having mechanism enabling its opening and closing or turning.
17. **Lifting load** is the sum of the safe working load defined as the maximum mass of cargoes themselves to be suspended and the mass of accessories such as hooks, cargo blocks, grabs, buckets, lifting beams, spreaders, etc. Unless otherwise deemed necessary by the Society, the mass of wire ropes used as cargo falls need not be taken into account except when the installation is designed for a lift of 50 m or more.
18. **The acceleration of gravity** is to be equal to 9.81 m/sec^2 .

103. Arrangement, Construction, Materials and Welding

1. Arrangement

- (1) The arrangement and dimensions of the cargo gear and the cargo ramps are to be determined with due consideration given to avoid interference with maneuvering lights, navigation lights and other functions of the ship.
- (2) When same parts of the cargo gear are utilized commonly for other functions, such as ventilators, or important systems or equipment designed for other purposes, or further, when some systems or equipment for other purposes are mounted on them, due considerations are to be given to avoid undue interference with each other in relation to their functions and strength.
- (3) When any parts of the cargo gear or the cargo ramps project beyond the ship's side under the working condition, it is recommended that such parts are to be of retractable, foldable or removable type designed for stowing within the line of ship's side when not in use.

- (4) The cargo gear and the cargo ramps are to be provided with equipments for securing the movable parts when not in use.

2. General Construction [See Guidance]

- (1) The cargo gear and the cargo ramps other than those used ordinary trim and heel in calm weather and sea states, are to comply with, in addition to the requirements in the Rules, such additional requirements as considered appropriate by the Society for the actual working condition.
- (2) The requirements in **Sec 3, 4** and **8** assume the use of hull structural rolled steels specified in **Pt 2, Ch 1, 301**. High tensile steels used in the structural members, if any, are to comply with requirements specially made up by the Society. The construction and dimensions of the structural members containing or made of materials other than those steel specified herebefore are to be specially considered by the Society.
- (3) The structural members are to be designed to avoid structural discontinuities and abrupt change of sections as far as practicable. The welded joints are to be arranged to avoid the parts where concentration of stress is expected.
- (4) Corners of openings in the structural members are to be appropriately rounded off.
- (5) Openings causing dimensional anisotropy in the structural members are to be so arranged as their long sides or long axes may assume parallel to the direction of principal stresses.
- (6) Where two members having remarkably different stiffness are directly connected with each other, proper reinforcement is to be made by means of brackets, etc. to maintain the continuity of stiffness. Special consideration is to be given to the connection to the hull structures.
- (7) The cargo blocks of the structural members are to comply with the requirements in **602**.

3. Direct Calculation of Strength

The dimensions of the structural members are to be determined by the method of direct calculation of strength approved by the Society using the design loads and allowable stresses specified in respective Sections concerned, with the exception of those members for which calculation formulae are given in **Sec 3**.

4. Materials [See Guidance]

- (1) The hull structural rolled steel used in the structural members are to be as given in **Table 9.2.1** depending on their thickness, except in cases considered appropriate by the Society.
- (2) For the cargo gear and the cargo ramps always used in especially cold zones or refrigerated hold chambers and for any other cases considered to be necessary by the Society, the Society may require the use of steel materials of higher notch toughness notwithstanding the requirement specified in (1) above.
- (3) Steel casting and steel forgings used in the structural members are, as a rule, to comply with the requirements in **Pt 2, Ch 1, Sec 5** and **Sec 6** respectively or of equivalent qualities.
- (4) The materials of bolts and nuts used for connection of components of the structural members are to be considered appropriate by the Society.
- (5) Wire ropes used as components of the structural members are to be those specified in **Pt 4** for use as standing riggings or of an equivalent quality.
- (6) The materials used in the main parts of the installations of driving systems are to comply with the requirements in **Pt 2, Ch 1** or any standards recognized by the Society to be of equivalent qualities.

Table 9.2.1 Thickness and Grades of Steels

Thickness t (mm)	$t \leq 20$	$20 < t \leq 25$	$25 < t \leq 40$	$40 < t$
Grade	A/AH	B/AH	D/DH	E/EH
(NOTES) AH, DH and EH in the Table correspond to the following material grades. AH : AH32, AH36 and AH40 DH : DH32, DH36 and DH40 EH : EH32, EH36 and EH40				

5. Welding [See Guidance]

- (1) The Welding of the structural members is to comply with the requirements in **Pt 2, Ch 2** and the additional requirements considered necessary by the Society according to the types of construction.
- (2) The arrangement of welded joints in the structural members is to be specially considered to avoid remarkable difficulties in welding work.

6. Prevention of Corrosion

- (1) The structural members are to be protected against corrosion with coating of a good quality or using other proper means.
- (2) Any parts liable to the accumulation of rainwater or dew condensation are to be provided with proper draining means.

Section 2 Surveys

201. General

1. Application [See Guidance]

- (1) The requirements in this Section apply to the tests and surveys for the cargo handling appliances.
- (2) Where the structural members of the cargo handling appliances are permanently fitted to the hull structure or where they form an integral part thereof, the tests and surveys for these parts are to comply with the requirements in this Section and, in addition they are to comply with the relevant requirements of the other Part of the Rules.
- (3) At the Periodical Surveys, the Surveyor may require surveys other than those specified in **202.** through **205.** in this Section where deemed necessary.
- (4) At Annual Surveys, the Surveyor may reduce the extent and contents of the tests and surveys specified in **202.** through **205.** in this Section, where deemed appropriate, having regard to the purpose, construction, age, history, results of the previous surveys and the current condition of the cargo handling appliances.

2. Preparation for Surveys and Others

- (1) All such preparations as required for the survey to be carried out as well as those which may be required by the Surveyor as necessary in accordance with the requirements in the Rules are to be made by the applicant of the survey. The preparations are to include provisions of an easy and safe access, necessary facilities and necessary records for the execution of the survey. Inspection, measuring and test equipment, which Surveyors rely on to make decisions affecting classification are to be individually identified and calibrated to a standard deemed appropriate by the Society. However, the Surveyor may accept simple measuring equipment(e.g. rulers, measuring tapes, weld gauges, micrometers) without individual identification or confirmation of calibration, provided they are of standard commercial design, properly maintained and periodically compared with other similar equipment or test pieces. The Surveyor may also accept equipment fitted on board a ship and used in examination of shipboard equipment(e.g. pressure, temperature or rpm gauges and meters) based either on calibration records or comparison of readings with multiple instruments.
- (2) The applicant for the survey is to arrange a supervisor who is well conversant with the survey items intended for the preparation of the survey to provide the necessary assistance to the Surveyor according to his requests during the survey.
- (3) The survey may be suspended where necessary preparations have not been made, any appropriate attendant mentioned in the previous (2) is not present, or the Surveyor considers that the safety for execution of the survey is not ensured. **[See Guidance]**
- (4) Where repairs are deemed necessary as a result of the survey, the Surveyor will notify his recommendations to the applicant of the survey. Upon this notification, the repair is to be made to the satisfaction of the Surveyor.

3. Presentation of Certificates

All of the certificates for cargo handling appliances issued by the Society are to be kept on board and presented to the Surveyor when requested at the tests and surveys.

4. Records of the Surveys

The "Register of Ship's Lifting Appliances including Cargo Handling Gears" is to be made necessary entries on it and endorsed by the Surveyor at the completion of the Surveys.

5. Notification of Survey Results

- (1) The Society is to notify the results of the Survey to the applicant in a form of Survey Report.
- (2) In case where repairing is requested on the Survey Report, the repairs are to be made to the satisfaction of the Society.
- (3) The Survey Report in (1) above is to be kept on board and presented to the Surveyor when requested at the subsequent Survey.

6. Re-Survey

In case where the applicant has any complaints in the Survey carried out in accordance with the Rules, he may request execution of re-survey in writing to the Society.

202. Surveys of Cargo Handling Appliances

1. Kinds of Surveys

The kinds of Surveys for cargo handling appliances are as follows:

- (1) Registration Survey
 - (A) Registration Survey during Construction
 - (B) Registration Survey of Cargo Handling Appliances not built under survey (2019)
- (2) Periodical Survey for maintaining registration
 - (A) Annual Survey
 - (B) Load Test
- (3) Occasional Survey

2. Due range

The timing of the Surveys of cargo handling appliances are to be in accordance with the followings:

- (1) A Registration Surveys are to be carried out when the safety working load, etc. are assigned for the first time.
- (2) Annual Survey is to be carried out within 3 months before or after each anniversary date of periodical survey for Classification.
- (3) Load Test is to be carried out at the Registration Survey and at the dates not exceeding 5 years from the date of completion of the Registration Survey or the previous Load Test.
- (4) Occasional Survey is to be carried out as follows except periodical survey.
 - (A) When serious damage is caused on the structural members and the repair or conversion is made
 - (B) When major conversion is made in the cargo handling procedures, rigging arrangements, operation and control methods
 - (C) When the assignment and marking of safe working load, etc. is altered
 - (D) Other cases when considered necessary by the Society **【See Guidance】**
- (5) Notwithstanding (2) to (4) above, the postponement of inspection due to the force majeure are to be in accordance with the requirements specified in **Pt 1, Ch 1, 906. 6** of the Rules.

3. Periodical Surveys carried out in Advance

Periodical Surveys may be carried out in advance of the due date of each Survey upon application by the Owner.

203. Registration Surveys

1. Drawings and Other Documents to be Submitted **【See Guidance】**

- (1) At a Registration Survey, it is to be ascertained that the strength and construction of the cargo handling appliances comply with the Rules based on the drawings and documents submitted to the Society. In this case, the applicant is to submit the relevant drawings and documents out of listed in (2), (3) and (4) below.
- (2) The relevant drawings and documents listed in the following (A) through (K) are to be submitted for approval for cargo handling appliances to be newly constructed;
 - (A) General arrangement of cargo gears and cargo ramps

- (B) Construction drawings of cargo gears and cargo ramps(including the dimensions of structural members, specifications of materials and joint details)
 - (C) Drawings of cargo fittings(including the dimensions, specifications of materials and the fixing methods of these fittings with structural members or hull structure)
 - (D) Arrangement of loose gears(including rigging arrangement)
 - (E) List of loose gears(showing the construction, dimensions, materials and locations. For those in compliance with the well-known code or standard, the type symbol may be used in place of dimensions and materials)
 - (F) Construction drawings of driving gears
 - (G) Power system diagram
 - (H) Drawings of operation and control mechanism
 - (I) Drawings of safety devices
 - (J) Drawings of protective devices
 - (K) Other drawings and documents as deemed necessary by the Society
- (3) The relevant drawings and documents listed in the following (A) through (F) are to be submitted for reference for cargo handling appliances to be newly constructed; (2019)
- (A) Specifications for cargo gears and cargo ramps
 - (B) Calculation sheets or check sheets relevant to drawings and documents for approval specified in (2) above
 - (C) Operation manual for cargo gears and cargo ramps
 - (D) Procedures of non-destructive testing
 - (E) Procedures of Load tests
 - (F) Other drawings and documents as deemed necessary by the Society
- (4) At a Registration Survey of cargo handling appliances not built under Survey, the drawings and data to be submitted for the cargo handling appliances are to be same as specified in (2) and (3) above. However, some of these drawings and documents may be omitted submitting the past survey records and certificates if deemed appropriate by the Society. (2022)

2. Examinations for Workmanship [See Guidance]

- (1) Workmanship of cargo handling appliances is to be examined and ascertained to be in good order when any of the following (A) through (E) is relevant:
- (A) When, in process of manufacturing and assembling of structural members, requested by the Society
 - (B) When structural members are installed on board the ship
 - (C) For driving gears, at the times when the finishing work on major parts is completed and when the Surveyor considers necessary during the process of manufacture
 - (D) When the subcontracted materials, parts or equipment are incorporated to the cargo handling appliances
 - (E) Other cases when considered necessary by the Society
- (2) Cargo handling appliances are to be examined and ascertained to be in good order by the following tests and surveys:
- (A) Testing as specified in **Pt 2, Ch 1** where the materials need to be in compliance with the requirements in **Pt 2, Ch 1**
 - (B) Testing as specified in **Pt 2, Ch 2** where the welding works need to be in compliance with the requirements in **Pt 2, Ch 2**
 - (C) Non-destructive testing where requested by the Surveyor
 - (D) Shop trial of the driving gears
 - (E) Operation tests of the cargo handling appliances
 - (F) Operation tests of the safety devices and protective devices(including braking tests and electric power source cut-off tests with a testing weight equal to the safe working load applied)
 - (G) Other tests considered necessary by the Society

3. On board installation survey (2020)

- (1) survey for connection between the structural members and hull structure
- (A) survey for welded connection between the structural members and hull structure
 - (B) Non-destructive test (When considered necessary by the Surveyor)
- (2) On board operation tests and load tests
- (3) Other tests considered necessary by the Society

4. Registration Surveys for cargo handling appliances already installed on board a ship (2020)

- (1) Identification of materials and equipment certificates for cargo handling appliances
- (2) On board operation tests and load tests. However, load test may be omitted submitting the cer-

- tificates and inspection records issued by member Society of IACS. (2022)
(3) Other tests considered necessary by the Society

204. Annual Surveys [See Guidance]

1. Derrick Systems [See Guidance]

- (1) At Annual Surveys, the following items in (A) are to be visually examined for derrick systems and ascertained to be in good order. Where considered necessary by the Surveyor, the items in (B) are to be examined.
- (A) Items to be examined
- (a) Structural members
 - (b) Connection between the structural members and hull structure
 - (c) Driving systems
 - (d) Safety devices and protective devices
 - (e) Markings of the safe working load, etc., and the effectiveness of the relevant certificates
 - (f) Preservation of the instruction manuals on board the ship
- (B) Items to be examined where considered necessary by the Surveyor
- (a) Checking of plate thickness of the structural members, non-destructive testing and open-up examinations of the topping brackets, goose neck brackets and derrick heel lugs
 - (b) Open-up examination of the driving systems
 - (c) Operation tests of the safety devices and protective devices
- (2) At the fifth Annual Survey from the date of completion of the Registration Survey or the previous open-up examination but not exceeding 5 years, the open-up examination of the topping brackets, goose neck brackets and derrick heel lugs is to be carried out.

2. Cranes

At Annual Surveys, the following items in (A) are to be visually examined for cranes and ascertained to be in good order. Where considered necessary by the Surveyor, the items in (B) are to be examined.

- (A) Items to be examined
- (a) Structural members
 - (b) For stationary cranes, the connection between the structural members and hull structure
 - (c) For track-mounted cranes, rails, buffers and the connection between those members and hull structure
 - (d) Installations of driving system
 - (e) Safety devices and protective devices
 - (f) Markings of the safe working load, etc., and the effectiveness of the relevant certificates
 - (g) Preservation of instruction manuals on board the ship
- (B) Items to be examined where considered necessary by the Surveyor
- (a) Checking of plate thickness of the structural members, non-destructive testing and open-up examinations of the bearings
 - (b) Inside of the posts, their legs and stiffeners of cranes
 - (c) Open-up examinations of the driving gears
 - (d) Operation tests of the safety devices and protective devices

3. Cargo Ramps

At Annual Surveys, the items in (A) are to be visually examined for cargo ramps in detail and ascertained to be in good order. Where considered necessary by the Surveyor, the items in (B) are to be examined.

- (A) Items to be examined
- (a) Structural members
 - (b) Connection between the structural members and hull structure
 - (c) Connection between the stoppers and hull structure
 - (d) Water-tight or weather-tight arrangements of cargo ramps that are used as water-tight or weather-tight doors when closed
 - (e) The driving gears
 - (f) Safety devices and protective devices
 - (g) Markings of the safe working load and the effectiveness of the relevant certificates
 - (h) Preservation of the instruction manuals on board the ship

- (B) Items to be examined where considered necessary by the Surveyor
 - (a) Plate thickness measurements, open-up-inspection of lifting pins, nondestructive tests, etc.
 - (b) Hose testing or airtight testing for cargo ramps that are used as water-tight or weather-tight doors when closed
 - (c) Open-up examinations of the driving gears
 - (d) Operation tests of safety devices and protective devices

4. Cargo Lifts, etc.

- (1) At Annual Surveys, the items in (A) are to be visually examined for cargo lifts in detail and ascertained to be in good order. Where considered necessary by the Surveyor, the items in (B) are to be examined.
 - (A) Items to be examined
 - (a) Structural members
 - (b) Connection between the holding parts of cargo lifts and hull structure
 - (c) Connection between the lifting/lowering devices of cargo lifts and hull structure
 - (d) Driving gears
 - (e) Safety devices and protective devices
 - (f) Markings of the safe working load and the effectiveness of the relevant certificates
 - (g) Preservation of the instruction manuals on board the ship
 - (B) Items to be examined where considered necessary by the Surveyor
 - (a) Plate thickness measurements, open-up-inspection of lifting pins, nondestructive tests, etc.
 - (b) Open-up examinations of the driving gears
 - (c) Operation tests of the safety devices and protective devices
- (2) At Annual Surveys for other cargo handling appliances used for loading and unloading of cargoes and other articles, they are to be visually examined and ascertained to be in good order. When considered necessary by the Surveyor, a further examination may be carried out.

5. Loose Gears

- (1) At Annual Surveys, the following items in (A) through (C) of loose gears are to be visually examined and ascertained to be in good order. However, where considered necessary by the Surveyor, the items in (B) are to be opened up and examined.
 - (A) Wire ropes for their full length
 - (B) Cargo blocks, chains, rings, hooks, shackles, swivels, lifting beams, cramps, rigging screw grabs, lifting magnets, spreaders, etc.
 - (C) Markings of the safe working load and identification symbols, and the effectiveness of the relevant certificates
- (2) In case where some of loose gears need to be repaired or renewed at times other than at the Periodical Surveys, the Society may accept an autonomous inspection carried out by ship's master or his representative. In this case, the personnel who carried out an autonomous inspection is to record the following (A) through (F) for the loose gears renewed in the Inspection Record Book of Loose Gear, and show this Inspection Record Book and the certificates of the loose gears concerned to the Surveyor for his approval at the next Periodical Survey or Occasional Survey.
 - (A) Names and identification symbols
 - (B) Locations in service
 - (C) Safe working loads
 - (D) Testing loads
 - (E) Dates of renewal or repairs and dates of commencement of use
 - (F) Reasons for renewal or repairs

205. Load Tests [See Guidance]

- (1) At Load Tests, cargo handling appliances are to be examined by applying movable weights or loads at least equal to the test loads as specified in (2) below and in the manners specified in (3) or (4) depending on the types of cargo handling appliances and ascertained that they are in good order. However, Load Tests of loose gears may be omitted provided that the certificates with testing records of them are examined.
- (2) The test loads used for Load Tests are to comply with the requirements of the following (A) through (C) depending on the types of cargo handling appliances:
 - (A) The test loads for cargo gears and cargo ramps are to be as given in **Table 9.2.2**

- (B) The test loads for loose gears except for ropes are to be as given in **Table 9.2.3**
(C) The test loads for ropes are to satisfy the following formula;

$$T \geq W \cdot f$$

where,

T : Test loads for ropes (t)

W : Safe working loads of ropes (t)

f : Safety factors specified in **603. 1** (E) or **603. 2** (C)

Table 9.2.2 Test Load for Cargo Gear and Cargo Ramps

Safe working load SWL (t)	Test load (t)
$SWL < 20$	$1.25 \times SWL$
$20 \leq SWL < 50$	$SWL + 5$
$50 \leq SWL$	$1.1 \times SWL$

Table 9.2.3 Test Loads for Loose Gears

Article of Gear		Safe Working Load SWL (t)	Test Load (t)
Pulley blocks	Single-sheave block without becket	–	$4 \times SWL$
	Single-sheave block with becket	–	$6 \times SWL$
	Multi-sheave block	$SWL \leq 25$	$2 \times SWL$
		$25 < SWL \leq 160$	$(0.933 \times SWL) + 27$
$160 < SWL$		$1.1 \times SWL$	
Chain hook, shackle, ring, link, swivel, clamp and similar gear		$SWL \leq 25$	$2 \times SWL$
		$25 < SWL$	$(1.22 \times SWL) + 20$
Lifting beam, Lifting magnet, spreader and similar gear		$SWL \leq 10$	$2 \times SWL$
		$10 < SWL \leq 160$	$(1.04 \times SWL) + 9.6$
		$160 < SWL$	$1.1 \times SWL$

- (3) For cargo handling appliances of which the safe working loads, etc. are assigned for the first time, the methods of load tests are to comply with the following requirements in (A) through (E);

(A) Derrick systems

- In case of a swinging derrick system, the test weight is to be slewed throughout the working range at the allowable minimum angle and then lifted/lowered at some position of the working range.
- In case of a derrick crane, in addition to (a) above, the derrick boom is to be luffed with suspending the test weight at the position of outreach and ship's centre line.
- In case of a union-purchase derrick system, the test weight is to be maneuvered throughout the working range within the allowable lifting height or the maximum angle between two cargo falls specified in **902. 3**.

(B) Cranes

- In case of a jib crane, the test weight is to be slewed throughout the working range at the maximum slewing radius and then lifted/lowered at some position of the working range.
- In case of a track-mounted cranes, the crane with the test weight suspended is to be

- transversed throughout the working range and test weight is to be lifted/lowered at some position. Further, jib is to be luffed at some position of the working range.
- (c) In case of a track-mounted hoisting gear, the hoisting gear with suspending the test weight is to be traversed from one end of the bridge span to the other and the test weight is to be lifted/lowered at some position.
- (C) Cargo lifts
In case of a cargo lift, the test weight is to be so spaced that the most severe working condition is available taking into account one side loading, and the cargo lift is to be moved between each stop position, and to be lifted/lowered within the entire stroke of motion.
- (D) Cargo ramps
In case of a cargo ramp, the test weight is to be placed on the severest position of loading in the designed loading conditions, and the deflection is to be measured. As far as practicable, a vehicle with the mass corresponding to the safe working load is to run on the cargo ramp.
- (E) In case of loose gear, the test load is to be loaded in the method considered as appropriate by the Society.
- (4) For the cargo handling appliances other than described in (3) above, the methods of load tests are to comply with the following requirements in (A) or (B).
(A) The load test specified in (3) (A), (B), (C), or (D) above is to be carried out.
(B) The load test may be carried out using a spring or hydraulic weighing machine anchored suitably and safely in accordance with the method considered appropriate by the Society.

Section 3 Derrick Systems

301. General

1. Application

The requirements in this Section apply to the structural members of derrick systems.

302. Design Loads

1. Load Considerations [See Guidance]

The loads to be taken into the calculations of dimensions of the structural members are to be as specified in (A) through (G) below:

- (A) Safe working load of the derrick systems
- (B) Self-weight of derrick boom and cargo fittings attached thereto
- (C) Self-weight of loose gear
- (D) Friction of cargo blocks
- (E) Loads due to ship inclination
- (F) Wind Loading (2022)
- (G) Other loads considered to be necessary by the Society

2. Friction of Cargo Blocks

In calculating the load at the rope end, the following friction load coefficients are to be taken into account depending on the types of bearing:

- Bush bearing : 0.05
- Roller bearing : 0.02

3. Load due to Ship Inclination [See Guidance]

The angles of inclination used for the calculation of the loads due to ship inclination are to be the angles expected to occur in service condition, but they are not to be taken as less than 5° in angle of heel and 2° in angle of trim. If data on the angles of inclination of the ship concerned are submitted and recognized as appropriate by the Society, however, these angles may be used in the calculations.

4. Wind Loading (2022)

Wind loading are to be calculated in accordance with requirements in 402. 5.

5. Load Combinations

- (1) The load to be used in the strength analysis of the structural members is to be such a combined load that these members may be put in the most severe load condition considering the loads specified in **Par 1** above.
- (2) The union-purchase derrick system is to be analyzed as a swinging derrick system and a union-purchase derrick system respectively using the combined load according to the requirement in (1) above.

303. Strength and Construction of Derrick Posts, Masts and Stays

1. Strength Analysis

- (1) The strength of derrick posts, masts (hereinafter referred to as "posts") and stays are to be analyzed for the combined load specified in **302. 5** to determine the dimensions of their members in accordance with the requirement in **Par 2** to **Par 5** below.
- (2) The Young's modulus of the wire ropes to be used in the analysis of strength of stayed posts is to be 30.4 kN/mm² and 45.1 kN/mm² for the case of determining the dimensions of posts and stays respectively.

2. Allowable Stress for Combined Loads

- (1) The combined stress calculated by the following formula on the basis of the compressive stress due to bending moment, the compressive stress due to axial compression and the shearing stress due to twisting of the member is not to exceed the allowable stress σ_a given in **Table 9.2.4**.

$$\sqrt{(\sigma_b + \sigma_c)^2 + 3\tau^2} \quad (\text{N/mm}^2)$$

Where,

σ_b : Compressive stress due to bending moment (N/mm²)

σ_c : Compressive stress due to axial compression (N/mm²)

τ : Shearing stress due to twisting of member (N/mm²)

Table 9.2.4 Allowable Stress σ_a

Safe working load W (t)	Allowable stress σ_a (N/mm ²)
$W < 10$	$0.50\sigma_y$
$10 \leq W < 15$	$(0.016W + 0.34)\sigma_y$
$15 \leq W < 50$	$0.58\sigma_y$
$50 \leq W < 60$	$(0.005W + 0.33)\sigma_y$
$60 \leq W$	$0.63\sigma_y$
(NOTES)	
σ_y : Specified yield stress or proof stress of material (N/mm ²)	

- (2) The tension of the wire ropes used for stay is not to exceed the value obtained by dividing the value of breaking test loads specified in **Pt 4, Table 4.8.11** by the safety factor specified in **603. 1 (E)**.

3. Buckling Strength (2022)

For member subjected to compression, the value obtained from the following formula is not to exceed the allowable stress σ_a given in **Table 9.2.4**.

$$1.15\omega\sigma_c \quad (\text{N/mm}^2)$$

Where,

σ_c : Axial compressive stress (N/mm²)

ω : Coefficient calculated by the formula in **Table 9.2.6** and **Table 9.2.7** for the slenderness ratio and type of the member concerned

4. Combined Compressive Stress (2022)

The compressive stress due to combination of the compressive stress due to axial compression and that due to bending moment is to meet the following formula:

$$\frac{\sigma_c}{\sigma_{ca}} + \frac{\sigma_b}{\sigma_a} \leq 1.0$$

where,

σ_a : Allowable bending stress given in **Table 9.2.4** (N/mm²)

σ_{ca} : Allowable compressive stress to be taken as a quotient of σ_a divided 1.15 (N/mm²)

σ_b : Compressive stress due to bending moment (N/mm²)

σ_c : Compressive stress due to axial compression (N/mm²)

5. Minimum Plate Thickness of Posts

The plate thickness of posts is not to be less than 6 mm.

6. Construction of Posts (2022)

- (1) The lower part of the post is to be effectively connected to hull structures by any of the following methods (A), (B) or (C), or any other method approved as appropriate by the Society:
【See Guidance】
 (A) To be supported by two or more superposed decks
 (B) To be supported by deckhouse of an enough strength
 (C) To be supported by bulkhead for an ample depth beneath the deck
- (2) The post well below the base to well above the goose neck bracket is to be of the dimensions equivalent to that at the base as far as practicable.
- (3) The post is to be locally reinforced by the use of thicker plating, doubling plates, additional reinforcing members, etc. in the connection of post body and portal beam, the parts where the goose neck brackets and topping brackets are fitted, etc. and the parts where stress concentration expected.
- (4) At the ends of the upper portal, its depth and plate thickness are to be properly increased. When opening hole at the end of the upper portal is avoidable, properly reinforcement is to be provided around the opening hole.
- (5) The slenderness ratios of posts or other members subject to compression are to be not bigger than 150.
- (6) The stiffness of the main structural parts of posts is to be ensured to prevent any deformation that may interfere with the operation of the derrick.

304. Strength and Construction of Derrick Booms

1. General

The strength of derrick booms is to be analyzed for the load conditions specified in **302. 4** and their dimensions are to be determined according to the requirements in **Par 2** to **Par 5** below.

2. Strength for Combined Load

The combined stress calculated by the following formula on the basis of the compressive stress due to twisting of the member is not to exceed the allowable stress σ_a given in **Table 9.2.5**.

$$\sqrt{(\sigma_b + \sigma_c)^2 + 3\tau^2} \quad (\text{N/mm}^2)$$

Where,

σ_b : Compressive stress due to bending moment (N/mm²)

σ_c : Compressive stress due to axial compression (N/mm²)

τ : Shearing stress due to twisting of member (N/mm²)

Table 9.2.5 Allowable Stress σ_a

Safe working load W (t)	Allowable stress σ_a (N/mm ²)
$W < 10$ $10 \leq W < 15$ $15 \leq W$	$0.34\sigma_y$ $(0.018W + 0.16)\sigma_y$ $0.43\sigma_y$
(NOTES) σ_y : Specified yield stress or proof stress of material (N/mm ²)	

3. Buckling Strength

For member subjected to compression, the value obtained from the following formula is not to exceed the allowable stress σ_a given in **Table 9.2.5**.

$$1.15\omega\sigma_c \quad (\text{N/mm}^2)$$

Where,

σ_c : Axial compressive stress (N/mm²)

ω : Coefficient calculated by the formula in **Table 9.2.6** and **Table 9.2.7** for the slenderness ratio and type of the member concerned

4. Combined Compressive Stress

The compressive stress due to combination of the compressive stress due to axial compression and that due to bending moment is to meet the following formula:

$$\frac{\sigma_c}{\sigma_{ca}} + \frac{\sigma_b}{\sigma_a} \leq 1.0$$

where,

σ_a : Allowable bending stress given in **Table 9.2.5** (N/mm²)

σ_{ca} : Allowable compressive stress to be taken as a quotient of σ_a divided 1.15 (N/mm²)

σ_b : Compressive stress due to bending moment (N/mm²)

σ_c : Compressive stress due to axial compression (N/mm²)

Table 9.2.6 Formula for ω

Relation of λ and λ_0	Type of member	Formulae for ω
$\lambda \geq \lambda_0$	All members	$2.9 \left(\frac{\lambda}{\lambda_0} \right)^2$
$\lambda < \lambda_0$	Plate members	$\frac{1 + 0.45(\lambda/\lambda_0)}{1 - 0.5(\lambda/\lambda_0)^2}$
	Cylindrical members	$\frac{0.87 + 0.46(\lambda/\lambda_0) + 0.12(\lambda/\lambda_0)^2}{1 - 0.5(\lambda/\lambda_0)^2}$
<p>(NOTES)</p> <p>1. λ is the slenderness ratio of the member subjected to compression to be obtained from the following formula:</p> $l_e \sqrt{\frac{A}{I}}$ <p>where,</p> <p>A : Sectional area of the member (m²)</p> <p>I : Moment of inertia of section of member (m⁴)</p> <p>l_e : Effective length of the member to be determined as the product of the actual length of the member and coefficient K obtained from the following Table 9.2.7 for respective end conditions (m):</p> <p>2. λ_0 is the value obtained from the following formula:</p> $\sqrt{\frac{2\pi^2 E}{\sigma_y}}$ <p>where,</p> <p>π : The circular constant</p> <p>E : Young's modulus (N/mm²)</p> <p>σ_y : Specified yield stress or proof stress of material (N/mm²)</p>		

Table 9.2.7 Values of K

Another end	One end			
	R : con. D : con.	R : con. D : free	R : free D : con.	R : free D : free
R : con. D : con.	0.5	1.0	0.7	2.0
R : con. D : free	1.0	–	2.0	–
R : free D : con.	0.7	2.0	1.0	–
R : free D : free	2.0	–	–	–
<p>(NOTES)</p> <p>R : Rotation D : Displacement con. : constrained</p>				

5. Minimum Plate Thickness of Derrick Booms

The plate thickness used for the body of derrick booms is not to be less than 2 % of the outside diameter at middle of the effective length of the boom or 6 mm, whichever is the greater.

6. Construction of Derrick Booms (2022)

- (1) The plating at the head of the derricks booms to which fittings are attached is to be provided with doubling plates or reinforced by other suitable means.
- (2) Where cargo fittings for whipped rigging are attached to the boom, proper reinforcement is to be made by doubling plates or other suitable means.
- (3) The slenderness ratios of derrick booms subject to compression are to be not bigger than 150.
- (4) The stiffness of the main structural parts of derrick booms is to be ensured to prevent any deformation that may interfere with the operation of the derrick.

7. Derrick Boom Stopper for Dropping Out

Derrick booms are to be supported by a goose neck bracket and to be safeguarded against dropping out of their sockets or supports.

305. Simplified Calculation Method for Post and Stays of Swinging Derrick Systems

1. Application

Notwithstanding the provisions in **303. 1** through **3**, the dimensions of posts and stays of swinging derrick systems may be determined according to the requirements in **305**.

2. Diameter of Post at the Base

The outside diameter of post at the base is not to be less than the value obtained from the following formula. For elliptic or oval section, its minor diameter is to be regarded as the outside diameter, while the short side is to be regarded as the outside diameter for rectangular cross section.

$$5h \quad (\text{cm})$$

where,

h : Vertical distance from the base of post to the topping bracket (m)

3. Section Modulus of Post at the Base

- (1) The section modulus of unstayed posts at the base is not to be less than the value obtained according to (A) through (C) below depending upon the arrangement of derrick booms.
- (A) When a derrick boom is fitted on either of forward or aftward side of the post, the section modulus is to be the value obtained from the following formula:

$$C_1 C_2 \rho W \quad (\text{cm}^3)$$

where,

W : Safe working load (t)

ρ : Slewing radius at the allowable minimum angle (m)

C_1 and C_2 : Coefficients obtained from **Table 9.2.8**. For intermediate values of W , the coefficients C_1 and C_2 are to be obtained by interpolation.

Table 9.2.8 Values of C_1 and C_2

W (t)	2 or less	3	4	5	6	7	8	9	10
C_1	1.35	1.25	1.20	1.17	1.15	1.14	1.13	1.12	1.10
C_2	125	120	117	115	114	113	112	111	110

- (B) The section modulus about the axis parallel to the longitudinal direction of the ship is to be the value obtained from (A) above or the value obtained from the following formula, whichever is the greater, when two derrick booms are fitted on both the forward and aftward the post.

$$\sum C_2 W u \quad (\text{cm}^3)$$

where,

$\sum C_2 W$: Sum of $C_2 W$ for derrick booms situated forward and aftward the post respectively Where C_2 and W are those obtained from (A) above

u : Distance from the center of the post to the side of the ship, plus the out-reach (m)

- (C) Where derrick booms are supported by an independent structure other than the post, the section modulus is not to be less than obtained from the formula in (A) and (B) above, multiplied by the value obtained from the following formula. In this case, the coefficient C_1 in the formula specified in (A) above is to be taken as 1.0.

$$\frac{h}{h-h'}$$

where,

h' : Vertical distance from the base of the post to the center of horizontal pin of the goose neck bracket (m)

h : As specified in **Par 2** above

- (2) The section modulus of stayed posts at the base may be the value specified in (1) above reduced by the value obtained from the following formula:

$$10 \frac{h^3}{d_m^3} \sum R \quad (\text{cm}^3)$$

where,

h : As specified in **Par 2** above

d_m : Outside diameter of the post at the base in the direction in which R assumes minimum in the slewing range for the formula in (1) (A) above, or in the axis parallel to the athwartship direction of the ship for the formula in (1) (B) above (cm)

$\sum R$: Sum of the values obtained from the following formula for each effective stay:

$$\frac{d_s^2 a^2}{l_0^2 l_s^2}$$

where,

- d_s : Diameter of the wire rope for stays (mm)
 l_s : Length of stays between the upper and lower ends (m)
 l_0 : Length equal to l_s reduced by the value obtained from the following formula: (m)
 $0.045d_s + 0.26$ (m)
 a : Length of horizontal projection of the stays measured in the same direction as the measurement of d_m (m)

- (3) Where the derrick booms are supported by a king post with a portal having uniform cross section, the section modulus of the post at the base is not to be less than the values obtained from (A), (B) and (C) below:

- (A) The section modulus about the axis parallel to the athwartship direction of the ship is to be the value obtained by the formula in (1) (A) multiplied by the following coefficient C_P :

$$\begin{array}{ll} 0.7 & \text{for } r \geq 0.6 \\ 1 - 0.5r & \text{for } r < 0.6 \end{array}$$

where,

r : Ratio of the breadth of the cross section of the portal to the diameter of the post at the base in the longitudinal of the ship

- (B) The section modulus about the axis parallel to the longitudinal direction of the ship is to be the values obtained from (1) (A) or (B) above, whichever is the greater, multiplied by the following coefficient:

$$\begin{array}{ll} 0.35 & \text{for } r' \geq 0.3 \\ 0.5 - 1.67r'^2 & \text{for } r' < 0.3 \end{array}$$

where,

r' : Ratio of the depth of the cross section of the portal to the diameter of the post at the base in the athwartship direction

- (C) Where the distance between posts on the port and starboard sides exceed 2/3 of the height of the post, the coefficients specified in (A) and (B) above are to be suitably increased.

- (4) The section modulus of the stayed king post at the base is not to be less than the values obtained from (A) and (B) below:

- (A) The section modulus about the axis parallel to the athwartship direction of the ship is to be the value obtained from the following formula:

$$C_P \left(C_1 C_2 \rho W - 10 \frac{h^3}{d_m} \sum R \right) \quad (\text{cm}^3)$$

where,

C_P : As specified in (3) (A) above

C_1 , C_2 and ρ : As specified in (1) (A) above

$10 \frac{h^3}{d_m} \sum R$: Values obtained according to (2) above, provided that stays on one side only are to be taken into account

- (B) The section modulus about the axis parallel to the longitudinal direction of the ship is to be the value given in (3) (B) above.

- (5) The section modulus of the short side post at the base supporting the derrick boom is not to be less than the value obtained according to (A) or (B) below:

(A) When a derrick boom is fitted on either of the forward or aftward the side post, the section modulus is to be the value obtained from the following formula:

$$85 \frac{h'}{h-h'} \rho W \quad (\text{cm}^3)$$

where,

W and ρ : As specified in (1) (A) above

h' : As specified in (1) (C) above

h : As specified in **Par 2** above

(B) Where derrick booms are fitted on the forward and aftward the side post, the section modulus of the side post about the parallel to the longitudinal direction of the ship is to be the greater of the value obtained from (A) above or the value obtained from the formula in (A) above using, in place of ρW , the product of the sum of W values for the forward and aftward booms and the value u given in (1) (B) above, provided that u is to be measured from the center of the side post.

4. Dimensions of Post other than at the Base

- (1) The post from well below the base to well above the goose neck bracket is to be of the dimensions equivalent to that at the base as far as practicable.
- (2) The diameter and thickness of the post above the position specified in (1) above may be gradually reduced according to the following (A) and (B).
 - (A) The outside diameter where the outrigger or the topping bracket are fitted may be 85 % of the diameter at the base.
 - (B) The plate thickness at any arbitrary position of the post is not to be less than obtained from the following formula.

$$0.1d_m + 2.5 \quad (\text{mm})$$

where,

d_m : Minimum outside diameter of the post at each position (cm)

5. Outriggers

Outriggers are to be properly constructed and of sufficient strength.

6. Portals

- (1) The section modulus of the portal of uniform section fitted to the king post is not to be less than the values obtained from (A) to (C) below:
 - (A) The section modulus about the vertical axis is to the value obtained from the formula given in **Par 3** (1) (A) above multiplied by the coefficient obtained from the following formula. Where this coefficient exceeds 0.2, it may be taken as 0.2.

$$0.1 + 0.235 \frac{r}{c}$$

where,

r : As specified in **Par 3** (3) (A) above

c : Ratio of the actual section modulus (cm^3) of the post at the base about the axis parallel to the athwarship direction of the ship to that obtained from the formula in **Par 3** (1) (A) above

- (B) Notwithstanding the requirements in (A) above, the section modulus of the portal about the vertical axis may be reduced to a half of the value in (A) above where derrick boom is fitted only on one side of the forward of post.
- (C) The section modulus about the horizontal axis is to be the value obtained from the formula in **Par 3** (1) (B) above multiplied by the coefficient obtained from the following formula. Where this coefficient exceeds 0.2, it may be taken as 0.2.

$$0.25 \frac{r'}{c'}$$

where,

r' : As specified in **Par 3** (3) (B) above

c' : Ratio of the actual section modulus (cm^3) of the post at the base about the axis parallel to the longitudinal direction of the ship to that obtained from the formula in **Par 3** (1) (B) above

- (2) The portal is to be properly stiffened so as to prevent the deformation due to bending.

7. Stays

The tension in wire ropes used for stays is to be less than the value obtained from the following formula.

$$18 \frac{d_s^2 a}{l_0 l_s} \delta \quad (\text{kN})$$

where,

a , d_s , l_0 and l_s : As specified in **Par 3** (2) above. In this case, a is to be measured in the same direction as in the calculation of the value of δ .

δ : Value obtained from the following formula:

$$C_s \frac{h}{h-h'} \cdot \frac{\rho W}{\frac{I}{h^2} + 7.32h \sum R}$$

where,

I : Moment of inertia of section (cm^4) of the post at the base about the axis parallel to the athwarship direction of the ship. For the king posts, however, the value of I divided by the coefficient C_p given in **Par 3** (3) (A) above is to be used in place of I .

h : As specified in **Par 2** above

h' , W and ρ : As specified in **Par 3** (1) (A) and (C)

$\sum R$: As specified in **Par 3** (2) above. In this case, a is to be measured in all directions in the slewing range of the derrick boom in calculating $\sum R$

C_s : Value given in **Table 9.2.9**. For intermediate values of W , the coefficient C_s is to be obtained by interpolation.

Table 9.2.9 Values of C_s

W (t)	2 or less	3	4	5	6	7	8	9	10	15 and above
C_s	2.64	2.52	2.46	2.41	2.38	2.35	2.33	2.31	2.29	2.22

306. Simplified Calculation Methods for Derrick Booms

1. General

Notwithstanding the requirements in **304. 1** through **5**, the dimensions of derrick booms may be determined in accordance with requirements in this **306**.

2. Derrick Booms without Whipped Rigging

(1) The dimensions of derrick booms of derrick system without whipped rigging are not to be less than obtained according to (A), (B) and (C) below:

(A) The moment of inertia of derrick boom at the middle post is not to be less than obtained from the following formula:

$$C_B P l^2 \quad (\text{cm}^4)$$

where,

C_B : Value obtained from **Table 9.2.10**

l : Effective length of derrick boom (m) (See **Fig 9.2.1**)

P : Axial compression of derrick boom to be determined according to (a) or (b) depending on the type of the derrick systems. When the self-weight of derrick boom and its fitting are accurately estimated, the value obtained from the force diagram may be used as P .

(a) Swinging Derrick Systems

$$P = \left(\alpha_1 \frac{l}{h-h'} + f \right) Wg \quad (\text{kN})$$

where,

W and h' : As specified in **305. 3** (1) (A) and (C)

h : As specified in **305. 2**

α_1 : Value obtained from **Table 9.2.11**. For intermediate values of W , α_1 is to be obtained by interpolation.

f : Coefficient obtained from **Table 9.2.12**, depending on the number of cargo block for cargo fall. Where the cargo fall is carried to the top of the post through the sheave fixed to the top of the boom, f may be taken as zero.

Table 9.2.10 Values of C_B [See Guidance]

Safe working load W (t)	C_B
$W \leq 10$	0.28
$10 < W < 15$	$0.40 - 0.012 W$
$15 \leq W \leq 50$	0.22
$50 < W$	Value as considered appropriate by the Society

Table 9.2.11 Values of α_1 [See Guidance]

W (t)	2 or less	3	4	5	6	7	8	9	10	above 10
α_1	1.28	1.23	1.20	1.18	1.16	1.15	1.14	1.13	1.13	Value as considered appropriate by the Society

Table 9.2.12 Values of f

n	1	2	3	4	5	6	7	8
f	1.102	0.570	0.392	0.304	0.251	0.216	0.192	0.172
(NOTES) n : The sum of sheaves of cargo block for cargo fall.								

(b) Derrick systems other than swinging derrick systems

$$P = \left(\alpha_1 \frac{l}{h-h'} + f \right) Wg + \frac{Kn_1\alpha_1\alpha_2}{n_2\sqrt{b^2+l^2}} l Wg \quad (\text{kN})$$

where,

α_1 , l , h , h' , f and W : As specified in (a) above

α_2 : As specified 502. 2

b : Horizontal distance from the goose neck bracket to guy post (m)

n_1 : Number of guy ropes

n_2 : Number of topping ropes

K : Values given in Table 9.2.13 depending on the type of rigging

Table 9.2.13 Values of K

Rigging system	K
Type A	0
Type B	1.2
Type C	2.0
(NOTES) 1. Type A is rigging system having two guy tackles on port and starboard sides of the top of the post so that these guy tackles may also serve as topping lifts. 2. Type B is a rigging system having a deltaplate connecting the end of topping lift and ends of port and starboard side guy ropes so that the tension of topping lift may absorb the slackening of guy ropes. 3. Type C is a rigging systems having a connecting block connecting the end of guy rope(s) of both sides (or of one side) and the topping lift led along the derrick post so that the slackening of guy rope(s) may be absorbed by the topping lift.	

(B) In derrick booms with tapered end parts, the parallel part in the midlength is, as a standard, to be of a length equal to 1/3 of the effective length, and the diameter at the ends is not to be less than 60 % of the diameter of the parallel midlength part.

(C) The thickness of steel plate used for the body of derrick booms is not to be less than the value obtained from the following formula or 2 % of the outside diameter at the middle part whichever is the greater.

$$\begin{aligned} 6 \text{ (mm)} & \quad \text{for } P < 75.5 \text{ (kN)} \\ 5 + 0.0133 P \text{ (mm)} & \quad \text{for } P \geq 75.5 \text{ (kN)} \end{aligned}$$

(2) The shape and dimensions of the derrick boom of swinging derrick system may be in accordance with any other standards recognized by the Society to be equivalent. **【See Guidance】**

3. Derrick Booms with Whipped Rigging

The dimensions of derrick booms of derrick system with whipped rigging are not to be less than obtained according to (A) and (B).

- (A) The moment of inertia of section at an arbitrary position at a distance of x (m) from the center of eye fitting at derrick heel is not to be less than obtained from the following formula. Where a doubling plate is fitted for a sufficient length, 70 % of the doubling plate may be added to $D(x)$ and $A(x)$ in the formula.

$$I(x) = C_B P l^2 \left\{ 1 - 3.136 \left(\frac{x}{l} - 0.5 \right)^2 \right\} + \frac{D(x) l_1 x}{2 \left(\sigma_0 - \frac{P}{A(x)} \times 10 \right) l} \cdot \frac{W g}{N} \cos \theta \times 10^3$$

where,

$I(x)$: Required moment of inertia of section at a distance of x (m) from the derrick heel (cm^4)

C_B : As specified in **Par 2** above

P : Axial compression of boom specified in **Par 2** (1) (A) (kN)

l : Effective length of boom (m)

W : Safe working load as specified in **305. 3** (1) (A) (t)

N : Sum of sheaves of cargo block for cargo fall(except cargo block for cargo relief)

θ : Allowable minimum angle of boom (degree)

l_1 : Distance between the eye fittings for whipped rigging (m) (See **Fig 9.2.1**)

$D(x)$: Outside diameter of derrick boom at a distance of x (m) from the boom heel minus plate thickness (cm)

$A(x)$: Sectional area of derrick boom at a distance of x (m) from the boom heel (cm^2)

σ_0 : Value given in **Table 9.2.14** (N/mm^2)

- (B) The length of parallel part at the middle, the diameter at ends and the plate thickness of the boom body are to be as specified in **Par 2** (1) (B) and (C) above.

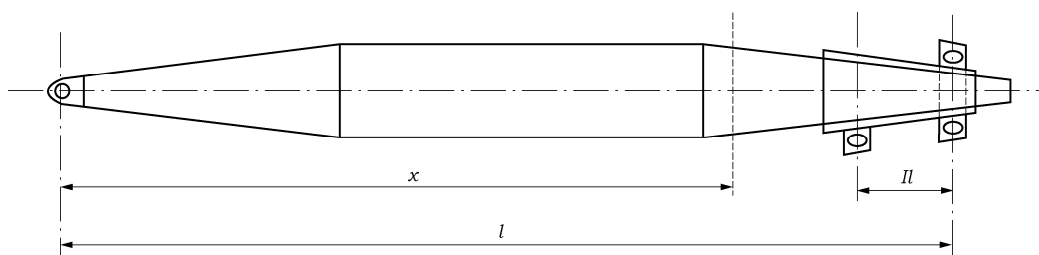


Fig 9.2.1 Derrick Boom with Whipped Rigging

Table 9.2.14 Values of σ_0 [See Guidance]

Safe working load W (t)	σ_0
$W \leq 10$	80.4
$10 < W < 15$	$4.04 W + 40.0$
$15 \leq W \leq 50$	100.6
$50 < W$	Value as considered appropriate by the Society

Section 4 Cranes

401. General

1. Application

The requirements in this Section apply to the structural members of cranes.

402. Design Loads [See Guidance]

1. Load Considerations

The loads to be taken into the calculation of dimensions of structural members are to be those related to the crane concerned among the items enumerated from (A) to (K) below:

- (A) Safe working load of the cranes
- (B) Additional impact loads
- (C) Self-weight of crane system and cargo fittings attached thereto
- (D) Self-weight of loose gear
- (E) Friction of cargo blocks
- (F) Horizontal forces
- (G) Wind loading
- (H) Buffer forces
- (I) Loads due to ship inclination
- (J) Loads due to ship motion
- (K) Other loads considered necessary by the Society

2. Additional Impact Loads

- (1) The additional impact load is to be the product of the lifting load and the impact load coefficient given in **Table 9.2.15** depending on the type of cranes. When the stress due to hoisting of cargo and the stress due to the self weight have different signs in a member, 50 % of additional impact load is to be taken into account in addition to the self-weight, considering the shock due to unloading.
- (2) Notwithstanding the requirements specified in (1) above, additional impact load coefficient based on actual measurements taking into account the hoisting speed, deflections of girders, length of ropes, etc. may be used in place of the values given in **Table 9.2.15**.

Table 9.2.15 Additional Impact Load Coefficient

Types of cranes	Additional impact load coefficient
Provision handling crane, machinery handling crane, maintenance crane and hose handling crane	0.10
Jib crane and gantry crane for cargo handling	0.25
Jib crane and gantry crane occasionally used with hydraulically operated or rope-operated bucket, etc. for cargo handling	0.40
Jib crane and gantry crane always using grab, lifting magnet, etc. for cargo handling and offshore jib crane	0.60

3. Friction of Cargo Blocks

The friction of cargo blocks is to be as specified in **302. 2**.

4. Horizontal Forces

- (1) In track-mounted cranes, the transverse forces due to travel motion is to be taken into consideration as a factor of horizontal force in addition to the inertial force and centrifugal force.
- (2) The inertial force is to be obtained by multiplying the sum of the mass of the moving parts and the lifting load(in slewing motion, the load is assumed to be at the top of jib) by the following coefficient depending on the condition of motion. In the case of travelling by driven wheels, however, this inertial force need not exceed 15 % of the driving wheel load.

Level luffing motions	: $0.01 \sqrt{V}$
Traversing or travelling motions	: $0.008 \sqrt{V}$
Slewing motions	: $0.006 \sqrt{V}$

where,

V : Velocity of motion concerned to be determined by the designer (m/min)

- (3) Notwithstanding the requirements in (2) above, the values of the actual acceleration deceleration characteristics, the actual braking time, etc. for the mode of motion concerned may be used as the inertial forces, if such values are known.
- (4) For a system having structural members which will make slewing motions while supporting the safe working load, the centrifugal force determined from following formula is to be taken into consideration

$$\frac{Wv^2}{R} \text{ (kN)}$$

where,

W : Safe working load (t)

R : Slewing radius (m)

v : Circular speed (m/sec)

- (5) The transverse force due to travel motions is to be calculated from the following formula:

$$\lambda D \text{ (kN)}$$

where,

D : Wheel load (kN)

λ : Transverse force coefficient to be determined from the following formula depending on the value of l/a . However, λ need not exceed 0.15:

$$\begin{aligned} 0.05 & \quad \text{for } \frac{l}{a} \leq 2 \\ \frac{1}{60} \left(\frac{l}{a} + 1 \right) & \quad \text{for } \frac{l}{a} > 2 \end{aligned}$$

Where,

l : Span of rails (m)

a : Effective wheel base to be determined according to **Fig 9.2.2**

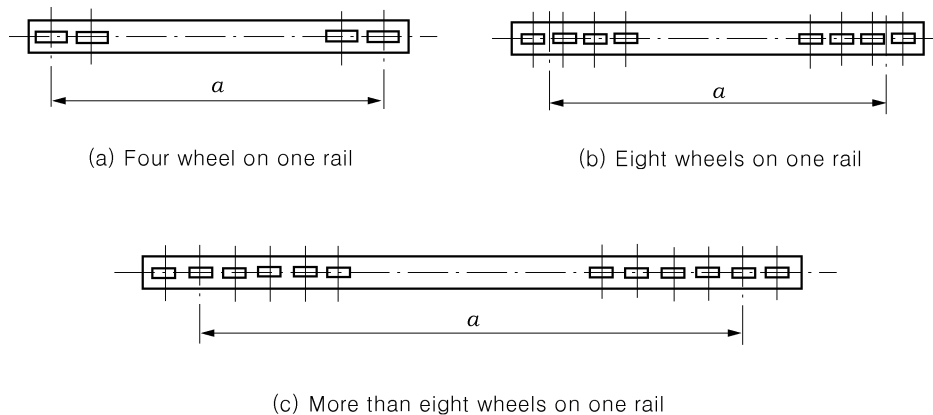


Fig 9.2.2 Measurement of Effective Wheel Base

5. Wind Loading

(1) The wind loading is to be calculated by the following formula:

$$F = PA \times 10^{-3} \quad (\text{kN})$$

where,

F : Wind loading (kN)

A : Sum of structural members and cargo under wind pressure in projection in respective wind direction, corresponding to respective conditions of the cargo gear (m^2). When a girder is wholly or partly protected from wind by another girder, the areas of the superposed portions may be multiplied by the reduction factor (η) obtained from **Fig 9.2.3**. The distance b between girders is to be as given in **Fig 9.2.4**.

P : Wind pressure calculated by the following formula (Pa)

$$\frac{1}{16} C_h C_s g V^2 \quad (\text{Pa})$$

where,

V : Wind velocity according to (A) and (B) below (m/sec)

(A) The velocity of wind giving effect on the structural members and cargo in the service conditions is to be the design wind velocity specified by the applicant, but not be less than 16 m/sec.

(B) The velocity of wind giving effect on the structural members in the stowage conditions is to be the design wind velocity specified by the applicant. In no case is the design wind velocity to be less than 51.5 m/sec. In ships with restricted navigation areas, however, the design wind velocity may be decreased according to the degree of restriction as approved by the Society in the range down to 25.8 m/sec.

C_h : "Height factor" to be determined according to **Table 9.2.16** depending on the height of the position is question from the light weight waterline.

C_s : "Shape factor" to be determined according to **Table 9.2.17** depending on the shapes of various parts of the cargo gear and the cargo.

(2) Notwithstanding the requirements in (1), the data on wind loading obtained by wind tunnel tests for the structural members and cargo may be used for calculations.

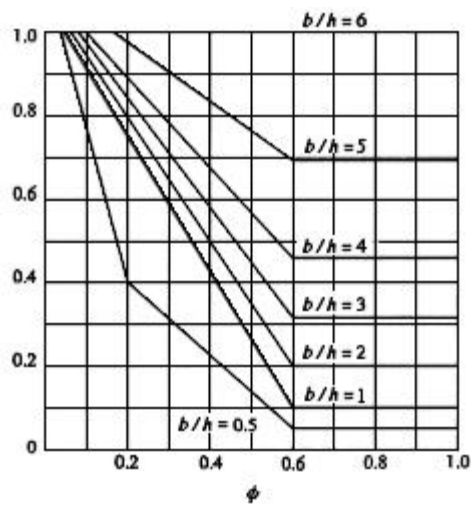


Fig 9.2.3 Replenishment Ratio, ϕ and versus Reduction Factor, η

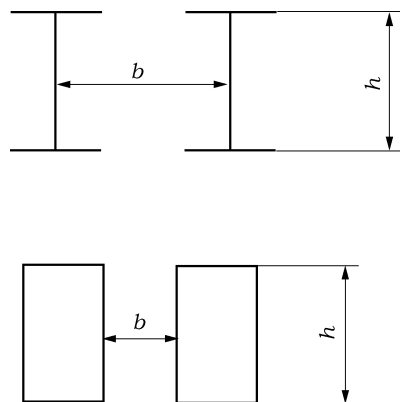
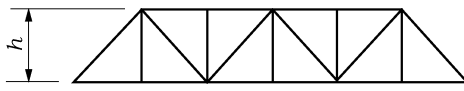
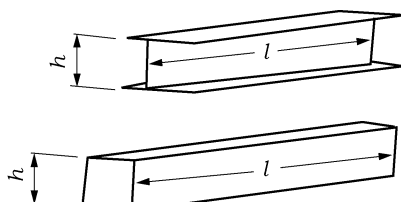
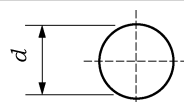


Fig 9.2.4 Distance between two neighbouring girders, b

Table 9.2.16 Height Factor C_h 【See Guidance】

Vertical height h (m)	C_h
$h < 15.3$	1.00
$15.3 \leq h < 30.5$	1.10
$30.5 \leq h < 46.0$	1.20
$46.0 \leq h < 61.0$	1.30
$61.0 \leq h < 76.0$	1.37
$76.0 \leq h$	Value as considered appropriate by the Society

Table 9.2.17 Shape Factor C_s (2022)

Type of area under wind pressure			C_s
Truss of angle		$\phi < 0.1$	2.0
		$0.1 \leq \phi < 0.3$	1.8
		$0.3 \leq \phi < 0.9$	1.6
		$0.9 \leq \phi$	2.0
Plate girder or Box girder		$\frac{l}{h} < 5$	1.2
		$5 \leq \frac{l}{h} < 10$	1.3
		$10 \leq \frac{l}{h} < 15$	1.4
		$15 \leq \frac{l}{h} < 25$	1.6
		$25 \leq \frac{l}{h} < 50$	1.7
		$50 \leq \frac{l}{h} < 100$	1.8
		$100 \leq \frac{l}{h}$	1.9
Cylindrical member or truss of cylindrical member		$d\sqrt{q} < 1.0$	1.2
		$1.0 \leq d\sqrt{q}$	0.7

(NOTES)

ϕ : Repleteness ratio equal to the ratio of projected area under wind pressure to the projected area surrounded by the outer contour of the area under wind pressure

l : Length of plate girder or box girder (m)

h : Height of plate girder or box girder looked at from windward (m)

d : Outer diameter of cylindrical member (m)

q : Value calculated by the following formula:

$$\frac{1}{16} C_h \cdot g V^2 \times 10^{-3} (\text{kPa})$$

6. Buffer Forces

- (1) The buffer forces are assumed to be the loads in the crane system originating from collision with buffer at a speed equal to 70% of the rated speed when no cargo is suspended from the crane. In a crane system having a rigid guide, etc. to limit the swinging of suspended cargo due to collision, the influence of the cargo weight is also to be taken into consideration.
- (2) Notwithstanding the requirement in (1) above, in a crane system designed to be automatically decelerated before colliding the buffer, the speed after deceleration may be regarded as the rated speed in the requirement in (1) above.

7. Loads due to Ship Inclination [See Guidance]

The angles of inclination used for the calculation of loads due to ship inclination are not to be less than the values specified below:

In service conditions : 5° in angle of heel and 2° in angle of trim occurring simultaneously
In stowage conditions : 30° in angle of heel

8. Loads due to Ship Motion

The accelerations used for the calculation of loads due to ship motion are the severest of the combinations (A) or (B) below for the stowage condition, and values recognized by the Society to be appropriate for the service condition. If data on the ship's motions are submitted and recognized by

the Society to be appropriate, the values in such data may be used in the calculations.

- (A) $\pm 1.0g$ in the direction normal to the deck and $\pm 0.5g$ in the longitudinal direction parallel to the deck
- (B) $\pm 1.0g$ in the direction normal to the deck and $\pm 0.5g$ in the transverse direction parallel to the deck

9. Load Combinations [See Guidance]

- (1) The load to be used in the strength analysis of structural members is to be such a combined load that these members may be put in the severest loading condition considering the loads specified in (2) through (5) below.
- (2) When the wind loading is not taken into account in service condition, the sum of loads from (A) to (I) below multiplied by a work coefficient given in **Table 9.2.18** according to the type of crane concerned is to be considered.
 - (A) Safe working load of the cranes
 - (B) Additional impact loads
 - (C) Self-weights of crane system and cargo fittings attached thereto
 - (D) Self-weights of loose gear
 - (E) Friction of cargo blocks
 - (F) Horizontal loads
 - (G) Loads due to ship inclination
 - (H) Loads due to ship motion(except those intended to cargo handling in harbours only)
 - (I) Other loads considered necessary by the Society
- (3) When the wind loading are to be taken into consideration in the service conditions, the wind loading is to be added to the design load as specified in (2) above.
- (4) The buffer forces as given in **Par 6** above are to be taken into consideration for the track-mounted cranes.
- (5) In stowage condition, the loads from (A) to (E) below are to be considered
 - (A) Self-weights of crane system and cargo fittings attached thereto
 - (B) Wind Loading in the stowage conditions
 - (C) Loads due to ship inclination in the stowage conditions
 - (D) Loads due to ship motion stowage conditions
 - (E) Other loads considered necessary by the Society

Table 9.2.18 Work Coefficient of Crane Systems

Type of crane	Work coefficient
Provision handling crane, machinery handling crane, maintenance crane and hose handling crane	1.00
Jib crane and gantry crane for cargo handling	1.05
Jib crane and gantry crane occasionally used with hydraulically operated or rope-operated bucket, etc. for cargo handling	1.10
Jib crane and gantry crane always using grab, lifting magnet, etc. for cargo handling and offshore jib crane	1.20

403. Strength and Construction

1. General [See Guidance]

- (1) The strength of structural members is to be analyzed on the load conditions specified in **402. 9** to determine their dimensions according to requirements in **Par 2** through **Par 9** below.
- (2) For structures connected by bolts and nuts, proper considerations are to be given to the decrease of effective sectional areas.
- (3) When considered necessary by the Society may require the confirmation of the appropriateness of strength analyses by examination of models or the things in question.

2. Allowable Stress for Combined Loads

The allowable stress given in **Table 9.2.19** are to be used for components subjected to combined loads.

3. Buckling Strength

For members subjected to compression, the values obtained from the following formula is not to exceed the allowable compressive stress given in **Table 9.2.19**.

$$\omega \sigma_c \quad (\text{N/mm}^2)$$

where,

ω and σ_c : As specified in **304. 3**

4. Combined Compressive Stress

When the compressive stress of a member is determined as a combination of compressive stress due to axial compression and that due to bending moment such a compressive stress is to comply with the following formula:

$$\frac{\sigma_c}{\sigma_{ca}} + \frac{\sigma_b}{\sigma_a} \leq 1.0$$

where,

σ_b : Compressive stress due to bending moment (N/mm²)

σ_c : Compressive stress due to axial compression (N/mm²)

σ_a : Allowable bending stress given in **Table 9.2.19** (N/mm²). For fixed posts at the base, however, the allowable stress σ_a in **Table 9.2.4** is to be used.

σ_{ca} : Allowable compressive stress given in **Table 9.2.19** (N/mm²). For fixed post at the base, however, the allowable stress (N/mm²) is to be taken equal to the allowable stress in **Table 9.2.4** divided by 1.15.

Table 9.2.19 Allowable Stress σ_a (2022)

Load Condition	Kind of stress				
	Tension	Shear	Compression	Bearing	Combined stress
Condition specified in 402. 9 (2)	$0.67\sigma_Y$	$0.39\sigma_Y$	$0.58\sigma_Y$	$0.94\sigma_Y$	$0.77\sigma_Y$
Condition specified in 402. 9 (3)	$0.77\sigma_Y$	$0.45\sigma_Y$	$0.67\sigma_Y$	$1.09\sigma_Y$	$0.89\sigma_Y$
Condition specified in 402. 9 (4) and (5)	$0.87\sigma_Y$	$0.50\sigma_Y$	$0.76\sigma_Y$	$1.23\sigma_Y$	$1.00\sigma_Y$
(NOTES) 1. σ_Y : Specified yield stress or proof stress of material (N/mm ²) For steel material of $\sigma_Y \geq 0.83 \cdot \sigma_T$, the value of $0.83 \cdot \sigma_T$ is to be applied instead on σ_Y . where σ_T : Specified tensile stress of material(N/mm ²) 2. The combined stress is to be the value obtained from the following formula: $\sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x \sigma_y + 3\tau_{xy}^2} \quad (\text{N/mm}^2)$ where, σ_x : Applied stress in x -direction at the middle of plate thickness (N/mm ²) σ_y : Applied stress in y -direction at the middle of plate thickness (N/mm ²) τ_{xy} : Applied shear stress in the $x-y$ plane (N/mm ²)					

5. Fatigue Strength

Where the influence of repeated stress cannot be neglected, the member is to have an ample strength against fatigue with due consideration for the magnitude and frequency of repeated stress, the form of the member in question, etc.

6. Minimum Thickness

The thickness of structural members is not to be less than 6 mm.

7. Strength of Bolts, Nuts and Pins

Bolts, nuts and pins are to have sufficient strength for the magnitudes and directions of the loads they are subjected to.

8. Fixed Posts [See Guidance]

- (1) The fixed posts are to be effectively connected to the hull structure in accordance with the requirements in 303. 4 (1).
- (2) The upper part of fixed post where the flange is attached is to be sufficiently reinforced by increasing the plate thickness or by providing of brackets.

9. Slewing-Ring Fixing Bolts

- (1) Any material having a tensile strength exceeding 1.18 kN/mm² and yield stress exceeding 1.06 kN/mm² is not to be used for the bolts fixing the slewing-rings except when special considerations have given to the strength characteristics of the bolts.
- (2) Special considerations are to be given to the tightening force of fixing bolts.
- (3) The stress generated in fixing bolts is not to exceed the allowable stress given in Table 9.2.20 according to the load conditions specified in 402. 9. In this case, the stress in bolts is taken as the value of the axial compression determined by the following formula divided by the minimum sectional area of fixing bolts.

$$\frac{4M}{D \cdot N} - \frac{W}{N} \quad (\text{N})$$

where,

M : Upsetting moment (N·mm)

D : Pitch circle diameter of fixing bolts (mm)

N : Number of fixing bolts
 W : Axial compression on the slewing-ring (N)

Table 9.2.20 Allowable Stress of Fixing Bolts σ_a

Load condition	σ_a
Condition specified in 402. 9 (2) and (3)	$0.4 \sigma_y$
Condition specified in 402. 9 (5)	$0.54 \sigma_y$
(NOTES) σ_y : Specified yield stress or proof stress of the material (N/mm ²)	

404. Special Requirements for Track-mounted Cranes

1. Stability [See Guidance]

The track-mounted cranes are to have an sufficient stability under the load conditions specified in **402. 9**.

2. Prevention of Upsetting

The track-mounted cranes are to be designed with sufficient considerations for the stability to prevent upsetting even if the wheel shafts or wheels are damaged.

3. Deflection Criteria

When suspending the safe working load, deflection of the traveling girder of the track-mounted cranes is not to exceed 1/800 of the span between the supporting points.

4. Travel Gear

The travel gear is to be securely fixed to the main body of the track-mounted cranes by bolts, welding or pins. The inclinations of hull in service condition and stowage condition are to be taken into consideration.

5. Buffers

The track-mounted cranes are to be provided with buffers in accordance with (A) and (B) below, except when automatic system for prevention of collision is provided.

- (A) At both ends of tracks or any other equivalent positions. These buffers may be replaced by stops of a height not less than 1/2 of the diameter of wheels.
- (B) Where more than two track-mounted cranes are provided on one track, between these track-mounted cranes.

Section 5 Cargo Fittings

501. General

1. Application

The requirements in this Section apply to the cargo fittings.

502. Cargo Fittings [See Guidance]

1. Goose Neck Brackets and Derrick Heel Lugs

- (1) The sizes of goose neck pin, cross bolt and derrick heel lug shown in **Fig 9.2.5** are to be not less than the following values.

$$b = e_1 \sqrt{\frac{P}{g}} \quad (\text{mm})$$

$$c = 0.55e_1 \sqrt{\frac{P}{g}} \quad (\text{mm})$$

$$d = e_1 \sqrt{\frac{P}{g}} \quad (\text{mm})$$

where,

P : Design axial compressive force acting on derrick boom (kN)

e_1 : 15.6. However, in the swinging derrick system, the values given in **Table 9.2.21** may be used according to the safe working load.

- (2) It is recommended that clearance at parts where the cross bolt penetrates through the derrick heel lug and the gooseneck pin of gooseneck bracket is to be less than 2 mm in diameter. The size of the outer parts of bolt holes for the gooseneck pin and derrick heel lug is to be of the same size as the cross bolt radius, as a standard.
- (3) Notwithstanding the requirements in (1) above, the sizes of gooseneck bracket and derrick heel lug may be in accordance with any other standards recognized by the Society. However, for the cargo fittings used for other than the swinging derrick systems, consideration to the effect of increasing load caused by the guy ropes is to be given.

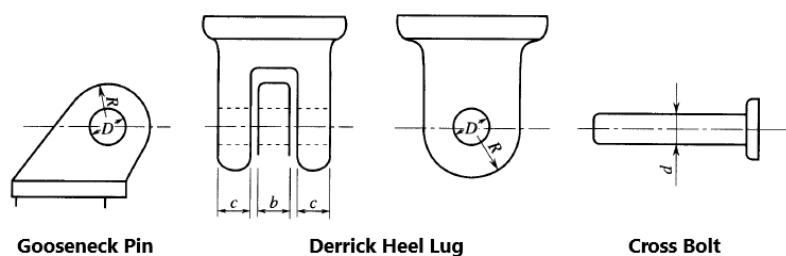


Fig 9.2.5 Gooseneck Pin, Derrick Heel Lug and Cross Bolt

Table 9.2.21 Values of e_1 [See Guidance]

Safe working load W (t)	e_1
$W \leq 10$	15.6
$10 < W < 15$	$18.8 - 0.32 W$
$15 \leq W \leq 50$	14.0
$50 < W$	Value as considered appropriate by the Society

2. Cargo Fittings attached to Head of Derrick Booms

(1) The sizes of cargo fittings attached to the head of derrick booms are not to be less than the values given in the following (A) to (C) according to the respective purpose and shapes of the fittings:

(A) Where the shape of cargo fittings attached to the head of derrick boom are as given in **Fig. 9.2.6**, the sizes of them are not to be less than the following values.

$$d = e_2 \sqrt{\frac{T}{g}} \quad (\text{mm})$$

$$t = e_2 \sqrt{\frac{T}{g}} \quad (\text{mm})$$

where,

e_2 : Value as given in **Table 9.2.22**

T : Maximum tension applied to cargo fitting at the head of derrick boom (kN).
However, in the swinging derrick system, the following value may be used:

$\alpha_1 \alpha_2 W g$ for topping lift

$\lambda W g$ for cargo fall

where,

W : Safe working load (t)

α_1 : As specified in **306. 2**

α_2 : As given in **Table 9.2.23** depending on the value of $l/(h-h')$. However, for intermediate values of α_2 , it is to be obtained by interpolation.

λ : Value given in **Table 9.2.24** depending on the number of sheaves of blocks for cargo fall. However, the value of λ may be taken as 1.0 where the cargo fall is led to the top of derrick post through the sheave incorporated in the head of the derrick boom.

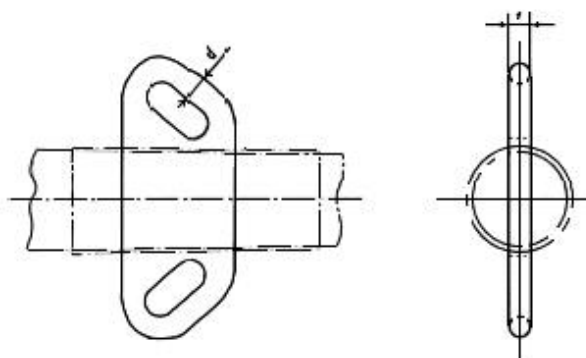


Fig 9.2.6 Cargo Fitting attached at Head of Derrick Boom

Table 9.2.22 Values of e_2 [See Guidance]

Safe working load W (t)	e_2
$W \leq 10$	12.5
$10 < W < 15$	$15.1 - 0.26 W$
$15 \leq W \leq 50$	11.2
$50 < W$	Value as considered appropriate by the Society

Table 9.2.23 Values of α_2

$l/(h-h')$		2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2
α_2	$W < 10$	1.99	1.90	1.81	1.73	1.65	1.57	1.49	1.42	1.35
	$15 \leq W < 50$	1.82	1.73	1.65	1.57	1.49	1.41	1.33	1.26	1.19
(NOTES) l , h and h' : As specified in 306. 2 .										

Table 9.2.24 Values of λ

Sum of the number of sheaves of blocks for cargo fall	1	2	3	4	5	6	7	8
λ	2.10	1.58	1.40	1.31	1.26	1.23	1.20	1.18

- (B) Where the shape of cargo fitting attached to the head of cargo derrick boom is as shown in **Fig 9.2.7**, the sizes of them are not to be less than the following values.

$$R \geq D$$

$$t = e_1 \sqrt{\frac{T}{g}} \quad (\text{mm})$$

However, where the value of R is larger than $1.15D$, the value obtained from the following formula may be taken:

$$t = \frac{e_3}{\left(R - \frac{D}{2}\right)} \cdot \frac{T}{g} \quad (\text{mm})$$

where,

e_1 : As specified in **Par 1 (1)** above

T : As specified in (A) above

e_3 : As given in **Table 9.2.25**

- (C) The sizes of guy fittings attached the head of derrick boom are to be enough against the design load.
- (2) Notwithstanding the requirements in (1) above, the sizes of cargo fittings attached at the head of derrick boom may be in accordance with any other standards recognized by the Society to be equivalent. However, for the cargo fittings used for other than the swinging derrick systems, consideration to the effect of increasing load caused by the guy ropes is to be given.

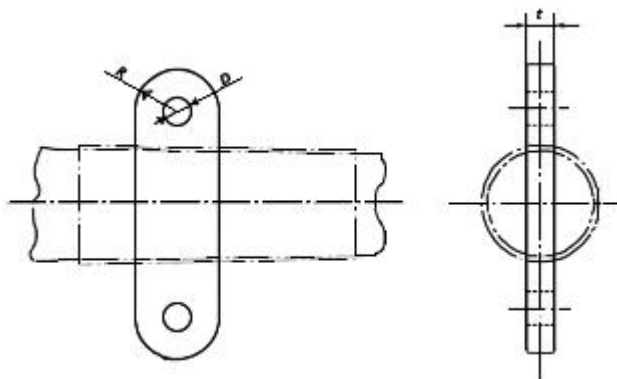


Fig 9.2.7 Fitting attached at Head of Derrick Boom

Table 9.2.25 Values of e_3 【See Guidance】

Safe working load W (t)	e_3
$W \leq 10$	122
$10 < W < 15$	$170 - 4.8 W$
$15 \leq W \leq 50$	98
$50 < W$	Value as considered appropriate by the Society

3. Other Cargo Fittings

The sizes of the other cargo fittings such as topping bracket, guy cleat, eye and so on, may be in accordance with any other standards recognized by the Society. However, for the topping bracket used for other than the swinging derrick systems, consideration to the effect of increasing load caused by the guy ropes is to be given.

Section 6 Loose Gear

601. General

1. Application

The requirements in this Section apply to the loose gear.

2. General Requirements

When the safe working load is applied to the cargo gear and cargo ramps, the load created in the important part of those loose gears and ropes is not to be exceed the respective specified safe working load.

602. Cargo Blocks

1. Cargo Blocks for Wire Ropes [See Guidance]

The cargo blocks for wire ropes are to comply with the following requirements (A) through (D). However, in sheaves for equalizer sheaves or those for overload sensors, they are to be as deemed appropriate by the Society. (See **Fig 9.2.8**)

- (A) The diameter of the sheave at the bottom of the rope groove is not to be less than 14 times the wire rope diameter.
- (B) The depth of the groove of the sheave is not to be less than the wire rope diameter.
- (C) The bottom of the groove of the sheave is to have a circular contour over a segment sustained by angle of not less than 120°
- (D) The groove diameter of the sheave is to be 1.1 times the wire rope diameter, as a standard.

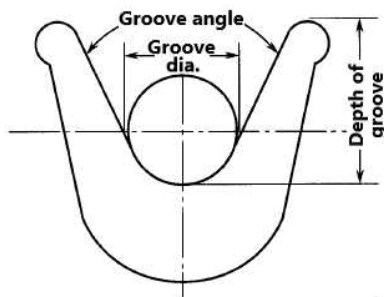


Fig 9.2.8 Sheave Groove

2. Cargo Blocks for Fibre Ropes

The cargo blocks for fibre ropes are to comply with the following requirements (A) through (C) below:

- (A) The diameter of the bottom of the rope groove is not be less than 5.5 times the fibre rope diameter.
- (B) The depth of the groove of the sheave is not be less than the fibre rope diameter.
- (C) The groove diameter of the sheave is to be the fibre rope diameter plus 2 mm, as a standard.

603. Ropes

1. Wire Ropes [See Guidance]

The wire ropes are to comply with the following requirements (A) through (E) below:

- (A) The wire ropes are to be subjected to suitable corrosion prevention treatment.
- (B) The wire ropes are to be suitable for the purpose of application, and in addition are to attach

- a certificate stating that they conform to the requirements of **Pt 4, Ch 8** of the Rules or the requirements of the standards as deemed appropriate by the Society.
- (C) No splicing of the wire ropes is permitted.
 - (D) Terminal connection of wire ropes is to be made in a method approved by the Society to have sufficient strength.
 - (E) The safety factor of the wire ropes is not to be less than the following value according to their purpose and their safe working load. However, the safety factor of the wire ropes for running rigging may not exceed 5, and those for standing rigging, 4.

$$\frac{10^4}{8.85 W + 1910} \quad \text{for } W \leq 160$$

$$3 \quad \text{for } W > 160$$

where,

W : Safe working load (t)

2. Fibre Ropes

Fibre ropes are to comply with the following requirements (A) through (C) below:

- (A) The fibre ropes are to comply with the recognized standards and to be provided with the certificate deemed appropriate by the Society.
- (B) The diameter of the fibre ropes is not to be less than 12 mm.
- (C) The safety factor of fibre ropes is not be less than the value given in **Table 9.2.26** depending on the rope diameter.

Table 9.2.26 Safety Factor of Fibre Ropes

Rope diameter D (mm)	Safety Factor
$12 \leq D < 14$	12
$14 \leq D < 18$	10
$18 \leq D < 24$	8
$24 \leq D < 40$	7
$40 \leq D$	6

604. Other Loose Gears

1. General

The design loads of loose gears such as chain, rings, hooks, shackles, swivels, clamps, grabs, lifting beams, lifting magnets, spreader, etc. are not to be more than the value obtained by dividing the breaking strength of each gears by the safety factor of 5.

605. Equivalent Requirements

1. General [See Guidance]

Notwithstanding the requirements in **602.** through **604.** above, the constructions of loose gear may be in accordance with any other standards recognized by the Society.

Section 7 Machinery, Electrical Installations and Control Engineering Systems

701. General

1. Application [See Guidance]

The requirement in this Section apply to the machinery, electrical installations and control engineering systems used in the cargo handling appliances. However, in applying the requirements in this Section to winches used for cargo ramps, they may be suitably modified.

702. Machinery

1. General

The driving systems of the cargo handling appliances are to be steadily operated in the rated speed under the safe working load.

2. Hoisting Machinery [See Guidance]

- (1) The construction of the hoisting machinery is to comply with the following requirements (A) through (F) below:
 - (A) The drum end flange diameter is to have an allowance corresponding to not less than 2.5 times the rope diameter as measured from the outer rim of the outermost layer of ropes in service condition. However, where rope disengagement prevention system is provided or in case of single layer winding on the drum, this requirement may be dispensed with.
 - (B) The pitch circle diameter of winch drum is to be not less than 18 times the rope diameter.
 - (C) Winches are to be installed on the winch foundation with foundation bolts having sufficient proof strength against the drum load (the maximum rope tension applied on the drum when the rope is wound under the single winding at a nominal rope hoisting speed) created when the safe working load is applied to the cargo handling appliances.
 - (D) Braking system complying with the following requirements (a) through (c) below is to be provided:
 - (a) The braking system is to be able to exert a breaking torque 50 % in excess of the torque required when the safe working load is applied to the cargo handling appliances.
 - (b) The power operated braking system is to operate automatically when the manoeuvring is returned to its neutral position.
 - (c) The power operated braking system is to operate automatically when there is any failure in the power supply. In this case, emergency retrieval for cargo lowering is to be provided.
 - (E) Clutchable drums are to be provided with effective locking system capable of restricting rotation of the drum. The locking system is to be, as a rule, capable of resisting the torque not less than 1.5 times the torque required when the safe working load is applied to the cargo handling appliances.
 - (F) Rope guards or suitable other means of protection are to be provided.
- (2) The winding of the wire rope into the winch drum is to comply with the following (A) and (B) except in cases where the winch drum is equipped with the over-winding prevention device. (2022)
 - (A) For grooved drums such as a hoisting winch, etc., the angle between the direction in which the wire rope is caught in the groove of the drum and the direction of the wire rope when it is caught in the groove (i.e. the limiting fleet angle) is to be 4° or less.
 - (B) For drums other than grooved drums, the limiting fleet angle is to be 2° or less.
- (3) The rope at its end is to be secured to the drum in such a manner that will not damage any part of the rope and to have such a length that not less than 3 complete turns in case of an ungrooved drum, or 2 complete turns in case of a grooved drum are remaining on the drum when the complete working length of rope has been paid out.

703. Power Supply

1. General [See Guidance]

- (1) The equipment, piping and cables consisting of the electric, hydraulic, pneumatic or steam power

supply system and their arrangements are, as a rule, to comply with the relevant requirements of the Rules.

- (2) The construction, strength etc. of internal combustion engine used as the prime mover are to comply with the requirements in **Pt 5. (2017)**

704. Control Engineering Systems

1. General

- (1) The electric, hydraulic or pneumatic equipments used for the control, alarm and safety systems are, as a rule, to comply with the relevant requirements of the Rules.
- (2) The control, alarm and safety systems are to be designed on the basis of the principle of fail-safe.

2. Control System

- (1) Control systems are to be so arranged as not interfere with the operator or qualified other personnel giving signals for operation.
- (2) Control systems are, as a rule, to be of such design that controls automatically return to the neutral position when control operation by the operator is interrupted.
- (3) For electric winches, local power disconnecting switch is to be provided at the position in the proximity of the place of operation.
- (4) Cranes and cargo lifts are to be provided with emergency switch capable of stopping all the motions at the position readily accessible for the operator.
- (5) Cargo lifts are to be provided with a suitable automatic speed control system that reduces the starting acceleration and stopping deceleration as far as practicable.
- (6) Cargo lifts are to be provided with a suitable control system that stops the lift at the specified deck position.
- (7) Where cargo lifts are secured by locking latches, suitable means is to be provided so as to prevent the impact load to be induced on the lift in case of withdrawal of the latches.
- (8) Control systems for the track-mounted cranes (including their trolleys) are to be provided with braking devices to control travelling except for the human-powered travelling cranes. *(2022)*

3. Safety System [See Guidance]

- (1) The cargo handling appliances are, as a rule, to be provided with an overload protection system.
- (2) The cargo handling appliances are to be provided with suitable safety systems capable of preventing the abnormalities given in the following (A) through (F) according to kind of appliances and their motion:
 - (A) Over hoisting
 - (B) Over slewing
 - (C) Over luffing
 - (D) Excessive travelling speed
 - (E) Over run on the track
 - (F) Other items of abnormality recognized by the Society
- (3) In cranes where the safe working load varies according to the operating radius, rating chart showing the relationship between the operating radius and safe working load are to be provided in the control cab and in addition, equipment satisfying the following (A) and (B) or (C) is, as a rule, to be provided:
 - (A) Operating radius indicator
 - (B) Lifting load indicator
 - (C) Overload preventer with respect to the safe working load according to the operating radius

4. Protection System

- (1) For the rotating parts of the driving machinery, electrical installations and steam pipes, necessary means to protect the operator are to be provided.
- (2) Steam winches are to be arranged not to interfere with the operator's field of vision by the steam.
- (3) Cargo lifts are to be provided with the protection systems given in the following (A) through (D):
 - (A) Protective barriers of a height of not less than 1 m above deck level around the deck opening provided for lift platform.
 - (B) Interlocking system so that cargo lifts cannot be moved unless the barriers are all closed.
 - (C) Interlocking system that prevents opening of protective barriers unless cargo lifts are at the

- opening position of the barriers.
(D) Warning lights or suitable other warning signs at the boarding place of cargo lifts.

Section 8 Cargo Lifts and Cargo Ramps

801. General

1. Application

The provisions in this Section apply to the structural members of cargo lifts and cargo ramps.

802. Design Loads [See Guidance]

1. Load Considerations

Consideration is to be given to the utilization and duty of the particular type of cargo lifts and cargo ramp in the "in service" and stowage conditions with respect to the following loads listed from (A) to (G) below.

- (A) Safe working load
- (B) Self-weight of the installation
- (C) Wind loading
- (D) Wave loading
- (E) Loads due to ship inclination
- (F) Loads due to ship motion
- (G) Other loads considered necessary by the Society

2. Wind Loading

The wind loading is to be calculated according to **402. 5.**

3. Wave Loading

For the structural members forming parts of shell plating and subjected to the wave load, the head of water is not to be less than that obtained from the following formula:

$$\left\{d - 0.125D + 0.05L' + \Delta H_w(x)\right\} \frac{gD}{D + 2h_s} \quad (\text{kPa})$$

where,

- x : Distance from the forward face of stem on the designed maximum load line defined in **Pt 3, Ch 1, 110.** (m)
- d : Designed maximum load draught defined in **Pt 3, Ch 1, 111.** (m)
- D : Depth of ship defined in **Pt 3, Ch 1, 106.** (m)
- L' : Length of ship defined in **Pt 3, Ch 1, 102.** (m). L' is to be taken as 230 m when the length exceeds 230 m.
- $\Delta H_w(x)$: Value obtained from the following formula for respective value of x

$$\begin{aligned} & \left(38 - 45C'_b\right) \left(1 - \frac{x}{0.3L}\right)^2 & \text{for } x \leq 0.3L \\ & 0 & \text{for } x > 0.3L \end{aligned}$$

Where,

- C'_b : Block coefficient defined in **Pt 3, Ch 1, 113.** C'_b is to be taken as 0.85 when the block coefficient exceeds 0.85.

L : Length of ship defined in **Pt 3, Ch 1, 102.** (m)
 h_s : Value shown in **Table 9.2.27** depending on the length of ship

Table 9.2.27 Values of h_s

Length of ship L (m)	h_s
$L \leq 90$	1.95
$90 < L < 125$	$0.01L + 1.05$
$125 \leq L$	2.30

4. Loads due to Ship Inclination [See Guidance]

The loads due to ship inclination are to be as recognized by the Society to be appropriate.

5. Loads due to Ship Motion

The loads due to ship motion are to be as specified in **402. 8.**

6. Load Combinations

- (1) The load combinations to be used in strength analysis of structural members is to be those causing the more severe loading condition of the structural members resulting from the load combinations specified in (2) to (5) below.
- (2) The load combination of the following loads (A) to (E) are to be taken into consideration "in service" conditions:
 - (A) Safe working load
 - (B) Self-weight of slewing or moving parts of the cargo lifts and cargo ramps
 - (C) Self-weight of the fixed parts of the cargo lifts and cargo ramps
 - (D) Loads due to ship inclination
 - (E) Other loads considered necessary by the Society
- (3) The loads (2) (A) and (B) above are to be multiplied by 1.2 for the installations designed to slew or move with cargo loaded thereon/therein and by 1.1 for the cargo ramps designed not to slew or move with cargo loaded thereon.
- (4) The following loads (A) to (F) are to be taken into consideration for cargo lifts in stowage conditions.
 - (A) Loads in stowage conditions
 - (B) Self-weight of the cargo lifts
 - (C) Wind loading
 - (D) Loads due to ship inclinations in navigation
 - (E) Loads due to ship motions in navigation
 - (F) Other loads considered necessary by the Society
- (5) The following loads (A) to (E) are to be taken into consideration for cargo ramps in stowage conditions.
 - (A) Self-weight of the cargo ramps
 - (B) Wind loading
 - (C) Loads due to ship inclinations in navigation
 - (D) Loads due to ship motions in navigation
 - (E) Other loads considered necessary by the Society

803. Strength and Construction

1. General

- (1) The strength of structural members is to be analyzed for the load conditions specified in **802. 6** according to the requirements in **Par 2** to **Par 7** below.
- (2) For the installations loaded with vehicles, the concentrated loads from wheels corresponding to their loading or running conditions are to be taken into account.
- (3) The strength of structural members forming parts of shell plating is, in general, to be equivalent to that of the surrounding hull structure.

- (4) The structural members are to have proper stiffeners and, in addition, suitable lashing devices for preventing their vertical and horizontal movements when stowed in position.

2. Allowable Stress for Combined Loads

The allowable stress prescribed in **Table 9.2.28** are to be used for components subjected to combined loads.

Table 9.2.28 Allowable Stress σ_a (2022)

Load Condition	Kind of stress				
	Tension	Shear	Compression	Bearing	Combined stress
Condition given in 802. 6 (2)	$0.67\sigma_Y$	$0.39\sigma_Y$	$0.58\sigma_Y$	$0.94\sigma_Y$	$0.77\sigma_Y$
Condition given in 802. 6 (4) and (5)	$0.77\sigma_Y$	$0.45\sigma_Y$	$0.67\sigma_Y$	$1.09\sigma_Y$	$0.89\sigma_Y$
<p>(NOTES)</p> <p>1. σ_Y : Specified yield stress or proof stress of material (N/mm²) For steel material of $\sigma_Y \geq 0.83 \cdot \sigma_T$, the value of $0.83 \cdot \sigma_T$ is to be applied instead on σ_Y. where σ_T : Specified tensile stress of material (N/mm²)</p> <p>2. The combined stress is to be the value obtained from the following formula: $\sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x \sigma_y + 3\tau_{xy}^2} \quad (\text{N/mm}^2)$ where, σ_x : Applied stress in x-direction at the middle of plate thickness (N/mm²) σ_y : Applied stress in y-direction at the middle of plate thickness (N/mm²) τ_{xy} : Applied shear stress in the $x-y$ plane (N/mm²)</p>					

3. Lift Deck Plating and Ramp Plating Thickness

- (1) The thickness of the plating forming a part of shell plating is not to be less than the thickness of shell plating at the position concerned to be determined regarding the actual stiffener spacing as the frame spacing.
- (2) The plate thickness of the plating forming a part of bulkhead is not to be less than the thickness of bulkhead plating at the position concerned to be determined regarding the actual stiffener spacing as the bulkhead stiffener spacing.
- (3) For the installations loaded with vehicles the thickness of lift deck plating or ramp plating is not to be less than required for deck plating of the car deck.

4. Minimum Thickness

The thickness of structural members is not to be less than 6 mm in the parts exposed to weather and 5 mm in the parts not exposed to weather.

5. Deflection Criteria [See Guidance]

The deflection of the structural members due to the safe working load is to be limited, as a rule, to 1/400 of the span between supports in cargo lifts and 1/250 of the span between supports in cargo ramps.

6. Strength of Bolts, Nuts and Pins

Bolts, nuts and pins are to have ample strength for the magnitudes and directions of the loads they are subjected to.

7. Locking Devices of Cargo Ramps

- (1) Stowage locks are to be provided to resist the load resulting from consideration of loads specified in **802. 6** (5).
- (2) The hydraulic locking devices are to be designed to keep the ramp locked mechanically even in

- the event of failure of the hydraulic pressure.
- (3) For a cargo ramp utilized commonly as a means for closing openings, the closing devices may be utilized as locking devices, if the area of opening is larger than half of the projected area of the stowed ramp. The design load of the closing devices is to include also the loads specified in **802. 6 (5)** in addition to the loads in **Pt 4, Ch 3**.

Section 9 Certification, Marking and Documentation

901. General

1. Application

The requirements in this Section apply to the certification, marking and documentation of the cargo handling appliances.

902. Assignment of Safe Working Load, etc.

1. General

The Society assigns the safe working load, etc., for the cargo handling appliances that have passed the inspection and load tests specified in **Sec 2**.

2. Duplicated Assignment of Safe Working Load, etc.

The Society will assign, at the application of the shipowner, the following (A) or (B) in addition to the safe working load etc. in accordance with the requirements in **Par 1** above:

- (A) The maximum load corresponding to an angle smaller than the assigned allowable minimum angle in case of derrick systems
- (B) The maximum load corresponding to a radius exceeding the assigned maximum slewing radius in case of jib cranes

3. Assignment for Union-Purchase Derrick Systems

- (1) The assignments of the safe working load, etc. for the union-purchase derrick systems are the safe working load and maximum angle between two cargo falls or the safe working load and allowable lifting height (the vertical distance between the highest position of the structure above the upper deck with hatch opening and the delta plate or ring attached to the cargo falls).
- (2) The maximum angle between two cargo falls specified in (1) above is not to be assigned to exceed 120 °.

903. Marking of Safe Working Load, etc.

1. Marking for Cargo Gear and Cargo Ramps

- (1) On the cargo gear and cargo ramps assigned by the requirements specified in **902.** above, the safe working load, allowable minimum angle, maximum slewing radius and other restrictive conditions are to be marked by using stamps in accordance with the following requirement in (A) through (C):
 - (A) Derrick systems
At the conspicuous place of the base of derrick boom, the stamp mark of the Society, the safe working load, the allowable minimum angle of the boom and other restrictive conditions are to be marked.
 - (B) Jib cranes
At the conspicuous place of the base of jib or the similar position, the stamp mark of the Society, the safe working load, the maximum slewing radius and other restrictive conditions are to be marked.
 - (C) Other cargo gear and cargo ramps
At the conspicuous place which is hardly fouled, the stamp mark of the Society, the safe working load and other restrictive conditions are to be marked.
- (2) In the case of the duplicated assignment of safe working loads are assigned to derrick systems

and jib cranes in accordance with the requirements of **902. 2**, the necessary markings for respective combinations are to be made correspondingly in accordance to the requirements of (1) above.

- (3) For the cargo gear which is used with grabs, lifting beams, lifting magnets, spreaders and similar other loose gear and assigned the maximum cargo load excluding the self-weight of such loose gear to safe working load, the notation in this connection to be marked as other restrictive conditions correspondingly according to (1) above.
- (4) The stamp marks are to be coated with anti-corrosive paint and framed with paint for easy recognition.
- (5) In addition to the markings specified in (1), (2) and (3) above, the same markings (except the stamp mark of the Society) are to be made at the conspicuous places with paint, etc. In this case, the size of letters should not be less than 77 mm in height.

2. Marking for Loose Gear

- (1) On the loose gear other than wire ropes and fibre ropes, the test load, the safe working load and the identification symbols are to be marked by using stamps at the conspicuous place and no adverse effects are to be caused for both their strength and service. On grabs, lifting beams, lifting magnets, spreaders and similar other loose gear, the self-weight of them are to be stamped additionally.
- (2) The stamp marks are to be coated with anti-corrosive paint and framed with paint for easy recognition.
- (3) In addition to the markings specified in (1) above, grabs, lifting beams, lifting magnets, spreaders and similar other loose gear are to be marked with the safe working load and the self-weight of them with paint, etc. In this case the size of letters should not be less than 77 mm in height.
- (4) Notwithstanding the requirements in (1) and (3) above, where it is difficult to make direct stamp mark or marking with paint, other means may be taken when approved by the Society.

904. Documentation

1. Kinds of Documents

The kinds of the documents issued by the Society for cargo gears, cargo ramps and loose gear are to be as specified in the followings:

- (A) Register of Ship's Lifting Appliances including Cargo Handling Gears(Form CG1)
- (B) Certificate of Test and Thorough Examination of Lifting Appliances(Form CG2)
- (C) Certificate of Test and Thorough Examination of Lifting Appliances for Operation in Union Purchase(Form CG2(U))
- (D) Certificate of Test and Thorough Examination of Loose Gear(Form CG3)
- (E) Certificate of Test and Thorough Examination of Wire Rope(Form CG4)
- (F) Certificate of Test and Thorough Examination of Fibre Rope(Form CG5)

2. Timing of Issuance of Documents

The timing of issuance of documents specified in **Par 1** above is to be as given in **Table 9.2.29** depending on the tests and survey.

3. Revocation of the Documents

- (1) The whole or part of the certificates specified in **Par 1** above will be revoked when either of the following (A) through (I) is relevant:
 - (A) When application is made by the shipowner for cancellation or alteration of the assignment of the safe working load, etc.
 - (B) When the construction, arrangement or rigging of the cargo handling appliances are altered
 - (C) When the cargo handling appliances are removed
 - (D) When the surveys specified in **Sec 2** are not subjected to
 - (E) When the cargo handling appliances are considered to be unserviceable by the Surveyor
 - (F) When the contents in the certificates are intentionally altered
 - (G) When the contents in the certificates have become illegible due to foul or damage
 - (H) When the specified fee covering the survey is not paid
 - (I) In case where the Society has a doubt on the effectiveness of the certificates, etc.
- (2) The certificates which become invalid in accordance with the provisions in (1) above are to be returned to the Society without delay.

4. Reissuance and Corrections of Documents

In case where the certificates, etc. become invalid in accordance with the provisions of the preceding **Par 3** (1) above or lost, the Society will reissue the certificates or make necessary corrections thereto depending on the circumstances involved.

905. Preservation of Documents

1. General

The Certificates issued depend on the requirements in **904.** by the Society and the instruction manual for cargo handling appliances are to be preserved aboard the ship or by shipowner's responsible person in case of towing boat not manned.

2. Instruction Manual

The instruction manual mentioned in **Par 1** above is to note essential items necessary for operation and maintenance of the cargo handling appliances among those given in the following (A) through (H):

- (A) General arrangement of cargo gear and cargo ramps
- (B) Arrangement drawing of loose gear(including rigging arrangement)
- (C) List of loose gear
- (D) Design conditions(including safe working load, wind speed, trim and heel of ship, etc.)
- (E) List of materials
- (F) Operation manual(including functions of safety systems and protective systems)
- (G) Load testing procedure
- (H) Maintenance and control procedures

Table 9.2.29 Timing of Issuance

Kind of Documents		Timing of Issuance
A	Document in 904. 1 (A)	When the application for assignment is made and the ship passes the Registration Survey for the first time
B	Document in 904. 1 (B)	(1) When the application for assignment is made and the ship passes the Registration Survey for the first time
	Document in 904. 1 (C)	(2) When the cargo handling appliances that are installed additionally pass the Registration Survey (3) When the safe working load, etc. is altered (4) When the ship passes the load tests specified in 205.
C	Document in 904. 1 (D)	(1) When the application for assignment is made and the ship passes the Registration Survey for the first time (2) When the cargo handling appliances that are installed additionally pass the Registration Survey
	Document in 904. 1 (E) and (F)	(3) When loose gear is replaced or repair at time of the Periodical Surveys and the Occasional Survey, and when the contents of autonomous inspection is recognised appropriate by the Society



CHAPTER 3 AUTOMATIC AND REMOTE CONTROL SYSTEMS

Section 1 General

101. General

1. Scope

The Rules for the Automatic and Remote Control Systems (hereinafter referred to as “the Rules”) apply to the survey and construction of centralized monitoring and control systems for main propulsion and essential auxiliary machinery, operating systems for periodically unattended machinery spaces and specific automation equipment (hereinafter referred to as “automatic and remote control systems”) of ships classed or to be classed with the requirements of **Pt 1, Ch 1** intended to be assigned and registered the class notations in accordance with **Pt 1, Ch 1, Sec 2**.

2. Equivalency

Automatic and remote control systems which do not fully comply with the requirements of the Rules may be accepted provided that they are deemed by the Society to be equivalent to those specified in the Rules.

3. Modification of requirements

The Society may modify parts of the requirements specified in the Rules taking the national requirements of the ships nationality, purpose and service areas of the ship into consideration.

4. Automatic and remote control systems with novel design features

For automatic and remote control systems with novel design features the Society may impose appropriate requirements of the Rules to the extent practically applicable with additional requirements made on design and test procedures other than those specified in the Rules.

5. Definitions

The definitions of terms which appear in the Rules are specified as the following unless otherwise specified in other Sections.

- (1) **Specific automation equipment** is a general term for Class 1 specific automation equipment, Class 2 specific automation equipment and Class 3 specific automation equipments detailed below:
 - (A) Class 1 specific automation equipment
Automatic or remote control equipment for remote controlled ballasting/deballasting arrangement, automatic steering system, remote-controlled handling system for liquid cargo in bulk, power-driven opening and closing devices, automatic recording devices for main engine, remote-controlled mooring arrangements and air-conditioning arrangements for control stations.
 - (B) Class 2 specific automation equipment
In addition to those in (A), Automatic or remote control equipment for remote-controlled fuel oil filling arrangements, centralized monitoring device for refrigerating containers, cargo hose handling winches, automatic deck washing arrangements, remote-controlled mooring arrangements at ship-sides, power-operated pilot ladder winding appliances and emergency towing rope winches
 - (C) Class 3 specific automation equipment
In addition to those in (B), Automatic or remote control equipment centralized monitoring systems for machinery, centralized control systems for machinery, remote control arrangements for main engines and steering gear at the outside of the navigating bridge, high level alarm devices for cargo hold bilge, independent remote-controlled mooring arrangements and towing rope winches
- (2) An **CMA ship** is the ship of which centralized monitoring and control systems for main propulsion and essential auxiliary machinery comply with the requirements of **Sec 3** and is registered.
- (3) An **UMA ship** is the ship of which operating systems for periodically unattended machinery spaces comply with the requirements of **Sec 4** and is registered.
- (4) An **UMA1 ship** is the UMA ship of which Class 1 specific automation equipment complies with the requirements of **502**. and is registered.

- (5) An **UMA2 ship** is the UMA ship of which Class 2 specific automation equipment complies with the requirements of **503.** and is registered.
- (6) An **UMA3 ship** is the UMA ship of which Class 3 specific automation equipment complies with the requirements of **504.** and is registered.

6. Installations characters

- (1) Character **CMA** is given in the Register for the centralized monitoring and control systems for main propulsion and essential auxiliary machinery of the CMA ship.
- (2) Character **UMA** is given in the Register for the operating systems for periodically unattended machinery spaces of the UMA ship.
- (3) Character **UMA1** is given in the Register for the Class 1 specific automation equipment of the UMA1 ship.
- (4) Character **UMA2** is given in the Register for the Class 2 specific automation equipment of the UMA2 ship.
- (5) Character **UMA3** is given in the Register for the Class 3 specific automation equipment of the UMA3 ship.

7. Terminology

Terms used in the Rules are defined as follows:

- (1) **Monitoring station** (excluding control station) is a position where measuring instruments, indicators, alarms, etc. for the machinery and equipment are centralized and necessary information to grasp the operating condition of them can be obtained. Where, however, a monitoring station is provided with the ship in addition to a control station mentioned in (2) below, the requirements of the Rules relating to a monitoring station do not apply to the monitoring station concerned.
- (2) **Control station** is a position which has a function as a monitoring station and from which the machinery and equipment can be controlled.
- (3) **Main control station** is a control station provided with equipment necessary and sufficient to control the main propulsion machinery (this equipment will be referred to as "main control equipment" in this (3) and (4) and from which the main propulsion machinery is normally controlled, of the ship which provides the main control equipment at the outside of the navigation bridge.
- (4) **Main control station on bridge** is a navigation bridge of the ship which provides main control equipment at the navigation bridge and that the main propulsion machinery is normally controlled there.
- (5) **Sub-control station** is such a control station at which the main propulsion machinery is capable of being controlled, except for local control station for the main propulsion machinery, that is provided in the machinery room of the ship provided with a main control station on bridge.
- (6) **Bridge control devices** are remote control devices for the main propulsion machinery or controllable pitch propellers provided on a navigation bridge or a main control station on bridge.
- (7) **Sequential control** is a pattern of control that can be carried out automatically in the re-determined sequence.
- (8) **Program control** is a pattern of control that desired values can be changed in the predetermined schedule.
- (9) **Local control** is direct manual control of the machinery and equipment performed at or near their locations, receiving the necessary information from the measuring instruments, indicators and so on.
- (10) **Safety system** is a system which operates automatically, in order to prevent damages to the machinery and equipment in case where serious impediments to functioning should occur on them during operation so that one of the following actions will take place.
 - (A) Starting of standby machinery or equipment.
 - (B) Reduction of outputs of the machinery or equipment.
 - (C) Shutting off the fuel or power supplies thereby stopping the machinery or equipment.
- (11) **Override arrangements** are arrangements for stopping temporarily the functions of safety system in part or in whole.
- (12) **Centralized control station** is one of the control stations of a ship which has necessary and sufficient systems to control main propulsion machinery, generating sets, auxiliary machinery essential for main propulsion of the ship (hereinafter referred to as "essential auxiliary machinery") and other auxiliaries considered necessary by the Society (hereinafter such are referred to as centralized monitoring and control systems for machinery in (12) and (13) outside the navigation

- bridge, and a room specially provided for the purpose of installing centralized monitoring and control systems for machinery, from which main propulsion machinery is normally controlled.
- (13) **Centralized monitoring and control station on bridge** is a navigation bridge of a ship which has centralized monitoring and control systems for machinery on her bridge and from which main propulsion machinery is normally controlled.
- (14) **Unattended machinery operation** is an operation of machinery and equipment specified as following (A) to (G) without watchkeeping personnel with the specific duty of the operation and surveillance during a predetermined period.
- (A) Main propulsion machinery (propulsion generating set in electric propulsion ships are excluded)
 - (B) Controllable pitch propeller
 - (C) Steam generating set
 - (D) Electric generating set (propulsion generating set in electric propulsion ship are included)
 - (E) Auxiliary machinery associated with machinery and equipment listed in (A) to (G)
 - (F) Fuel oil systems
 - (G) Bilge systems
- (15) **Bridge** is an area from which the navigation and control of the ship is exercised, including the wheelhouse and bridge wings.
- (16) **Bridge wings** are parts of the bridge on both sides of the ships wheelhouse which extended to the ships side.
- (17) **Wheelhouse** is an enclosed area of the bridge.
- (18) **Computer-based system** is a system of one or more computers, associated software, peripherals and interfaces, and the computer network with its protocol.
- (19) **Integrated system** is a system consisting of two or more subsystem having independent functions connected by a data transmission network and operated from one or more workstations.
- (20) **Expert system** is an intelligent knowledge-based system that is designed to solve a problem with information that has been compiled using some form of human expertise.
- (21) **Software** is the program, procedures and associated documentation pertaining to the operation of the computer system.
- (22) **Basic software** is the minimum software, which includes firmware and middleware, required to support the application software.
- (23) **Application software** is a software performing tasks specific to the actual configuration of the computer-based system and supported by the basic software.
- (24) **Redundancy** is the existence of more than one means for performing a required function.
- (25) **Interface** is a transfer point at which information is exchanged. (examples : interfaces including input/output interface; communications interface)
- (26) **Peripheral** is a device performing an auxiliary function in the system. (examples : printer, data storage device)
- (27) **Failure mode and effect analysis(FMEA)** is a failure analysis methodology used during design to postulate every failure mode and the corresponding effect or consequences.

Section 2 Surveys of Automatic and Remote Control Systems

201. General

1. Kinds of surveys

Kinds of surveys are as follows:

- (1) Surveys for registration (hereinafter referred to as "Registration Surveys")
- (2) Surveys for registration maintenance
 - (A) Annual Surveys
 - (B) Special Surveys
 - (C) Occasional Surveys

2. Survey intervals

Surveys are to be carried out in accordance with the following requirements.

- (1) A Classification Survey is to be carried out at the time when application for registration is made.
- (2) Classification Maintenance Surveys are to be carried out at the times as prescribed below.
 - (A) Annual Surveys are to be carried out at intervals specified in **Pt 1, Ch 2, 201.**
 - (B) Special Surveys are to be carried out at intervals specified in **Pt 1, Ch 2, 401.**
 - (C) An Occasional Survey: at a time falling on any of mentioned below, independently of Special Surveys and Annual Surveys.
 - (a) When main parts of the systems have been damaged, repaired or renewed
 - (b) When the systems are modified or altered
 - (c) Whenever considered necessary by the Society

3. Preparation for surveys and others

- (1) All such preparations as required for the survey to be carried out as well as those which may be required by the Surveyor as necessary in accordance with the requirements in the Rules are to be made by the applicant of the survey. The preparations are to include provisions of an easy and safe access, necessary facilities and necessary records for the execution of the survey. inspection, measuring and test equipment, which Surveyors rely on to make decisions affecting classification are to be individually identified and calibrated to a standard deemed appropriate by the Society. However, the Surveyor may accept simple measuring equipment (e.g. rulers, measuring tapes, weld gauges, micrometers) without individual identification or confirmation of calibration, provided they are of standard commercial design, properly maintained and periodically compared with other similar equipment or test pieces. The Surveyor may also accept equipment fitted on board a ship and used in examination of shipboard equipment (e.g. pressure, temperature or rpm gauges and meters) based either on calibration records or comparison of readings with multiple instruments. **【See Guidance】**
- (2) The applicant for the survey is to arrange a supervisor who is well conversant with the survey items intended for the preparation of the survey to provide the necessary assistance to the Surveyor according to his requests during the survey.
- (3) The survey may be suspended where necessary preparations have not been made, any appropriate attendant is not present, or the Surveyor considers that the safety for execution of the survey is not ensured.
- (4) Where repairs are deemed necessary as a result of the survey, the Surveyor will notify his recommendations to the applicant of the survey. Upon this notification, the repair is to be made to the satisfaction of the Surveyor.

202. Classification surveys

1. Drawings and data

- (1) For centralized monitoring and control systems for main propulsion and essential auxiliary machinery or operating systems for periodically unattended machinery spaces intended to be registered, three copies of the following drawings and data are to be submitted.
 - (A) Drawings and data concerning automation
 - (a) List of measuring points
 - (b) List of alarm points
 - (c) Control devices and safety devices
 - (i) List of controlled objects and controlled variables

- (ii) Kinds of sources of control energy (self-actuated, pneumatic, electric, etc.)
 - (iii) List of conditions for emergency stopping, speed reduction (automatic or demand for reduction), etc.
- (B) Following drawings and data for the automatic control devices and remote control devices for main propulsion machinery or controllable pitch propellers:
 - (a) Operating instructions of main propulsion machinery such as starting and stopping, changeover of direction of revolution, increase and decreased of output, etc.
 - (b) Arrangements of safety devices (including those attached to the engines) and indicating lamps
 - (c) Controlling diagrams
- (C) Following drawings and data for the automatic control devices and remote control devices for boilers:
 - (a) Operating instructions of sequential control, feed water control, pressure control, combustion control and safety devices.
 - (b) Diagrams for automatic combustion control devices and automatic feed water control devices
- (D) Diagrams and operating instructions for automatic control devices for electric generating sets (automatic load sharing devices, preference tripping devices, automatic starting devices, automatic synchronous making devices, sequential starting devices, etc.)
- (E) Panel arrangements of monitoring panels, alarming panels and control stands at respective control stations
- (F) Schedules of on-board tests and sea trials
- (2) For computer-based systems intended to be registered, three copies of following drawings and data are to be submitted and the contents are to comply with the requirements specified in **Pt 6, Ch 2, 101. 3 (7)**.
- (3) For specific automation equipment intended to be registered, three copies of the following drawings and data are to be submitted.
 - (A) Drawings showing the construction and layout of the specific automation equipment
 - (B) Drawings and data relative to the automatic and remote control systems of the specific automation equipment
 - (C) Particulars of the specific automation equipment
 - (D) Drawings and data other than above where deemed necessary by the Society **【See Guidance】**

203. Shop tests

1. Type approval **【See Guidance】**

Devices, units and sensors (hereinafter referred to as "automatic devices" in the Rules) and automatic equipment composed of automatic devices and basic software(if applicable) are to be type approved, in principle, according to the test methods approved by the Society before being taken into use.

2. Shop tests of automatic systems

The automatic devices which have passed through the type approval tests specified in **Par 1** are to be subjected to the following tests after completion of assembly as automatic system.

- (1) Hardware
 - (A) External examination
 - (B) Operation tests and performance tests
 - (C) Insulation resistance tests and high voltage tests (to be applied to electric devices, electronic devices and so on)
 - (D) Pressure tests (to be applied to hydraulic devices, pneumatic devices and so on)
 - (E) Other tests considered necessary by the Society **【See Guidance】**
- (2) Software

Software acceptance tests of computer-based systems are to be carried out to verify their adaptation to their use on board, and concern mainly the application software

 - (A) The software modules of the application software are to be tested individually and subsequently subjected to an integration test. The test results are to be documented and to be part of the final file. The followings are to be checked.
 - (a) The development work has been carried out in accordance with the plan

- (b) The documentation includes the proposed test, the acceptance criteria and the result. Repetition tests may be required to verify the consistency of test results.
- (B) Software acceptance will be granted subject followings.
 - (a) Examination of the available documentation
 - (b) A function test of the whole system

204. On-board tests [See Guidance]

The systems of automatic or remote control of the machinery and equipment are to be, after installed on board, confirmed that they operate effectively, respectively under as far practical condition as possible. Further, where deemed necessary by the Society, automatically or remotely controlled machinery and equipment are to be confirmed that they operate so as not to endanger the safety of the ship and machinery plant even in the case of failure of control systems as well. However, part of these tests may be carried out during sea trials. The proper documents, in which test procedures, set value for alarms and for operation of safety systems and so on are recorded, are to be kept on board.

205. Sea trials for the centralized monitoring and control systems for main propulsion and essential auxiliary machinery

1. Main propulsion machinery and controllable pitch propellers [See Guidance]

The control systems for main propulsion machinery or controllable pitch propellers are to be subjected to the following tests and other tests considered necessary by the Society in accordance with the schedule of sea trials submitted in advance. After completion of the test on transfer of control specified in (3), it is to be shown that the main propulsion machinery or the controllable pitch propellers can be smoothly operated from the respective control stations.

- (1) The main propulsion machinery or the controllable pitch propellers are to be subjected to starting tests, ahead-astern tests and running tests in the whole range of output, by means of the remote control devices from the main control station or the main control station on bridge.
- (2) In addition to output increase and decrease tests, the operation tests of the main propulsion machinery or the controllable pitch propellers using the bridge control devices are to be carried out as deemed appropriate by the Society.
- (3) In case where there are two or more control stations for main propulsion machinery or controllable pitch propellers, the test on transfer of control is to be carried out during ahead and astern operations of the main propulsion machinery or the controllable pitch propellers. In case where the transfer of control of the remote control devices for main propulsion machinery or controllable pitch propellers is carried out in accordance with 305.2 (2) (C) (b), the above-mentioned test may be carried out during the stopping condition of the main propulsion machinery.

2. Boilers

The control systems for boilers are to be subjected to the following tests.

- (1) With respect to main boilers, it is to be confirmed that the feed water control devices, combustion control devices and so on can operate stably in response to load variation of the main boilers, and the main boilers can supply steam stably to the main propulsion machinery, the electric generating sets and the auxiliary machinery essential for main propulsion of the ship without local manual operation.
- (2) With respect to essential auxiliary boilers, it is to be confirmed that they can supply steam stably to the auxiliary machinery essential for main propulsion of the ship without manual operation.
- (3) In case where an exhaust gas economizer is used as a source of steam supply to a turbine for driving a generator and steam is supplied from a boiler automatically in case of low power condition of the main propulsion machinery, operation tests of automatic control devices for this system are to be carried out.

3. Electric generating sets

In case where generators which supply electrical power to the loads necessary for propulsion of the ship and whose motive power is relying upon the propulsion systems, the systems of automatic or remote control of electric generating sets are to be subjected to operation tests.

206. Sea trials for the operating systems for periodically unattended machinery spaces

[See Guidance]

1. In sea trials, the tests specified in **205.** and this **206.** and other tests considered necessary by the Society are to be carried out in accordance with the schedule of sea trials submitted in advance.
2. The main propulsion machinery or the controllable pitch propellers are to show that they can be safely and surely operated in starting tests and ahead-astern tests and in the whole range of output, by means of the bridge control devices.
3. The electric generating sets are to be subjected to the following tests while the ship is navigating at normal sea going speed.
 - (1) In case where only one electric generating set is normally used, when stopping the main source of electrical power by tripping the circuit breaker, it is to be confirmed that automatic starting of the standby generator, automatic making of the air circuit breaker and sequential starting of important auxiliaries are performed.
 - (2) In case where two electric generating sets are normally used, when tripping the circuit breaker for one set, it is to be confirmed that preference tripping of non-important loads is performed, and propulsion and steering of the ship are maintained.
4. The auxiliary machinery is to be subjected to the following tests while controlling the main propulsion machinery or the controllable pitch propellers from the navigation bridge.
 - (1) Automatic starting tests of the standby pumps specified in **Table 9.3.1** to **9.3.6** and **Table 9.3.8** to **9.3.9.**
 - (2) For ships fitted with sea inlet scoops, automatic change over test to the circulating pumps.
 - (3) While the ship is navigating at normal sea going speed, it is to be confirmed that the exclusive air reservoirs for control use, if fitted, are capable of supplying air for at least five minutes after operation of a low pressure alarm for control air in a condition that the automatic starting function of control air compressor is stopped.
5. The exhaust gas economizer for supplying steam to turbine driving generator is to be subjected to the following tests.
 - (1) Operation tests such as steam supply from boilers and automatic starting of diesel engine driving generators, when putting back rapidly the handle of main propulsion machinery to the stop position while the ship is navigating at normal speed.
 - (2) When the main propulsion machinery is put into action expeditiously, it is to be confirmed that no critical condition occurs to water separator drums, piping, steam turbines and so on.
6. After completion of tests of automatic devices and automatic equipment, it is to be confirmed that the machinery can be safely and surely monitored and controlled under an unattended machinery operating condition as far similar to the normal sea going condition as practicable.

In this case, except where the operation mode is changed over, the running condition of the machinery is not to be adjusted by means of manual operation from any control station other than that on navigation bridge (including the centralized monitoring and control station on bridge).

207. Tests and Evidence of Computer-based systems

Tests and Evidence of Computer-based system are to comply with the requirements specified in **Pt 6, Ch 2, 407.** of the Rules.

208. Classification maintenance surveys

1. Annual surveys

- (1) At each Annual Survey for the centralized monitoring and control systems for main propulsion and essential auxiliary machinery, the following performance tests are to be tested and placed in order. Where appropriate records of daily checks and periodical maintenances have been kept, some of the tests may be dispensed with at the Surveyors discretion.
 - (A) Safety devices for main propulsion machinery or controllable pitch propellers, and emergency stopping devices for main propulsion machinery fitted in the remote control station for the main propulsion machinery or controllable pitch propellers
 - (B) Safety devices for boilers

- (C) Safety devices for electric generating sets
- (2) At each Annual Survey for the operating systems for periodically unattended machinery spaces, the following performance tests are to be tested and placed in order. Where appropriate records of daily checks and periodical maintenances have been kept, some of the tests may be dispensed with at the Surveyors discretion.
 - (A) Safety devices for main propulsion machinery or controllable pitch propellers, and emergency stopping devices for main propulsion machinery fitted in the remote control station for the main propulsion machinery or controllable pitch propellers
 - (B) Safety devices for boilers
 - (C) Safety devices for electric generating sets
 - (D) Communication systems specified in **403. 2**
- (3) At each Annual Survey for the specific automation equipment, general examination is to be carried out. Where considered necessary by the Surveyor, performance tests for the equipment may be required.
【See Guidance】

2. Special surveys

- (1) At each special Survey for the centralized monitoring and control systems for main propulsion and essential auxiliary machinery, the followings are to be tested and placed in order. Where appropriate records of daily checks and periodical maintenances throughout the period since the last Periodical Survey have been kept, some of the tests may be abbreviated for the some parts which are in good condition.
 - (A) Main propulsion machinery and controllable pitch propellers
 - (a) Change-over devices of control positions between navigation bridge and centralized control station and between centralized control station and local control station; or between centralized monitoring and control station on bridge and local control station or sub-control station (where applicable to the ships which provide bridge control devices); and remote control systems installed in these positions
 - (b) Safety devices
 - (B) Boilers
 - (a) Automatic and remote control systems
 - (b) Safety devices
 - (C) Electric generating sets
 - (a) Automatic and remote control systems
 - (b) Safety devices
 - (D) Automatic change-over devices of essential pumps and automatic starting devices (or remote start/stop devices) of air compressors
 - (E) Alarm systems
 - (a) Function of alarm systems and indicator devices
 - (b) Confirmations of setting points of alarms
 - (F) Remote monitoring systems
- (2) At each Special Survey for the operating systems for periodically unattended machinery spaces, the followings are to be tested and placed in order.
 - (A) Main propulsion machinery and controllable pitch propellers
 - (a) Change-over devices of control positions between navigation bridge and centralized control station and between centralized control station and local control station; or between centralized monitoring and control station on bridge and local control station or sub-control station; and remote control systems installed in these positions
 - (b) Safety devices
 - (B) Boilers
 - (a) Automatic and remote control systems
 - (b) Safety devices
 - (C) Electric generating sets
 - (a) Automatic and remote control systems
 - (b) Safety devices
 - (c) Automatic start of stand-by power supply unit after black-out
 - (d) Preferential trip systems
 - (D) Automatic change-over devices of essential pumps and automatic starting devices of air compressors
 - (E) Communication systems specified in **403. 2**
 - (F) Alarm systems

- (3) At each Special Survey for the specific automation equipment, general examination and performance tests are to be carried out.
- (4) Where considered necessary by the Surveyor, sea trials may be required after completion of the above mentioned tests in (1), (2) or (3).

Section 3 Centralized Monitoring and Control Systems for Main Propulsion and Essential Auxiliary Machinery

301. General

1. Scope

- (1) The requirements in this Section apply to the centralized monitoring and control systems for main propulsion and essential auxiliary machinery of CMA ships.
- (2) Automatic and remote control systems of CMA ships, which are specified in **Sec 4** or **Sec 5**, are to comply with the requirements in the Section concerned.

302. System design

1. System design

- (1) Control systems, alarm systems and safety systems are to be so designed that one fault does not result in other faults as far as practicable and the extent of the damage could be kept to a minimum.
- (2) Control systems, alarm systems and safety systems are to be designed on the fail-to-safe principle. The characteristic of fail-to-safe is to be evaluated on the basis not only of the respective systems themselves and associated machinery and equipment, but also the total safety of the ship.
- (3) Systems of automatic or remote control are to be sufficiently reliable under service conditions.
- (4) Cables for signals are to be installed in such a manner that harmful induced interference can be avoided.
- (5) Constitution of systems is to comply with the following requirements:
 - (A) Control systems, alarm systems and safety systems are to be independent each other as far as practicable.
 - (B) Safety systems intended for the functions specified in **101.7 (10) (C)** are to be, in any case, independent of the other systems.
 - (C) Means are to be provided for the safety systems to investigate the cause of the action of the safety systems.

2. Supply of power

- (1) Supply of electrical power
The supply of electrical power is to be in accordance with the following:
 - (A) Electrical supply circuits to control systems, alarm systems and safety systems are not to branch off from the power circuits and lighting circuits, except that the electrical power to the control systems, alarm systems and safety systems may be supplied from the power circuits to the machinery and equipment they serve.
 - (B) The electrical power to alarm systems and safety systems for electric generating sets is also to be supplied from an accumulator battery.
- (2) Supply of oil pressure
The supply of control oil pressure is to be in accordance with the following:
 - (A) Sources of oil pressure are to be capable of supplying stably necessary pressure and quantity of purified oil.
 - (B) Overpressure preventive devices are to be provided on the delivery side of oil pressure pumps.
 - (C) Two or more sets of oil pressure pumps for the control of main propulsion machinery and main shaftings are to be provided and they are to be so arranged that in case where one of the pumps in operation becomes out of operation standby pump(s) may start automatically or may be readily remotely started. In this case, the oil pressure pumps are not to be used for the control of other machinery and equipment than main propulsion machinery and main shaftings.

(3) Supply of pneumatic pressure

The supply of control air is to be in accordance with the following:

- (A) Control systems are to be provided with an air reservoir having a capacity capable of supplying air to control devices at least for 5 minutes in the event of failure of the control air compressor.
- (B) Where starting air reservoirs for diesel engines used as main propulsion machinery are used as control air reservoirs, pressure reducing valves are to be duplicated.
- (C) There are to be two or more sets of air compressors which may be used as a source of control air. Each air compressor is to have redundant capacity even in the event of failure of either one of them.
- (D) Control air is to pass through a filter and, if necessary, a drier so that solid, oil and water may be removed to a minimum.
- (E) Control air pipes are to be independent of general service air pipes and starting air pipes.

3. Environmental conditions

Systems of automatic or remote control are to be capable of withstanding the environmental conditions of the places where they are installed.

4. Control systems

(1) Independency of control systems

Control systems for main propulsion machinery or controllable pitch propellers, boilers, electric generating sets and auxiliary machinery essential for main propulsion of the ship are to be independent each other or designed such that failure of one system does not degrade the performance of other system.

(2) Interconnection devices

In case of plural main propulsion machinery or controllable pitch propellers, electric generating sets, or essential auxiliary machinery which are designed to be operated simultaneously in multiple under the same condition, interconnection devices may be provided between the control devices of these installations.

(3) Control characteristics

Remote control devices and automatic control devices are to have control characteristics in conformity with the dynamic properties of the machinery and equipment they serve and to be considered not to invite malfunction and hunting due to disturbance.

(4) Interlock

Control devices are to be provided with suitable interlocking arrangements in order to prevent damages to the machinery and equipment due to anticipated malfunction and maloperation of the machinery and equipment.

(5) Change-over to manual operating

Change-over to manual operating is to comply with the following requirements:

- (A) Main propulsion machinery or controllable pitch propellers, boilers, electric generating sets and auxiliary machinery essential for main propulsion of the ship are to be so arranged as to be manually started, operated and controlled even in the event where automatic control devices become out of operation.
- (B) Automatic control devices are generally to be provided with provisions to stop manually the automatic function of these devices.
- (C) The provisions specified in (B) are to be capable of stopping the automatic function of the automatic control devices, even where any part of the automatic control devices become out of operation.

(6) Cancellation of remote control function

For remote control devices, the function of remote control is to be capable of being manually cancelled.

(7) Indication of control locations **[See Guidance]**

In case where the machinery and equipment are capable of being operated from more than one station, the following requirements are to be complied with. However, this requirement need not be complied with in case the safety of the machinery and equipment and the safety at the time of maintenance work can be obtained by means of other measures considered appropriate by the Society.

- (A) At each control station there is to be an indicator showing which station is in control of the machinery and equipment.

(B) Control of the machinery and equipment is to be possible only from one station at a time.

5. Alarm systems

- (1) Function of alarm systems is to comply with the following requirements:
 - (A) In case where an abnormal condition is detected devices to issue a visual and audible alarm (hereinafter referred to as "alarm devices" in the Rules) are to operate.
 - (B) In case where arrangements are made to silence audible alarms they are not to extinguish visual alarms.
 - (C) Two or more faults are to be indicated at the same time.
 - (D) Audible alarms for machinery and equipment are to be clearly distinguishable from other audible alarms such as general alarm, fire alarm, CO₂ flooding alarm, etc.
 - (E) Alarm systems are to be designed with self-monitoring properties and alarms are to be given in the case of power and sensors failure.
 - (F) Alarm systems are to be capable of being tested during normal machinery operation.
 - (G) Where practicable, means are to be provided at convenient and accessible positions to permit the sensors to be tested without affecting the operation of the machinery.
 - (H) For the detection of transient faults which are subsequently self-correcting, a visual and audible alarm is required to lock in until accepted.
- (2) Function of the alarm systems provided in the monitoring station for main propulsion machinery or controllable pitch propellers is to comply with the following requirements, in addition to the requirements in (1):
 - (A) The visual indication of the alarm is to remain until the fault has been corrected.
 - (B) The acceptance of any alarm is not to inhibit another alarm.
 - (C) If an alarm has been acknowledged and a second fault occurs prior to the first being rectified, alarm devices are again to operate.
 - (D) Manual stopping of each alarm system is to be clearly indicated.
- (3) Visual alarms are to be so arranged that each abnormal condition of the machinery and equipment is readily distinguishable.

6. Safety systems

- (1) Constitution of systems
Constitution of safety systems is to comply with the following requirements:
 - (A) Safety systems are to be, as far as practicable, provided independently of control systems and alarm systems.
 - (B) Safety systems for the main propulsion machinery, boilers, electric generating sets and auxiliary machinery essential for main propulsion of the ship are to be independent each other.
- (2) Function of safety systems
Function of the safety systems is to comply with the following requirements:
 - (A) Alarm systems which have functions prescribed in **302. 5** are to operate when safety systems are put into action.
 - (B) In case where safety systems are put into action and the operation of the machinery or equipment is stopped, it is not to automatically restart before manual reset is made.
- (3) Override arrangements
Override arrangements are to be complied with:
 - (A) A visual indication is to be given at the relevant control stations of the machinery and equipment when an override is operated.
 - (B) The override arrangements are to be such that inadvertent operation is prevented.

7. Computer-based Systems [See Guidance]

The contents are to comply with the requirements specified in Rule **Pt 6, Ch 2, Sec 4**.

303. Prevention of flooding and fire safety measures

1. Prevention of flooding

- (1) Bilge wells in the spaces where main propulsion machinery, main shaftings, boilers, electric generating sets and auxiliary machinery essential for main propulsion of the ship are situated and other spaces considered necessary by the Society are to be large enough to accommodate easily the normal drainage during operation of the machinery installations and high liquid level alarm devices are to be provided at two or more places so that the increase of bilge can be detected

at normal angles of heel and trim, except for such spaces that the Society appreciated that there is no fear of flooding.

- (2) Where bilge pumps are capable of being started and stopped automatically, small bilge wells may be accepted in consideration of the operating frequency of the pump.
- (3) Where bilge pumps are capable of being started and stopped automatically, alarm devices are to be provided to indicate either one of the following conditions:
 - (A) When the influx of liquid is greater than the pump capacity.
 - (B) When the pump is operating more frequently than would be normally expected.
- (4) The controls of any valve serving a sea inlet, a discharge below the load water line or a bilge injection system are to be so sited as to allow adequate time for operation in case of influx of water to the space with the ship in the fully loaded condition, having regard to the time likely to be required in order to reach and operate such controls. **[See Guidance]**

2. Fire Safety Measures **[See Guidance]**

- (1) Fuel oil arrangements and lubricating oil arrangements installed in the spaces where main engines, boilers, electric generating sets and auxiliaries for propulsion of the ship are situated and other spaces which are considered necessary by the Society, are to comply with the following requirements, in addition to the requirements in **Pt 5, Ch 6, Sec 8 and 9**.
 - (A) Fuel oil piping system and lubricating oil piping system are, if necessary, to be shielded or appropriately protected in order to prevent, as far as practicable, scattering or leaking oil from touching the hot surfaces or from entering into the air inlets. The number of joints of piping systems is to be limited to a minimum.
 - (B) Where fuel oil service tanks are filled automatically or by remote control, means are to be provided to prevent overflow spillages.
 - (C) Equipment (except for tanks) which treats flammable liquids, e.g. fuel oil purifiers, which, whenever practicable, is to be installed in a special space reserved for purifiers and their heaters, is to have arrangements to prevent overflow spillages.
 - (D) In case where fuel oil service tanks or settling tanks are fitted with heating arrangements, a high temperature alarm device is to be provided, if the flash point of the fuel oil can be exceeded.

304. Centralized monitoring and control systems

1. General

Centralized control station or centralized monitoring and control station on bridge, designed and equipped to ensure the operation of the main propulsion and essential auxiliary machinery as safe as that under direct supervision under all sailing conditions including manoeuvring is to be provided.

2. Centralized monitoring and control systems for main propulsion and essential auxiliary machinery

Following devices are to be provided in the centralized control station or the centralized monitoring and control station on bridge:

- (1) Remote control devices and monitoring devices for main propulsion machinery or controllable pitch propellers
- (2) Remote control devices and monitoring devices for boilers
In this case, the remote control devices are to be in accordance with the following:
 - (A) Main boilers
Control devices for the control of the number of firing burners and combustion control devices, this does not include the ignition of the main boilers.
Where, however, the combustion and the number of the firing burners are automatically controlled, these control devices need not be fitted.
 - (B) Auxiliary boilers
Remote control devices for boilers which are required to be operated to supply steam to the turbines of exhaust gas turbo generator set in order to maintain stable electrical power in the case of low power condition of the main propulsion machinery.
However, where the boilers are arranged to operate automatically, the remote control devices may be dispensed with.
- (3) Remote control devices and monitoring devices for electric generating sets
In case where the equipment specified in **Pt 6, Ch 1, 202. 1 (3)** is provided, the remote control

- devices may be dispensed with.
- (4) Remote starting and stopping devices and monitoring devices for pumps used as auxiliary machinery essential for main propulsion
In case where the standby pumps for these pumps are arranged to start automatically, the remote starting and stopping devices may be dispensed with.
 - (5) Remote starting and stopping devices and monitoring devices for air compressors for starting of main propulsion machinery and for controlling
In case where these air compressors are arranged to operate automatically, the remote starting and stopping devices may be dispensed with.
 - (6) Alarm devices to indicate the operation of the safety systems and the faults of the machinery specified in **305.** to **310.**
 - (7) Emergency stopping devices for main propulsion machinery specified in **305. 2 (3) (E).**
 - (8) Communication means specified in **Pt 5, Ch 1, 106.** and engineers alarm specified in **Pt 5, Ch 1, 107.**
 - (9) Bilge alarm device specified in **303. 1 (1) and (3)**
 - (10) Fire detectors
 - (11) Remote indications specified in **Table 9.3.1 to 9.3.9**
 - (12) Override arrangements

305. Automatic and remote control of main propulsion machinery or controllable pitch propellers [See Guidance]

1. General

Devices for remote or automatic control by which the main propulsion machinery or the controllable pitch propellers are controlled are to comply with the requirements in this **305.**

2. Remote control devices for main propulsion machinery or controllable pitch propellers

(1) General

Remote control devices for main propulsion machinery or controllable pitch propellers are to be complied with the following requirements:

- (A) Remote control devices for main propulsion machinery or controllable pitch propellers are to be capable of controlling the propeller speed and the direction of thrust (the blade angle of propellers in the case of controllable pitch propellers) by means of a simple operation.
- (B) Remote control devices for main propulsion machinery or controllable pitch propellers are to be provided for each propeller. Where multiple propellers are designed to operate simultaneously, they may be control by one control device.
- (C) In case where the speed of the diesel engines used as main propulsion machinery is controlled by governors, the governors are to be adjusted so that main propulsion machinery may not exceed 103 % of the maximum continuous revolutions. The governors are to be capable of maintaining the safe minimum speed.
- (D) In case where a program control is adopted, the program for increase and decrease of output is to be so designed that undue mechanical stresses and thermal stresses do not occur in any parts of machinery.
- (E) In the remote control stations or monitoring stations and at the maneuvering platform for the main propulsion machinery or controllable pitch propellers, the following instruments are to be provided.
 - (a) Indicators for propeller speed and direction of rotation in the case of solid propellers.
 - (b) Indicators for propeller speed and pitch position in the case of controllable pitch propeller.
- (F) In the remote control stations for main engines or controllable pitch propellers, alarm devices necessary for the control of main engines are to be provided.

(2) Transfer of control

Remote control devices for main propulsion machinery or controllable pitch propellers are to comply with the following requirements with respect to transfer of control:

- (A) Each control station for main propulsion machinery or controllable pitch propellers is to be provided with means to indicate which of them is in control.
- (B) Remote control of main propulsion machinery or controllable pitch propellers is to be possible only from one location at a time.
- (C) Transfer of control is to be possible only with order by the serving station and acknowledgement by the receiving station except for the following cases:

- (a) Transfer of control between local control station for main propulsion machinery or controllable pitch propellers and main control station or subcontrol station; and
 - (b) Transfer of control during the stopping condition of the main propulsion machinery.
 - (D) While main propulsion machinery or controllable pitch propellers are controlled from the navigation bridge or the main control station on bridge, transfer of control is to be possible from the local control station for the main propulsion machinery or controllable pitch propellers, the main control station or the sub-control station with no order of the transfer of control from the navigation bridge or the main control station on bridge.
 - (E) Means are to be provided to prevent the propelling thrust from altering significantly when transferring control from one location to another except for the transfer of control described in (C) (a) and (D).
- (3) Failure of remote control systems of main propulsion machinery or controllable pitch propellers
- The following requirements are to be complied with in case of failure of remote control devices for main propulsion machinery or controllable pitch propellers:
- (A) In the remote control stations for main propulsion machinery or controllable pitch propellers alarm devices which operate in the event of failure of the remote control devices for main propulsion machinery or controllable pitch propellers are to be provided.
 - (B) In the event of failure of the remote control devices for main propulsion machinery or controllable pitch propellers, the main propulsion machinery or the controllable pitch propellers are to be possible to control locally.
 - (C) In the event of failure of the remote control devices for main propulsion machinery or controllable pitch propellers, the preset speed and direction of the propeller thrust are to be maintained until the control is in operation at the main control station, the sub-control station or the local control station for main propulsion machinery or controllable pitch propellers, unless this is considered impracticable by the Society.
 - (D) In the event of failure of the remote control devices for main propulsion machinery or controllable pitch propellers, the transfer of control to the main control station, the sub-control station or the local control station for main propulsion machinery or controllable pitch propellers is to be possible by a simple operation.
 - (E) Remote control stations for main propulsion machinery or controllable pitch propellers are to be provided with independent emergency stopping devices for the main propulsion machinery, which are effective in the event of failure of the remote control devices for the main propulsion machinery or the controllable pitch propellers.
- (4) Remote starting of main propulsion machinery in diesel ships
- Starting by means of remote control devices for main propulsion machinery is to comply with the following:
- (A) The number of starting of main propulsion machinery is to satisfy the number specified in **Pt 5, Ch 6, 1101**.
 - (B) Remote control devices for main propulsion machinery arranged to automatically start are to be so designed that the number of automatic consecutive attempts which fail to produce a start is limited to three times. In the event of failure of starting, a visual and audible alarm is to be issued at the relevant control station as well as the main control station on bridge, the main control station or the monitoring station (where the main control station on bridge and the main control station are not provided) for the main propulsion machinery or the controllable pitch propellers.
 - (C) Where compressed air is used for starting of the main propulsion machinery, alarm devices to indicate the low starting air pressure are to be provided at the remote control station and the monitoring station for the main propulsion machinery.
 - (D) The low starting air pressure mentioned in (C) for the operation of alarm devices is to be set at a level to permit further main propulsion machinery starting operations.

3. Bridge control devices

Bridge control devices are to comply with the following requirements as well as those in **305. 2**.

- (1) Even when main propulsion machinery or controllable pitch propellers is controlled from the navigation bridge or the main control station on bridge, the telegraph orders at the navigation bridge or the main control station on bridge are to be indicated in the control stations and at the maneuvering platform which are capable of controlling main propulsion machinery or controllable pitch propellers.
- (A) Sub-control station or local control station for main propulsion machinery or controllable pitch

- propellers for ships provided with main control station on bridge, or
- (B) Main control station for ships not provided with main control station on bridge.
- (2) Bridge control devices are to be provided with either one of the following devices in order to prevent prolonged running of main propulsion machinery in critical speed range:
 - (A) Devices to make to pass automatically and rapidly through the critical speed range.
 - (B) Alarm devices which operate in case where the main propulsion machinery operate exceeding a predetermined period in the critical speed range.

4. Safety measures

- (1) Safety measures for main propulsion machinery or controllable pitch propellers
Safety measures for main propulsion machinery or controllable pitch propellers are to comply with the following requirements:
 - (A) The following safety measures are to be taken to remote control devices for main propulsion machinery or controllable pitch propellers:
 - (a) Necessary interlocking devices are to be provided to prevent serious damage due to mis-operation.
 - (b) Where the auxiliary machinery essential for main propulsion of the ship are driven by electric motors, the main propulsion machinery is to be so designed as to stop automatically in the event of failure of the main source of electrical power or to be capable of being stopped.
 - (c) The main propulsion machinery is to be so arranged as not to re-start automatically when electrical power is restored after the failure of the main source of electrical power whereas the main propulsion machinery was stopped.
 - (d) The remote control devices for main propulsion machinery or controllable pitch propellers are to be so designed that the engine may not be abnormally overloaded in the event of failure of them.
 - (B) Stopping devices for main propulsion machinery are to be provided at the monitoring station for main propulsion machinery or controllable pitch propellers.
- (2) Safety systems of main propulsion machinery
Safety systems of main propulsion machinery are to comply with the following requirements:
 - (A) A device to shut off the fuel or steam supply (this device hereinafter being referred to as "safety device") for the main propulsion machinery is not to be automatically activated except in cases which could lead to complete breakdown, serious damage or explosion.
 - (B) The safety systems for the main propulsion machinery are to be so designed as not to lose their function or as to fail to safe, even in the event of failure of main electrical source or air source.
- (3) Self-reversing diesel engines
At least the following safety measures are to be taken to the remote control devices for self-reversing diesel engines:
 - (A) Starting operation is to be possible only when the camshaft is surely at the position of "Ahead" or "Astern".
 - (B) During reversing operation, fuel is not to be injected.
 - (C) Reversing operation is to be conducted after "Ahead" revolution is reduced to a pre-determined value.
- (4) Main propulsion machinery of a multi-engines coupled to a single shaft ship
At least the following safety measures are to be taken to the remote control devices for multi-engines coupled to a single shaft:
 - (A) Each main propulsion machinery is to be provided with an overload preventive device.
 - (B) Each main propulsion machinery is not to be subjected to an abnormally unbalanced load.
- (5) Main propulsion machinery with clutch
At least the following safety measures are to be taken to the remote control devices for engines with clutch:
 - (A) The clutch equipped to a main propulsion machinery in a multi-engines coupled to a single shaft is to be disengaged when the main propulsion machinery is stopped in an emergency. While multi-engines are operating in different directions of rotation their clutches are not to be engaged simultaneously.
 - (B) Engaging and disengaging of clutches are to be carried out below a predetermined revolutions of the main propulsion machinery.
 - (C) An overspeed protective devices specified in **Pt 5, Ch 2, 203. 1 and 2** or **Pt 5, Ch 2, 304. 1** is to be provided.

- (D) In case where there is fear that the speed of the propulsion motor would exceed 125 % of the rated revolution when the clutch is disengaged, an overspeed protective device as deemed appropriate by the Society is to be provided.
- (6) Main propulsion machinery driving controllable pitch propellers
At least the following safety measures are to be taken to the remote control devices for engines driving controllable pitch propellers:
 - (A) In overload preventive device is to be provided.
 - (B) Starting of engines or engaging of clutches is to be performed while the propeller blades are in a neutral position.
 - (C) An overspeed protective device as specified in **Pt 5, Ch 2, 203. 1** or **Pt 5, Ch 2, 304. 1** is to be provided.
 - (D) In case where there is fear that the speed of the propulsion motor would exceed 125 % of the rated revolution when the propeller pitch is altered, an overspeed protective device as deemed appropriate by the Society is to be provided.
- (7) Crosshead main diesel engines
For crosshead main diesel engines, safety system specified in **Table 9.3.1** is to be provided.
- (8) Trunk piston main diesel engines
For trunk piston main diesel engines, safety system specified in **Table 9.3.2** is to be provided.
- (9) Propulsion steam turbine
For propulsion steam turbines, safety system specified in **Table 9.3.3** is to be provided.
- (10) Electric propulsion equipments
For electric propulsion equipments, safety system specified in **Table 9.3.4** is to be provided.
- (11) Controllable pitch propellers
For controllable pitch propellers, safety system specified in **Table 9.3.5** is to be provided.

306. Automatic and remote control of boilers

1. General

- (1) The systems of automatic control for both combustion and feed water of oil-fired boilers are to comply with the requirements in **Par 2** to **Par 4** respectively.
- (2) The systems of automatic control for either combustion or feed water of oil-fired boilers are to comply with the relevant requirements in **Par 2** or **Par 3** as well as the requirements in **Par 4**.
- (3) Automatic control of boilers other than oil-fired boilers or having a special feature is to be deemed appropriate by the Society. **[See Guidance]**
- (4) Remote water level indicators are to comply with the requirements in **Pt 5, Ch 5, 129..**

2. Automatic combustion control systems

(1) General

Automatic combustion control systems are to comply with the following requirements:

- (A) The automatic combustion control systems are to be able to control so as to obtain planned steam amount, steam pressure and steam temperature and to secure stable combustion.
- (B) The devices to control the fuel supply to meet the load imposed are to be capable of ensuring stable combustion in the controllable range of fuel supply.
- (C) Where combustion control is carried out according to the pressure of the boiler, the upper limit of this pressure is to be lower than the set pressure of the safety valves.

(2) Combustion control devices for intermittent operation

The combustion control devices for intermittent operation are to comply with the following requirements and they are to operate according to the planned sequence:

- (A) Before ignition on the pilot burner or before ignition on the main burner if the pilot burner is not fitted, the combustion chamber and the flue are to be pre-purged by air of not less than 4 times the volume of the combustion chamber and the flue up to the boiler uptake. For small boilers with only one burner, pre-purge for not less than 30 seconds will be accepted.
- (B) In case of direct ignition which is a method of ignition that the main burner is fired by ignition spark, opening of the fuel valve is not to precede the ignition spark.
- (C) In case of indirect ignition which is a method of ignition that the main burner is fired by the pilot burner, opening of the fuel valve for the pilot burner (hereinafter referred to as "ignition fuel valve") is not to precede the ignition spark, and opening of the fuel valve for the main burner (hereinafter referred to as "main fuel valve") is not to precede opening of the ignition fuel valve.

- (D) Firing is to be surely carried out within the planned period. Main fuel valve is to be so designed as to close after opening of the valve not exceeding 10 seconds in the case of direct ignition and 15 seconds in the case of indirect ignition if the firing on the main burner has failed.
- (E) Firing on the main burners is to be carried out at their low firing position.
- (F) After closure of the main fuel valve, post-purge is to be carried out for not less than 20 seconds to ensure adequate combustion air to completely burn all fuel oil remaining between the fuel oil valve and the burner nozzle. This requirements need not to be complied with in the case of auxiliary boilers as deemed appropriate by the Society. **【See Guidance】**
- (3) Combustion control devices for the control of the number of firing burners
The combustion control devices for the control of the number of firing burners are to comply with the following requirements:
 - (A) Each burner is to be fired and extinguished according to the planned sequence. However, the base burner may be fired by manual operation and other burners may be fired by flame of a burner(s) already fired.
 - (B) The remaining fuel in the extinguished burner is to be automatically burnt up in order not to interfere the restarting. However, while the pilot burner is not fired, the remaining fuel in the base burner is not to be removed by steam or air when it is in place.
 - (C) The burners for main boilers are to be capable of being fired and extinguished from the main control station or the main control station on bridge, except for the firing of base burner.
- (4) Other combustion control devices **【See Guidance】**
Other combustion control devices are to be deemed appropriate by the Society, as well as they are to comply with the relevant requirements in (2) and (3).

3. Automatic feed water control devices

- (1) Automatic feed water control devices are to be capable of controlling automatically the feed water in order to maintain the water level in the boilers in a predetermined range.
- (2) Main boilers are to be provided with not less than three water level detectors used for a feed water control device, a remote water level indicator, a low-water level safety device and a low-water level alarm device.

4. Safety measures

- (1) Safety devices
Safety devices are to comply with the following requirements.
 - (A) A self-closing valve is to be provided in the feed water piping of the main boiler, and is to operate automatically in the event of abnormal rise of the water level in the main boiler.
 - (B) Safety devices for low water level in the main boilers are to be put into action by means of a signal from either one of the two low water level detectors which are independent each other. However, one of those detectors may be used for other purpose.
- (2) For main boilers, safety system specified in **Table 9.3.6** is to be provided.
- (3) For essential auxiliary boilers, safety system specified in **Table 9.3.7** is to be provided.

307. Automatic and remote control of electric generating sets

1. General

- (1) Electric generating sets arranged to be automatically or remotely started are to be provided with interlocking devices necessary for safe operation.
- (2) Electric generating sets arranged to be automatically started are to be so designed that the number of automatic consecutive attempts which fail to produce a start is limited to two times and to be provided with an alarm device which operate at the time of the failure of starting.
- (3) In case where a diesel engine to drive a propulsion generator is remote started, the number of starting is to conform to the required number specified in **Pt 5, Ch 2, 202. 5**.
- (4) Where automatic start of the standby generating set with automatic connection to the switch-board busbars is provided, automatic closure on to the busbars is to be limited to one attempt in the event of the original power failure being caused by short circuit.
- (5) Automatic control and remote control systems for the electric generating set, whose generator is driven by the main propulsion machinery and supplies electrical power to the electrical installations relating to the services specified in **Pt 6, Ch 1, 201. 1 (1)** and is operated while the

main propulsion machinery is controlled by the bridge control devices are to comply with the requirement in **Pt 6, Ch 1, 202.** in addition to those in this **Sec 307.**

2. Safety measures

For auxiliary diesel engines and auxiliary steam turbines, safety system specified in **Table 9.3.8.** For main generators, safety system specified **Table 9.3.9** is to be provided.

308. Automatic and remote control of thermal oil installations

1. Control devices

Control devices are to comply with the requirements in **306. 2** (1) and (2) as well as those in **Pt 5, Ch 5, 202. 1** and **2.**

2. Safety measures

Safety devices are to comply with **Pt 5, Ch 5, 201.** and **Pt 5, Ch 5, 202. 5** and safety system specified in **Table 9.3.10.**

309. Automatic and remote control of other machinery

1. Air compressors

(1) Automatic operation of air compressors

In case where air compressors for starting and air compressors for controlling are automatically operated, alarm devices are to be provided to indicate pressure drop in air reservoirs.

(2) Safety devices

Air compressors are to be so arranged as to stop automatically in the event of drop of lubricating oil pressure.

2. Heat exchangers

The following heat exchangers used for main propulsion machinery, main boilers, important auxiliary boilers, generators and prime movers driving auxiliary machinery essential for main propulsion of ships are to be provided with temperature control devices in order to regulate the temperatures of lubricating oil, coolant and fuel oil in a predetermined range:

- (1) Lubricating oil coolers
- (2) Coolers for cylinder coolant water
- (3) Coolers for piston coolant
- (4) Coolers for fuel valve coolant
- (5) Fuel oil heaters
- (6) Heaters for fuel oil purifiers
- (7) Heaters for lubricating oil purifiers

3. High temperature alarm for oil heaters

In case where a temperature for fuel oil and lubricating oil is automatically controlled, high temperature alarm devices are to be provided, except where oils are not heated above the flash point.

4. Opening and closing devices for sea valves

In case where sea valves fitted on the shell plating below the load water line are remotely or automatically controlled, other opening and closing devices which can be easily operated even in the event of failure of the automatic or remote control devices are to be provided.

5. Liquid level alarm systems for fuel oil tanks

In case where fuel transfer to fuel oil tanks is automatically controlled, the receiving tanks are to be provided with a high and low level alarm.

6. Mooring arrangements

In case where mooring arrangements are provided with remote control devices, the mooring arrangements are to be capable of being locally operated.

7. Fuel oil filling arrangements

In case where arrangements for filling fuel oil into respective fuel oil tanks from the outside of the ships (hereinafter referred to as "fuel oil filling arrangements") are provided with remote control devices, the fuel oil filling arrangements are to be such as not to interfere with filling of fuel even in

the event of failure of the remote control devices.

8. Alarms

For other machinery alarm devices specified in **Table 9.3.11** are to be provided

310. Override arrangements

1. Application

- (1) Automatic slowdowns and automatic shutdowns specified in **Table 9.3.1** to **Table 9.3.8** are to be provided with override arrangements, regardless of the mode of control (manual, remote or automatic). However, override arrangements do not need to be fitted in those cases where override may result in total failure of the engine and/or propulsion equipment within a short time. Automatic slowdowns and automatic shutdowns where provided in excess of those indicated in **Table 9.3.1** to **Table 9.3.8** are to be provided with override arrangements.

Table 9.3.1 Crosshead diesel engines (2021)

Systems	Monitored parameters [H: High L: Low O: Abnormal status]	AA	RI	Auto slow down with alarm	Auto start of Stand by pump with alarm	Auto shut down with alarm	Notes [AA = Alarm Activation RI = Remote Indication* ●=apply]
Sensors	Common or separate		Gr 1		Gr 2	Gr 3	
Fuel oil	Fuel oil after filter (engine inlet), pressure	L	●	●	●		
	Fuel oil before injection pumps, temp. (or viscosity L)	H	●				
	Fuel oil before injection pumps, temp. (or viscosity H)	L	●				
	Leakage from high pressure pipes	O	●				
	Fuel oil service tank, level	L	●				
	Common rail fuel oil pressure	L	●				
Lubri- cating oil	Lub. oil to main bearing and thrust bearing, pressure	L	●	●	●	●	
	Lub. oil to crosshead bearing, pressure	L	●	●	●	●	If of a different system.
	Lub. oil to camshaft, pressure	L	●		●	●	If of a different system.
	Lub. oil to camshaft, temp.	H	●				If of a different system.
	Lub. oil inlet, temp.	H	●				
	Thrust bearing pads temp. or bearing outlet temp.	H	●	●		●	
	Activation of oil mist detection arrangements (or activation of the temperature monitoring systems or equivalent devices of: – the engine main, crank and cross-head bearing oil outlet; or – the engine main, crank and cross-head bearing)	O	●	●			For engines having power ≥ 2250 kW or cylinder bore > 300 mm ⁽¹⁾
	Each cylinder lubricator, flow rate	L	●	●			
	Lub. oil tanks, level	L	●				Where separate lubricating oil systems are installed (e.g. camshaft, rocker arms, etc.), individual level alarms are required for all the tanks.
Turbo- charger	Common rail servo oil pressure	L	●				
	Lub. oil inlet, pressure	L	●				Unless provided with a self-contained lubricating oil system integrated with the turbocharger
	Lub. oil outlet (each bearing), temp.	H	●				⁽²⁾
	Speed	H	●	●			For engines having power > 1000 kW

Table 9.3.1 Crosshead diesel engines (continued)

Systems	Monitored parameters [H: High L: Low O: Abnormal status]	AA	RI	Auto slow down with alarm	Auto start of Stand by pump with alarm	Auto shut down with alarm	Notes [AA = Alarm Activation RI = Remote Indication* ●=apply]
Sensors	Common or separate		Gr 1		Gr 2	Gr 3	
Piston cooling	Coolant inlet, pressure	L	●	●	●		The slow down is not required if the coolant is oil taken from the main cooling system of the engine.
	Coolant outlet (each cylinder), temp.	H	●	●			
	Coolant outlet (each cylinder), flow	L	●	●			Where due to the design of the engine the flow of piston coolant outlet cannot be monitored, this item may be reconsidered.
	Coolant in expansion tank, level	L	●				
Sea water cooling	Sea water cooling, pressure	L	●		●		
Cylinder fresh water cooling	Water inlet, pressure	L	●	●	●		
	Water outlet from each cylinder, temp. (or *common water outlet, temp. H)	H	●	●			* Sensing at common water outlet is permitted for cylinder jackets fitted with common cooling space without intervening stop valves.
	Oily contamination of engine cooling water system.	O	●				Where engine cooling water is used in fuel and lubricating oil heat exchangers.
	Cooling water expansion tank, level	L	●				
Compre- ssed air	Starting air before main shut-off valve, pressure	L	●	●			
	Control air, pressure	L	●				
	Safety air, pressure	L	●				
Scavenge air	Scavenge air receiver, pressure			●			
	Scavenge air box, temp. (fire)	H	●	●			
	Scavenge air receiver water level	H	●				
Exhaust gas	Exhaust gas after each cylinder, temp.	H	●	●	●		
	Exhaust gas after each cylinder, deviation from average, temp.	H	●				
	Exhaust gas before each turbo-charger, temp.	H	●	●			
	Exhaust gas after each turbo-charger, temp.	H	●	●			
Fuel valve Coolant	Coolant, pressure	L	●		●		
	Coolant, temp.	H	●				
	Coolant expansion tank, level	L	●				

Table 9.3.1 Crosshead diesel engines (continued)

Systems	Monitored parameters [H: High L: Low O: Abnormal status]	AA	RI	Auto slow down with alarm	Auto start of Stand by pump with alarm	Auto shut down with alarm	Notes [AA = Alarm Activation RI = Remote Indication* ●=apply]
Sensors	Common or separate		Gr 1		Gr 2	Gr 3	
Engine	Speed/direction of rotation			●			
	Rotation—wrong way	O	●				
	Engine overspeed	O	●			●	
	Remote start failure	O	●				
Power	Control, alarm or safety system, power supply failure	O	●				
<p>(NOTES)</p> <p>* Remote Indication(RI) : presentation of values in engine control room or another centralized control station</p> <p>* Gr 1 : Common sensor for indication, alarm, slow down Gr 2 : Sensor for automatic start of standby pump with alarm Gr 3 : Sensor for shut down</p> <p>(1) Oil mist detection system is to be of the approved type by the Society, tested by Ch 3, Sec. 10 of the Guidance for Approval of Manufacturing Process and Type Approval, Etc. and applied to Pt 5, Ch 2, 203.</p> <p>(2) Where outlet temperature from each bearing cannot be monitored due to the engine/turbocharger design, alternative arrangements may be accepted. Continuous monitoring of inlet pressure and inlet temperature in combination with specific intervals for bearing inspection in accordance with the turbocharger manufacturer's instructions may be accepted as an alternative.</p>							

Table 9.3.2 Trunk piston diesel engines (2021)

Systems	Monitored parameters [H: High L: Low O: Abnormal status]	AA	RI	Auto slow down with alarm	Auto start of Stand by pump with alarm	Auto shut down with alarm	Notes [AA = Alarm Activation RI = Remote Indication* ●=apply]
Sensors	Common or separate		Gr 1		Gr 2	Gr 3	
Fuel oil	Fuel oil after filter (engine inlet), pressure	L	●	●	●		
	Fuel oil before injection pumps, temp. (or viscosity L)	H	●				For heavy fuel oil burning engines only.
	Fuel oil before injection pumps, temp. (or viscosity H)	L	●				For heavy fuel oil burning engines only.
	Leakage from high pressure pipes	O	●				
	Fuel oil service tank, level	L	●				High level alarm is also required if without suitable overflow arrangements.
	Common rail fuel oil pressure	L	●				
Lubricating oil (Diesel engine)	Lub. oil to main bearing and thrust bearing, pressure	L	●	●	●	●	
	Lub. oil filter differential, pressure	H	●	●			
	Lub. oil inlet, temp.	H	●	●			
	Activation of oil mist detection arrangements (or activation of the temperature monitoring systems or equivalent devices of: – the engine main and crank bearing oil outlet; or – the engine main and crank bearing)	O	●			●	Only for medium speed engines having power ≥ 2250 kW or cylinder bore > 300 mm : for each engine, one oil mist detector (or engine bearing temperature monitoring system or equivalent device) having two independent outputs for initiating alarm and for shutdown will satisfy independence of alarm and shut-down systems. ⁽¹⁾ An equivalent device could be interpreted as measures applied to high speed engines where specific design features to preclude the risk of crankcase explosions are incorporated.
	Each cylinder lubricator, flow rate	L	●	●			If necessary for the safe operation of the engine.
	Common rail servo oil pressure	L	●				
Reduction Gear	Reduction gear lub. oil inlet pressure	L	●	●	●	●	Shutdown is to affect all power input to gear
Turbo-charger	Turbo-charger lub. oil inlet pressure	L	●	●			Unless provided with a self-contained lubricating oil system integrated with the turbocharger
	Turbo-charger lub. oil temperature each bearing	H	●				⁽²⁾
	Speed	H	●	●			For engines having power > 1000 kW
Sea water cooling	Sea water cooling system pressure	L	●	●	●		

Table 9.3.2 Trunk piston diesel engines (continued)

Systems	Monitored parameters [H: High L: Low O: Abnormal status]	AA	RI	Auto slow down with alarm	Auto start of Stand by pump with alarm	Auto shut down with alarm	Notes [AA = Alarm Activation RI = Remote Indication* ●=apply]
Sensors	Common or separate		Gr 1		Gr 2	Gr 3	
Cylinder fresh water cooling	Water inlet, pressure low or flow	L	●	●	●		
	Water outlet (general), temp.	H	●	●	●		Two separate sensors are re- quired for alarm and slowdown.
	Cooling water expansion tank, level	L	●				
Compressed air	Starting air before shut-off valve, pressure	L	●	●			
	Control air pressure	L	●	●			
Scavenge air	Scavenge air receiver temp.	H	●				
Exhaust gas	Exhaust gas after each cylinder, temp.	H	●	●	●		For engine power > 500 kW /cylinder
	Exhaust gas after each cylinder, deviation from average, temp.	H	●				
Engine	Speed			●			
	Overspeed	O	●			●	
	Remote start failure	O	●				
Power	Control, alarm or safety system, power supply failure	O	●				
(NOTES) * Remote Indication(RI) : presentation of values in engine control room or another centralized control station * Gr 1 : Common sensor for indication, alarm, slow down Gr 2 : Sensor for automatic start of standby pump with alarm Gr 3 : Sensor for shut down (1) Oil mist detection system is to be of the approved type by the Society, tested by Ch 3, Sec. 10 of the Guidance for Approval of Manufacturing Process and Type Approval, Etc. and applied to Pt 5, Ch 2, 203. (2) Where outlet temperature from each bearing cannot be monitored due to the engine/turbocharger design, alternative arrangements may be accepted. Continuous monitoring of inlet pressure and inlet temperature in combination with specific intervals for bearing inspection in accordance with the turbocharger manufacturer's instructions may be accepted as an alternative.							

Table 9.3.3 Propulsion steam turbines (2021)

Systems	Monitored parameters [H: High L: Low O: Abnormal status]	AA	RI	Auto slow down with alarm	Auto start of Stand by pump with alarm	Auto shut down with alarm	Notes [AA = Alarm Activation RI = Remote Indication* ●=apply]
Sensors	Common or separate		Gr 1		Gr 2	Gr 3	
Lubri- cating oil	Pressure at bearing inlets	L	●	●	●	●	For turbines, gears and thrust bearings.
	Temp. at bearing inlet	H	●	●			For turbines, gears and thrust bearings
	Bearing temp. or bearing oil outlet temp.	H	●	●			For turbines, gears and thrust bearings
	Filter differential pressure	H	●				
	Gravity tank and sump levels	L	●	●			
Lubri- cating oil Cooling medium	Pressure or flow	L	●	●	●		
	Temp. at outlet	H	●				
	Expansion tank level	L	●	●			
Sea water	Pressure or flow	L	●	●	●		
	Pump auto starting and running			●			For vessels fitted with sea inlet scoops
	Scoop valve open/close			●			For vessels fitted with sea inlet scoops
Steam	Pressure at throttle	L	●			●	
	Pressure, ahead chest			●			
	Pressure, astern chest			●			
	Pressure, gland seal			●			
	Gland seal exhaust fan failure	O	●				
	Astern guardian valve position			●			
	Astern guardian valve fail to open	O	●				In response to throttle trip or maneu- vering signal.
Cond- ensate	Condenser level	H	●	●		●	
	Condenser level	L	●	●			
	Condensate pump pressure	L	●		●		
	Condenser vacuum	L	●	●		●	
	Salinity	H	●	●			
Turbine	Vibration Level	H	●		●		
	Axial Displacement large	O	●			●	
	Speed			●			
	Overspeed	O	●			●	
	Shaft rollover activated			●			
	Shaft stopped excess of set period	O	●				Shaft rollover to be activated manually or automatically
Power	Throttle control system power failure	O	●				
(NOTES) * Remote Indication(RI) : presentation of values in engine control room or another centralized control station * Gr 1 : Common sensor for indication, alarm, slow down Gr 2 : Sensor for automatic start of standby pump with alarm Gr 3 : Sensor for shut down							

Table 9.3.4 Electric propulsion equipments

System	Monitored parameters [H: High L: Low O: Abnormal status]	AA	RI	Auto shut down with alarm	Notes [AA = Alarm Activation RI = Remote Indication* ●=apply]
Propulsion Generator	Bearing lub. oil inlet pressure	L	●	●	Prime mover automatic shutdown
	Voltage off-limits	O	●	●	To read all phases and at least one bus
	Frequency off-limits	O	●	●	
	Current			●	To read all phases
	Stationary windings temperature	H	●	●	To read all phases; for generators > 500 kW
	Main generator circuit breakers open/close			●	
	Generator running			●	
	Failure of on-line generator	O	●		
	Transfer of standby generator	O	●		
	Generator cooling medium temperature	H	●	●	If applicable
	Failure of generator cooling pump or fan motor	O	●		If applicable
	Field voltage and current			●	For DC generator
	Inter-pole winding temperature	H	●	●	For DC generator
Propulsion Motor – AC	Bearing, lub. oil inlet pressure	L	●	●	
	Armature voltage off-limits	O	●	●	To read all phases and at least one bus
	Field voltage			●	
	Frequency off-limits	O	●	●	
	Armature current			●	To read all phases
	Field current			●	For synchronous motors
	Ground lights or similar			●	
	Stationary windings temperature	H	●	●	To read all phases; for motors > 500 kW
	Motor circuit breakers open/close			●	
	Motor running			●	
	Failure of on-line motor	O	●		
	Transfer of standby motor	O	●		
	Motor cooling medium temperature	H	●	●	If applicable
	Failure of cooling pump or fan motor	O	●		If applicable

Table 9.3.4 Electric propulsion equipments (continued)

System	Monitored parameters [H: High L: Low O: Abnormal status]	AA	RI	Auto shut down with alarm	Notes [AA = Alarm Activation RI = Remote Indication* ●=apply]
Propulsion Motor – DC	Bearing lub. oil inlet pressure	L ●	●	●	
	Armature voltage off-limits	O ●	●		
	Field voltage		●		
	Armature current		●		
	Field current		●		
	Ground lights or similar		●		
	Motor circuit breakers open/close		●		
	Motor running		●		
	Motor overspeed	O ●		●	
	Failure of on-line motor	O ●			
	Transfer of standby motor	O ●			
	Motor cooling medium temperature	H ●	●		If applicable
	Failure of cooling pump or fan motor	O ●			If applicable
Propulsion SCR	Voltage		●		
	Current		●		
	Overload (high current)	O ●			Alarms before protective device is activated
	Open/close position for assignment switches		●		
	SCR cooling medium temperature	H ●	●		If applicable
	Failure of SCR cooling pump or fan motor	O ●			If applicable
Transformer	Transformer winding temperature high	O ●	●		For each phase
(NOTES)					
* Remote Indication(RI) : presentation of values in engine control room or another centralized control station					

Table 9.3.5 Controllable pitch propellers

System	Monitored parameters [H: High L: Low O: Abnormal status]	AA	Auto start of Stand by pump with alarm	Notes [AA = Alarm Activation ●=apply]
Hydraulic oil	Delivery pressure or flow rate	L ●	●	
	Tank, level	L ●		

Table 9.3.6 Main boiler (2021)

System	Monitored parameters [H: High L: Low LL: Low-Low O: Abnormal status]	AA	RI	Auto start of Stand by pump with alarm	Auto shut down with alarm	Notes [AA = Alarm Activation RI = Remote Indication* ●=apply]
Sensors	Common or separate		Gr 1	Gr 2	Gr 3	
Feed water	Atmospheric drain tank level	H L	● ●			
	Dearator level	H L	● ●			
	Dearator pressure	H L	● ●			
	Feed water pump pressure	L	● ●	●		
	Feed water temperature	H	● ●			
	Feed water outlet salinity	H	● ●			
Boiler Drum	Water level	H L	● ●			
	Water level	LL	●		●	
Steam	Pressure	H L	● ●			
	Superheater outlet temperature	H	● ●			
Air	Forced draft pressure failure	O	●		●	
	Rotating air heater motor failure	O	●			If provided
	Air register open/close			●		
	Fire in boiler casing	O	● ●			
Fuel oil	Pump pressure at outlet	L	● ●	●		
	Heavy fuel oil temperature (or viscosity L)	H	● ●			
	Heavy fuel oil temperature (or viscosity H)	L	● ●			
	Master fuel oil valve open/close			●		
Burner	Burner valve open/close			●		Individual
	Atomizing medium pressure off-limits	O	● ●			
	Ignition or flame of burners fails	O	● ●		●	For multiple burners, flame failure of a single burner is to shutdown the corresponding burner fuel valves.
	Flame scanner fails	O	●		●	For multiple burners fitted with individual flame scanner, failure of flame scanner is to shutdown the corresponding burner fuel valves.
	Uptake gas temperature	H	●			For fire detection
Power	Control system power supply fails	O	● ●		●	Automatic closing of fuel valve(s)
(NOTES) * Remote Indication(RI) : presentation of values in engine control room or another centralized control station * Gr 1 : Common sensor for indication, alarm, slow down Gr 2 : Sensor for automatic start of standby pump with alarm Gr 3 : Sensor for shut down						

Table 9.3.7 Essential auxiliary boiler (2018)

System	Monitored parameters [H: High L: Low O: Abnormal status]		AA	RI	Auto shut down with alarm	Notes [AA = Alarm Activation RI = Remote Indication* ●=apply]
Feed water	Feed water outlet salinity	H	●	●		
Boiler drum	Water level	H	●			
	Water level	L	●	●	●	
Steam	Pressure	H L	●	●		
	Superheater outlet temperature	H	●	●		
Air	Supply air pressure failure	O	●		●	
	Fire in boiler air supply casing ⁽¹⁾	O	●			
Fuel oil	Pump outlet pressure	L	●	●		
	Temperature (or viscosity L and H)	H L	●			For heavy fuel oil only
Burner	Fuel oil valves open/close			●		Individual valves
	Ignition or flame fails	O	●	●	●	Individual
	Flame scanner fails	O	●		●	Individual
	Uptake gas temp.	H	●			
Power	Control system power supply fails	O	●		●	
(NOTES) * Remote Indication(RI) : presentation of values in engine control room or another centralized control station (1) For auxiliary boiler without an boiler air supply casing, the required means to detect and alarm of a fire in the boiler air supply casing may be omitted provided the burner system is a pressure jet type and the windbox forms part of the combustion fan housing.						

Table 9.3.8 Auxiliary diesel engines and auxiliary turbines (2020)

Engine	System	Monitored parameters [H: High L: Low O: Abnormal status]	AA	RI	Auto start of Stand by pump with alarm	Auto shut down with alarm	Notes [AA = Alarm Activation RI = Remote Indication* ●=apply]
Diesel Engine	Lubricating oil	Bearing oil inlet pressure	L	●	●	●	
		Bearing oil inlet temperature	H	●	●		
		Activation of oil mist detection arrangements (or activation of the temperature monitoring systems or equivalent devices of: – the engine main and crank bearing oil outlet; or – the engine main and crank bearing)	O	●		●	Only for medium speed engines having power ≥ 2250 kW or cyl- inder bore > 300 mm : for each engine, one oil mist detector (or engine bearing temperature mon- itoring system or equivalent de- vice) having two independent outputs for initiating alarm and for shutdown will satisfy in- dependence of alarm and shut-down systems. ⁽¹⁾ An equivalent device could be in- terpreted as measures applied to high speed engines where spe- cific design features to preclude the risk of crankcase explosions are incorporated.
		Common rail servo oil pres- sure	L	●			
	Cooling medium	Pressure or flow	L	●	●	●	
		Temperature at outlet	H	●	●		
		Expansion tank level	L	●			
	Fuel oil	Fuel oil leakage from injection pipe	O	●			
		Fuel oil temp. (or viscosity L and H)	H L	●			For heavy fuel oil only
		Service tank level	L	●			
		Common rail fuel oil pressure	L	●			
	Starting medium	Energy level	L	●	●		
	Exhaust	Exhaust gas temperature after each cylinder	H	●			For engines having a power of more than 500 kW/cyl.
	Speed	Overspeed	O	●		●	
		Turbo-charger	H	●			For engines having power > 1000 kW

Table 9.3.8 Auxiliary diesel engines and auxiliary turbines (continued)

Table 3-1: Primary class engine and auxiliary machines (continued)								
Engine	System	Monitored parameters [H: High L: Low O: Abnormal status]		AA	RI	Auto start of Stand by pump with alarm	Auto shut down with alarm	Notes [AA = Alarm Activation RI = Remote Indication* ●=apply]
Steam Turbine	Lubricating oil	Bearing oil inlet pressure	L	●	●	●*	●	* : Back-up lubricating pump start
		Bearing oil inlet temperature	H	●	●			
		Bearing temperature or bearing oil outlet temperature	H	●	●			
	Lub. oil Cooling medium	Pressure or flow	L	●	●			
		Temperature at outlet	H	●				
		Expansion tank level	L	●				
	Sea water	Pressure or flow	L	●	●			
	Steam	Pressure at inlet	L	●	●			
	Condensate	Condenser vacuum	L	●	●		●	
		Condensate pump pressure	L	●	●			
	Rotor	Axial displacement large	O	●			●	
		Overspeed	O	●			●	
(NOTES)								
* Remote Indication(RI) : presentation of values in engine control room or another centralized control station								
(1) Oil mist detection system is to be of the approved type by the Society, tested by Ch 3, Sec. 10 of the Guidance for Approval of Manufacturing Process and Type Approval, Etc. and applied to Pt 5, Ch 2, 203.								

Table 9.3.9 Main generators

Table 6.10.3 Main generators					
System	Monitored parameters [H: High L: Low O: Abnormal status]		AA	RI	Notes [AA = Alarm Activation RI = Remote Indication* ●=apply]
Electricity	Ampere	H	●	●	Sensors for controllers may be used
	Voltage	H L	●	●	
	Frequency or revolution of generator	H L	●	●	
(NOTES)					
* Remote Indication(RI) : presentation of values in engine control room or another centralized control station					

Table 9.3.10 Thermal oil installations

System	Monitored parameters [H: High L: Low O: Abnormal status]	AA	Auto start of Stand by pump with alarm	Notes [AA = Alarm Activation ●=apply]
Thermal oil	Delivery pressure or flow rate	L	● ●*	* : Thermal oil circulating pump
	Flow or pressure difference between outlet and inlet of heater	L	●	
	Temperature	H	●	
	Level in expansion tank	L	●	
Fuel	Pressure, burner inlet	L	● ●**	** : Fuel oil supply pump
	Temperature, burner inlet	L	●	
Others	Flame failure	O	●	

Table 9.3.11 Other machinery

System	Monitored parameters [H: High L: Low O: Abnormal status]	AA	Notes [AA = Alarm Activation ●=apply]
Main shaftings	Stern tube aft bearing or bearing oil in bath	H ●	or stern tube outlet oil when forced circulation system is used. applied to oil lubrication system.
	Critical speed	O ●	
Auxiliaries	Distilling plant, salinity	H ●	
	Purifier, malfunction	O ●	
	F.O. or L.O. heater outlet, temperature	H ●	or heater outlet, flow L
	External desuperheater, steam temperature	H L ●	L is required when the steam is used for the aux. turbine relating to propulsion.
Fuel oil	Settling tank, level	H L ●	H is required in case of automatic filling only.
	Drain tank, level	H ●	
	Sludge tank, level	H ●	
Lub. oil and control oil	Drain tank, level	H ●	
	Sludge tank, level	H ●	
	Gravity tank, level	L ●	applied to oil bath type stern tube bearing, exhaust gas turbocharger and reduction gears for propulsion turbines
Water	Cooling water expansion (make-up) tank, level	L ●	
	Cascade tank, level	L ●	applied to diesel ship
	Atmospheric drain tank, level	H L ●	applied to steam turbine ship
	Distilled water tank, level	L ●	
Air	Starting air tank for propulsion engine, pressure	L ●	
	Starting air tank for generator diesel engine, pressure	L ●	applied to steam turbine ship
Control oil, control air and control power	Hydraulic control system, pressure	L ●	not required when they are integrated with engine's L.O. system
	Pneumatic control system, pressure	L ●	
	Control electric power, failure	O ●	

Section 4 Operating Systems for Periodically Unattended Machinery Spaces

401. General

1. Scope

- (1) The requirements in this Section apply to the operating systems for periodically unattended machinery spaces of UMA ships.
- (2) Automatic and remote control systems of UMA ships, which are specified in **Sec 5**, are to comply with the requirements in the Section.

2. General

- (1) UMA ships are to be designed and arranged as to ensure that the safety of the ship is equivalent under all sailing conditions including maneuvering to that of a ship operated with watch keeping personnel at all times.
The design and arrangements are to be capable of performing unattended machinery operation for at least 24 consecutive hours.
- (2) Operating systems for periodically unattended machinery spaces of UMA ships are to comply with the requirements in this Section as well as those in **Sec 3**. However, in **Sec 3**, standby pumps specified in **Table 9.3.1** to **Table 9.3.3**, **Table 9.3.5**, **Table 9.3.6**, **Table 9.3.8** and **Table 9.3.10** are to be automatically started and those relevant alarms are to be activated.

402. Monitoring and control systems in navigation

1. Bridge control devices

The bridge control devices specified in **305. 3** are to be provided in the navigation bridge. The bridge control devices provided in the navigation bridge or at the bridge the centralized monitoring and control station are to include the following devices:

- (1) Bypass devices to temporarily override the function of the program control devices or other devices considered appropriate by the Society which are provided according to the requirement in (2) and an indicator to show the activation of the bypass devices.
- (2) The bridge control devices are to be provided with program control devices or other approved means to ensure that the main propulsion machinery will not suffer undue mechanical stress and thermal stress and speed of the main propulsion machinery is easily increased and decreased or easily increased. In case where, however, specially approved by the Society taking the kind of engines and so on into consideration, the program control devices or other means as may be dispensed with.

2. Navigation bridge

The alarm devices specified in the following are to be provided in the navigation bridge.

- (1) Alarm devices for main propulsion machinery or controllable pitch propellers, electric generating sets and auxiliary machinery essential for main propulsion of the ship. The visual alarms may be displayed as group alarms. However, the visual alarms for automatic stoppage and for automatic reduction of speed of or load to the main propulsion machinery are to be displayed separately.
- (2) Bilge alarm devices
- (3) An alarm device for prolonged running in critical speed range

3. Bridge centralized monitoring and control station

- (1) The alarm devices provided at the bridge centralized monitoring and control station are to comply with the following requirements.
 - (A) At least the following visual alarms of alarms required in **304. 2** (6) are to be equipped at confirmable positions from the place to control the operating handle of the main propulsion machinery.
 - (a) The alarms for automatic stoppage
 - (b) The alarms for automatic reduction of speed or load, or the alarms for demanding speed or load reduction
 - (c) The alarms for failure of remote control systems specified in **305. 2** (3) (A)
 - (d) The alarms for low starting air pressure specified in **305. 2** (4) (C)
 - (e) The alarms for failure of remote starting specified in **Table 9.3.1** and **Table 9.3.2**
 - (f) The alarms for prolonged running in critical speed range specified in **Table 9.3.11**

- (B) The alarm devices required in **304. 2** (6) and (10), excluding those specified in (A), are to be so arranged that the working conditions of machinery are perceived at a glance from the place to control the operating handle of the main propulsion machinery. Where it is impracticable to comply with this requirement, additional visual alarms which may be of group indication are to be provided.
- (2) The bridge centralized monitoring and control station are to comply with the following requirements in their shapes, sizes and arrangements.
 - (A) The bridge centralized monitoring and control station is to be situated within one deck floor and not to be provided with any partition walls (steel walls, wooden walls, glass walls, etc.) inside of the station except where it is considered inevitable by the Society.
 - (B) At the bridge centralized monitoring and control station any audible alarm and order issued from any position is to be capable of being heard clearly and directly at any other position.

403. Safety measures, means of communication, etc.

1. Air compressors

- (1) Starting air compressors are to be capable of operating automatically so as to maintain the pressure in the starting air reservoirs in a predetermined range.
- (2) Air compressors used for charging the control air reservoirs are to be capable of operating automatically so as to maintain the pressure in the control air reservoirs in a predetermined range.

2. Means of communication

A means of vocal communication which is operable even in the event of failure of the main electrical power supply is to be provided between the bridge centralized monitoring and control station the local control station of main propulsion machinery (when a sub-control station is provided, the station may be acceptable instead) and the engineers accommodation for the ship provided with a bridge centralized monitoring and control station and between the navigating bridge, the centralized control station, the local control station of main propulsion machinery and the engineers accommodation for the other ships.

3. Alarm systems

Alarm systems are to comply with the following requirements.

- (1) Alarm systems are to be arranged with automatic change-over to an independent standby power supply in the event of loss of the normal power supply.
- (2) Failure of the normal power supply and standby power supply specified in (1) is to be indicated by independent alarms.
- (3) Alarm devices provided on the engineers accommodation are to comply with the following requirements:
 - (A) Alarm devices are to be provided in engineers public rooms.
 - (B) Alarm devices are to be provided in the respective private rooms for engineers and to have connection to each of the engineers cabins through a selector switch, to ensure connection to at least a cabin of an engineer on watch.
 - (C) Alarm devices are to be operated with abnormal state specified in **Table 9.3.1** to **Table 9.3.11**. These alarms may be common.
- (4) Audible alarm devices which will provide warning of faults in machinery and equipment specified in **101. 7** (14) (A) to (G) are to be installed in the spaces where main propulsion machinery, boilers, electric generating sets, etc. are situated.
- (5) Alarm devices are to be capable of activating the engineers alarm required by **Pt 5, Ch 1, 107**, if an alarm function has not received attention at the centralized control station within a limited time.
- (6) For the ships provided with a bridge centralized monitoring and control station the local silencing of the audible alarms equipped in engineers accommodation is not to stop the audible alarm required in (5) and the audible and visual alarms equipped at the bridge centralized monitoring and control station. For the other ships than the foregoing, the local silencing of the audible alarms equipped in the navigation bridge and engineers accommodation is not to stop the audible alarm required in (5) and the audible and visual alarms equipped at the centralized control station.
- (7) Where unattended machinery operation is adopted, alarm systems which will provide warning of faults in machinery and equipment specified in **101. 7** (14) (A) to (G) are to be such that the person on watch in the navigation bridge is made aware when:

- (A) a fault has occurred,
- (B) the fault is being attended to, and
- (C) the fault has been rectified.

However, communication system specified in **403. 2** will be accepted as a substitute for the alarm for (C).

Section 5 Specific Automatic Equipment

501. General

1. Scope

The requirements of this section is to apply specific automation equipments.

502. Class 1 specific automation equipment [See Guidance]

The ships intended to be registered as ships provided with Class 1 automation equipment are to be provided with the automation equipment specified in following **Par 1 to 7** in addition to the requirements in **Sec 4**. However, the equipment which considered acceptable by the Society may be omitted in consideration of the purpose of the ship, the method of the cargo handling and so on. (2019)

1. Remote-controlled ballasting/deballasting arrangement

The remote-controlled ballasting/deballasting arrangements are to comply with the following requirements:

- (1) Ballast pumps are to be provided with the following remote control devices, alarm devices, etc. at suitable positions and to be capable of being monitored and controlled in those positions:
 - (A) Speed control devices or start/stop devices of ballast pumps.
 - (B) Control devices necessary for ballasting and deballasting, such as opening and closing of valves. [See Guidance]
 - (C) Monitoring devices for ballast tank level.
 - (D) Audible and visible alarm devices which operate in the following cases where ballast pumps or prime movers driving a ballast pump are located in dangerous spaces:
 - (a) When the lubricating oil pressure of pumps or prime movers falls abnormally (only in the case of forced lubrication system).
 - (b) When the temperature of the bearings or the lubrication oil of pumps or prime movers rises abnormally.
 - (c) When the temperature of stuffing box provided at the penetration parts of the bulkhead between the engine room and the cargo pump room rises abnormally.
- (2) Steam turbines driving ballast pumps are to be provided with the following devices:
 - (A) An automatic shut-off device which operates in the overspeed of the turbine and its alarm device.
 - (B) An alarm device which operates in the case of abnormal increase of exhaust pressure of the turbines.

2. Automatic steering system

When the steering gear is operated with automatic pilot, the automatic steering system is to comply with the following requirements:

- (1) Running indication of the automatic pilot is to be provided.
- (2) The function of compass and other equipment necessary to maintain the maneuverability of ship is not to be affected.
- (3) Changing over from automatic to manual steering and vice versa is to be possible at the bridge.
- (4) Except for the course setting control, the actuation of any other control is not to be significantly affect the course of the ship.
- (5) Means are to be incorporated to prevent unnecessary activation of the rudder due to abnormal yaw motion.
- (6) The automatic pilots are to enable automatically the ship to keep a preset course by interlocking with a magnetic compass or gyrocompass.

- (7) When changing over from manual to automatic steering, the automatic pilot is to be capable of bringing the ship to the preset course.
- (8) Means are to be incorporated to enable rudder angle limitation, and also to be available to indicate when the angle of limitation has been reached.
- (9) Audible and visual alarms are to be issued on the navigating bridge when the heading direction of a ship is deviated exceeding the course deviation of a preset amount.
- (10) Audible and visual alarms are to be issued on the navigating bridge in order to indicate the failure in the power supply to the automatic pilot and the alarm system specified in (9) above.
- (11) Any other items considered necessary by the Society. **【See Guidance】**

3. Remote-controlled handling system for liquid cargo in bulk

The remote-controlled handling system for liquid cargo in bulk is to comply with the following requirements:

- (1) For ships carrying liquid cargoes in bulk, cargo-handling centralized control stations are to be provided.
- (2) Steam turbines driving cargo pumps are to be provided with the following devices:
 - (A) An automatic shut-off device which operates in the overspeed of the turbine and its alarm device.
 - (B) An alarm device which operate in the case of abnormal increase of exhaust pressure of the turbine.
- (3) At cargo-handling centralized control stations, the following remote control devices and alarm devices are to be provided:
 - (A) Speed control devices or start/stop devices of cargo pumps.
 - (B) Control devices necessary for loading and unloading of cargoes such as opening and closing of valves. **【See Guidance】**
 - (C) Monitoring devices for cargo tank level.
 - (D) Audible and visible alarm devices which operate in the following cases in case where ballast pumps or their prime movers are located in dangerous spaces:
 - (a) When the lubricating oil pressure of pumps or prime movers falls abnormally (only in the case of forced lubrication system).
 - (b) When the temperature of bearings or lubricating oil of pumps or prime movers rises abnormally.
 - (c) When the temperature of stuffing box at the penetrating part of pump room bulkheads (in case where pumps are driven by the prime movers installed in the engine room) has become high.
 - (d) When the temperature of casings of cargo oil pumps has become high.
 - (E) Other devices deemed necessary by the Society.

4. Power-driven opening and closing devices **【See Guidance】**

Side ports, ramp ways and steel hatch covers of hatchways on weather decks (except for those of pontoon type) (hereinafter referred to as "side port, etc.") are to be provided with power-driven opening and closing devices in compliance with the following requirements:

- (1) At the place where opening and closing operation is carried out, the operation necessary for opening and closing of the relevant side ports, etc. is to be easily executed.
- (2) At the place where opening and closing operation is carried out, the open or closed condition of side ports, etc. is to be capable of being confirmed.
- (3) In case where deemed necessary by the Society, appropriate measures to maintain the safety at the time of opening and closing operation are to be taken.

5. Automatic recording devices for main engine **【See Guidance】**

Automatic recording devices for main engine are to be capable of recording the lubricating oil pressure, the cooling water temperature and other necessary information in order to ascertain the operating condition of main engine automatically.

6. Remote control devices of bow and stern mooring arrangements (2017)

Remote control devices of bow and stern mooring arrangements are to comply with the following requirements:

- (1) Mooring winches are to be provided with the remote control devices to be capable of effectively controlling releasing and winding of mooring lines. **【See Guidance】**

- (2) The remote control devices specified in (1) above are to be capable of handling three or more mooring lines respectively at bow and stern.

7. Air-conditioning arrangements for control stations

Air-conditioning arrangements for control stations are to have sufficient capacity to maintain a normal environmental condition in the control stations and are to be provided with alarm devices which give visual and audible alarms in the event of abnormal operation of the air-conditioning arrangements.

503. Class 2 specific automation equipment [See Guidance]

The ships intended to be registered as ships provided with Class 2 automation equipment are to be provided with the automation equipment specified in the following **Par 1 to 7** in addition to those in **502**. However, the equipment which considered acceptable by the Society may be omitted in consideration of the purpose of the ship, the method of the cargo handling and so on.

1. Remote-controlled fuel oil filling arrangements [See Guidance]

Remote-controlled fuel oil filling arrangements (limited to the case of filling fuel oil for main engines) are to be provided with the following remote control devices, alarm devices, etc. at suitable positions and to be capable of being monitored and controlled in those positions. However, the devices specified in (1) may be omitted when the Society considers acceptable in consideration of the valve arrangements and fuel oil tanks. In this case, the devices specified in (2) and (3) are not required.

- (1) Remote control devices for opening and closing of valves.
- (2) Level monitoring devices for fuel oil tanks (except for fuel oil tanks not built in as a part of hull in the engine room).
- (3) High level alarm devices for the fuel oil tanks (except for fuel oil tanks not built in as a part of hull in the engine room).
- (4) Speed control devices or start/stop devices of the pumps when fuel oil is filled by pumps provided on board.

2. Centralized monitoring device for refrigerating containers

The centralized monitoring device for the refrigerating containers is to be capable of carrying out the following functions for carrying refrigerating containers loaded with refrigerated cargo:

- (1) Monitoring of operating condition of the refrigerating machinery, working condition of the defrosting device and inside temperature of refrigerating containers are to be clearly indicated.
- (2) An alarm device which gives visual and audible alarms in the event of the abnormal conditions of inside temperature of refrigerating containers is to be provided.

3. Cargo hose handling winches [See Guidance]

For oil tanker, the cargo hose handling winch is to be easily operated in connecting and disconnecting the cargo hoses with manifolds.

4. Automatic deck washing arrangements

For ships carrying coals, ores or similar cargoes in bulk, the automatic deck washing arrangement are to be of fixed type and are to comply with the following requirements:

- (1) The automatic deck washing arrangements are to be capable of washing decks and hatch covers.
- (2) The deck washing machines are to have enough strength against its working pressure and enough corrosion resistance to sea water. **[See Guidance]**
- (3) The pipes for washing water are to be firmly fixed to the hull.

5. Remote control devices of bow and stern mooring arrangements at ship-sides (2017)

Remote control devices of mooring arrangements at ship-sides are to be located where leaving and berthing of the ship is visible by the operators at the bow and at the stern of the ship. And they are to be capable of effectively controlling three or more lines respectively.

6. Power-operated pilot ladder winding appliances

The power-operated pilot ladder winding appliances are to be capable of operating easily to wind

the ladder for pilots at the control position. However, the power-operated pilot ladder winding appliances need not to be provided where one person can operate.

7. Emergency towing rope winches

For ships carrying dangerous goods exclusively, the emergency towing rope winches are to be easily operated in heaving and releasing the emergency towing ropes, which are arranged at the time of berthing.

504. Class 3 specific automation equipment [See Guidance]

The ships intended to be registered as ships provided with Class 3 automation equipment are to be provided with the automation equipment specified in the following **Par 1 to 7** in addition to those in **502.** and **503.** However, the equipment which considered acceptable by the Society may be omitted in consideration of the purpose of the ship, the method of the cargo handling and so on.

1. Centralized monitoring systems for machinery [See Guidance]

The centralized monitoring systems for machinery are to be capable of clearly indicating the lubricating oil pressure, the cooling water temperature and other necessary information in order to monitor the conditions of main engines, prime movers for driving generators (excluding emergency generators), main boilers, essential auxiliary boilers and other machinery which affects the propulsion of ships at the navigating bridge.

2. Centralized control systems for machinery [See Guidance]

The centralized control systems for machinery are to be capable of effectively controlling main engines, prime movers for driving generators (excluding emergency generators), main boilers, essential auxiliary boilers and other machinery which are necessary in order to operate these machinery at the navigating bridge.

3. Remote control arrangement for main engines and steering gear at the outside of the navigating bridge

The remote control arrangements for main engines and steering gear are to be capable of effectively starting, stopping, reversing and speed controlling of main engines and effectively controlling the rudder angle at the control station outside of the navigating bridge.

4. High level alarm devices for cargo hold bilge

For ships deemed necessary by the Society, high level alarm devices which will operate in the event that the bilge reaches the pre-determined level, are to be provided.

5. Independent remote-controlled mooring arrangements [See Guidance]

The independent remote-controlled mooring arrangements are to be capable of controlling each drum of mooring winches independently at the remote control position, in addition to the requirement in **502. 6.**

6. Towing rope winches

Towing rope winches are to be effectively operated by one man in heaving and releasing the towing ropes at the control position. ⚓

CHAPTER 4 DYNAMIC POSITIONING SYSTEMS

Section 1 General

101. General

1. **Application** The requirements in this Chapter apply to the ships intended to be registered as ships provided with dynamic positioning systems(hereafter referred to as "DP system(s)").
2. **Related requirements** In addition to complying with the requirements in this Chapter, those are to be applied respectively such as follows: For machinery installations, **Pt 5**; For electrical installations, **Pt 6, Ch 1**; For Automatic and remote control systems, **Pt 6, Ch 2**.
3. **Classes of DP systems** DP systems are classified and defined by their worst case failure modes as follows:
 - (1) DPS(0), DPS(1)
Loss of position and/or heading may occur in the event of a single fault.
 - (2) DPS(2)
A loss of position and/or heading is not to occur in the event of a single failure in any active component or system. Normally static components will not be considered to fail where adequate protection from damage is demonstrated. Single failure criteria include:
 - (A) Any active component or system (generators, thrusters, switchboards, remote controlled valves, etc.).
 - (B) Any normally static component (cables, pipes, manual valves, etc.) which is not properly documented with respect to protection and reliability.
 - (3) DPS(3)
A loss of position and/or heading is not to occur in the event of a single failure. A single failure includes:
 - (A) Items listed above for DPS(2), and any normally static component is assumed to fail.
 - (B) All components in any one watertight compartment, from fire or flooding.
 - (C) All components in any one fire sub-division, from fire or flooding.

102. Definitions

Terms used in this Chapter are defined as follows:

- (1) **Dynamically positioned vessel (DP vessel)** means a unit or a vessel which automatically maintains its position and/or heading (fixed location, relative location or predetermined track) by means of thruster force.
- (2) **Dynamic positioning systems (DP system)** means the complete installation necessary for dynamically positioning a vessel comprising, but not limited to, the following sub-systems:
 - (A) Power system
 - (B) Thruster system
 - (C) DP control system
- (3) **Power system** means all components and systems necessary to supply the DP system with power and include the followings:
 - (A) Prime movers with necessary auxiliary systems including piping
 - (B) Generators
 - (C) Switchboards
 - (D) Distributing system (cabling and cable routing)
 - (E) Power supplies, including uninterruptible power supplies (UPS); and
 - (F) Power management system(s) (as appropriate).
- (4) **Thruster system** means all components and systems necessary to supply the DP system with thrust force and direction. The thruster system includes:
 - (A) Thrusters with drive units and necessary auxiliary systems including piping, cooling, hydraulic, and lubrication systems, etc.;
 - (B) Main propellers and rudders if these are under the control of the DP system;
 - (C) thruster control system(s);
 - (D) manual thruster controls; and
 - (E) associated cabling and cable routing.

- (5) **Dynamic Positioning control system (DP control system)** means all control components and systems, hardware and software necessary to dynamically position the vessel and include the followings:
- (A) Computer system/joystick system;
 - (B) Sensor system(s);
 - (C) Control stations and display system (operator panels);
 - (D) Position reference system(s);
 - (E) Associated cabling and cable routing; and
 - (F) Networks.
- (6) **Dynamic Positioning control station (DP control station)** means a workstation designated for DP operations, where necessary information sources, such as indicators, displays, alarm panels, control panels and internal communication systems are installed (this includes: DP control and independent joystick control operator stations, required position reference systems' Human Machine Interface (HMI), manual thruster levers, mode change systems, thruster emergency stops, internal communications).
- (7) **Joystick system** means a system with centralized manual position control and manual or automatic heading control.
- (8) **Measuring system** comprise all hardware and software for the following position reference system and environmental sensor to supply information and corrections necessary to give position and heading reference.
- (A) Position reference system
 - (a) Position reference system
Position reference system is to incorporate suitable position measurement techniques which may be by means of the followings.
 - Acoustic device
 - Radio
 - Radar
 - Inertial navigation
 - Satellite navigation
 - Taut wire
 - or, other acceptable means depending on the service conditions for which the ship is intended
 - (B) Environmental sensor
 - (a) Vertical reference sensor to measure the pitch and roll of the ship
 - (b) Means to ascertained the wind speed and direction acting on the ship
 - (c) Heading reference system
 - Gyrocompass or equivalent means
- (9) **Control panels** comprise centrally and locally situated panels for operating the DP system.
- (10) **Failure** is an occurrence in a component or system causing one or both of the following effects.
- (A) Loss of component of system function
 - (B) Deterioration of functional capability to such an extent that the safety of the vessel, personnel, or environment is significantly reduced
- (11) **Failure Modes and Effects Analysis (FMEA)** means a systematic analysis of systems and sub-systems to a level of detail that identifies all potential failure modes down to the appropriate sub-system level and their consequences.
- (12) **FMEA proving trials** means the test program for verifying the FMEA.
- (13) **Consequence analysis** means a software function continuously verifying that the vessel will remain in position even if the worst-case failure occurs.
- (14) **Hidden failure** means a failure that is not immediately evident to operations or maintenance personnel and has the potential for failure of equipment to perform an on-demand function, such as protective functions in power plants and switchboards, standby equipment, backup power supplies or lack of capacity or performance.
- (15) **Loss of position and/or heading** means that the vessel's position and/or heading is outside the limits set for carrying out the DP activity in progress.
- (16) **Position keeping** means maintaining a desired position and/or heading or track within the normal excursions of the control system and the defined environmental conditions (e.g. wind, waves, current, etc.).
- (17) **Operational Mode** is the manner of control under which DP system may be operated and comprise the followings:
- (A) Automatic mode : Automatic position and heading control

- (B) Joystick mode : Manual position control with selectable automatic or manual heading control
- (C) Manual mode : Individual control of thrust, azimuth, start and stop of each thruster
- (D) Auto tracking mode : Considered as a variant of automatic position control, with programmed movement of reference point
- (18) **Redundancy** is the ability of a component or system to maintain its function when a single failure has occurred. Redundancy can be achieved for instance by installation of multiple components, systems or alternative means of performing a function.
- (19) **Reliability** is the ability of a component or system to perform its required function without failure during a specified time interval.
- (20) **Worst-Case Failure Design Intent (WCFDI)** means the specified minimum DP system capabilities to be maintained following the worst-case failure. The worst-case failure design intent is used as the basis of the design. This usually relates to the number of thrusters and generators that can simultaneously fail.
- (21) **Worst-Case Failure (WCF)** means the identified single fault in the DP system resulting in maximum detrimental effect on DP capability as determined through the FMEA.

103. Drawings and data

1. **General** In the case of the ships intended to be registered as ships provided with DP systems, the drawings and data to be submitted for approval before the commencement of work are generally as follows:

- (1) Drawings
 - (A) Plans showing the construction and layout of the DP system
 - (B) In the case of the ships intended to be registered as ships provided with DPS(3), the following drawings are to be submitted for approval:
 - (a) Cable route layout drawing (apply to the ships intended to be registered as ships provided with DPS(3))
 - (b) Fire and flooding separation drawing (apply to the ships intended to be registered as ships provided with DPS(3))
 - (C) Plans with respect to the automatic and remote control of the DP system
 - (a) Functional block diagrams of the control system
 - (b) Functional block diagrams of the measuring system
 - (c) Details of monitoring functions of the control system and measuring system together with a description of the monitoring functions
 - (d) Details of the overall alarm system
 - (e) Details of the control stations, e.g. control panels and consoles, including the location of the control stations
 - (D) Electrical diagrams for control system and measuring system
- (2) Data
 - (A) Equipment list of DP systems (Name of equipment, model, type, Manufacturer)
 - (B) Failure modes and effect analysis(FMEA) data (in the case of the ships intended to be registered as ships provided with DPS(2) or DPS(3))
 - (C) Operation manuals (including details of the DP system operation, installation of equipment, maintenance and fault finding procedures together with a section on the procedure to be adopted in emergency)
 - (D) Test schedules including the methods of testing and the test facilities

2. **Reference data** For the ships intended to be registered as ships provided with DP systems, in addition to the requirements in **Par 1** above, the following data is to be submitted :

- (1) Drawings
 - (A) Lines plan
 - (B) General arrangement
 - (C) Details of thruster arrangement
- (2) Data
 - (A) Thruster power and thrusts
 - (B) Details of between thruster and thruster, between thruster and hull, and between thruster and current interaction
 - (C) Design maximum environmental conditions
 - (D) Details of sea current loads, wave drift forces and wind forces on ship
 - (E) Allocation logic of thrusters

Section 2 Requirements of Dynamic Positioning Systems

201. General

1. The ships intended to be registered as ships provided with DP systems are to be provided DP systems specified in this Section.
2. If external forces from mission-related systems (cable lay, pipe lay, mooring, etc.) have a direct impact on DP performance, the influence of these systems shall be considered and factored into the DP system design.
3. The ships In order to meet the single failure criteria given in **101. 3**, redundancy of components will normally be necessary as follows:
 - (1) For DPS(2), redundancy of all active components; and
 - (2) For DPS(3), redundancy of all components and A-60 physical separation of the components.
4. For DPS(3), full redundancy of the control systems may not be possible. (i.e. there may be a need for a single changeover system from the main computer system to the backup computer system). Such connections between otherwise redundant and separated systems may be accepted when these are operated so that they do not represent a possible failure propagation path during DP operations.
5. For DPS(2) and DPS(3), connections between otherwise redundant and separated systems shall be kept to a minimum and made to fail to the safest condition. Failure in one system shall in no case be transferred to the other redundant system.
6. The DP control station shall be arranged where the operator has a good view of the vessel's exterior limits and the surrounding area. Equipment that shall be located at the DP control station includes, but is not limited to:
 - (1) DP control and independent joystick control operator stations;
 - (2) Manual thruster levers;
 - (3) Mode change systems;
 - (4) Thruster emergency stops;
 - (5) Internal communications; and
 - (6) Position reference systems' HMI, when considered necessary.

202. Requirements of dynamic positioning systems

1. Power system

- (1) Electrical generating system
 - (A) Capacity of electrical generating system
For electrically driven thruster, the total capacity of electrical generating system is to be not less than the maximum DP load together with the maximum auxiliary load. This may be achieved by parallel operation of two or more generating sets provided that the requirements of **Pt 6, Ch 1, 202.** are complied with.
 - (B) Continuity of electric source
 - (a) When the electrical power requirements are supplied by one generator set, on loss of power there is to be provision for automatic starting and connection to the switchboard of a standby set and automatic restarting of essential auxiliary services.
 - (b) In the event of failure of one or more generators, protection measures against blackout caused by overload are to be provided. (2019)
- (2) Electrical supply for thruster auxiliaries, control computers and measuring system
Thruster auxiliaries, control computers and measuring systems are to be served by individual circuits. Services that are duplicated are to be separated throughout their length as widely as is practical and without the use of common feeders, transformers, converters, protective devices or control circuits.
- (3) Electrical supply for actuating mechanism
 - (A) Steerable thrusters are to be provided with two or more independent supplies of motive power to the pitch and direction actuating mechanisms.
 - (B) Thrusters having variable pitch propellers are to be provided with two or more independent supplies of motive power to the pitch actuating mechanisms.

(4) Common source

Where the electrical auxiliary services necessary for maintaining the ship normally in operational and habitable conditions, and the electrical service necessary for operating the DP thrusters are supplied from a common source, the following requirements are to be complied with:

- (A) The voltage regulation and current sharing requirements defined in **Pt 6, Ch 1, 305. 4 and 5** or **306. 2 and 4** are to be maintained over the full range of power factors that may occur in service.
- (B) Where silicon controlled converters (inverter, cycloconverter, rectifier, etc.) are used to feed the thruster motor and the instantaneous value of the line-to-line voltage wave-form on the *a.c.* auxiliary system busbars deviates by more than 10 percent of the maximum value of the fundamental harmonic, the electrical auxiliary services necessary for maintaining the ship normally in operational and habitable conditions are to be capable of withstanding the additional temperature rise due to the harmonic distortion. Control systems, alarms and safety equipment are to operate satisfactorily with the maximum supply system waveform distortion, or be provided with suitably filtered or converted supplies.
- (C) When the control system incorporates volatile memory, it is to be supplied via uninterruptible power supply. An uninterruptible power supply (UPS) is to be provided for each DP-computer system to ensure that any power failure will not affect more than one computer. UPS battery capacity is to provide a minimum of 30 minutes operation following a mains supply failure.

(5) Number and rating of transformers

The number and ratings of power transformers are to be sufficient to ensure full load operation of the DP system even when one transformer is out of service.

(6) Alarm for electrical generating system

An alarm is to be initiated at the DP control stations when the total electrical load of all operating thruster units exceeds a preset percentage of the running generators capacity. This alarm is to be adjustable between 50 and 100 percent of the full load capacity having regard to the number of electrical generators in service.

2. Thruster system

(1) Design and location of thruster

- (A) Thrusters are to be designed to minimize potential interference with other thrusters, sensors, hull or other surfaces which could be encountered in the service for which the ship is intended.
- (B) Thruster intakes are to be located at sufficient depth to reduce the possibility of ingesting floating debris and vortex formation.

(2) Performance of thruster

- (A) The response and repeatability of thrusters to changes in propeller pitch, speed or direction of rotation are to be suitable for maintaining the area of operation and the heading deviation specified.
- (B) Vessels with DPS(0) or DPS(1) are to have thrusters in number and of capacity sufficient to maintain position and heading under the specified maximum environmental conditions.
- (C) Vessels with DPS(2) or DPS(3) are to have thrusters in number and of capacity sufficient to maintain position and heading, in the event of any single fault, under the specified maximum environmental conditions. This includes the failure of any one thruster.

(3) Alarm for thruster

Each thruster unit is to be provided with a high power alarm. The setting of this alarm is to be adjustable and below the maximum thruster output.

3. DP control system

(1) General

- (A) In general the DP control system is to be arranged in a DP control station where the operator has a good view of the vessel's exterior limits and the surrounding area.
- (B) The DP control station is to display information from the power system, thruster system and DP control system to ensure that these systems are functioning correctly. Information necessary to operate the DP system safely is to be visible at all times.
- (C) The selection between operational mode is to be provided and easily operated. The active mode is always to be clearly displayed.
- (D) For class notation DPS(2) and DPS(3), means for preventing inadvertent operation which can lead to a loss of position or heading are to be provided.

- (E) Alarms and warnings for failures in all systems interfaced to and/or controlled by the DP control system shall be audible and visual. A record of their occurrence and of status changes shall be provided together with any necessary explanations.
- (F) The DP control system shall prevent failures being transferred from one system to another. The redundant components shall be so arranged that any failed component or components may be easily isolated so that the other component(s) can take over smoothly with no loss of position and/or heading.
- (G) Minimum number of control system, position reference system and environmental sensor for DP systems is to be in accordance with the **Table 9.4.1**:

Table 9.4.1 Minimum Number of Control System, Position reference System and Environmental Sensor (2020)

Class	Control system	Position reference system	Environmental sensor		
			Heading reference system	Vertical reference sensor	Means to ascertained the wind and direction
DPS(0)	Joystick system ⁽¹⁾ 1 set	1 set	1 set	1 set	each 1 set
DPS(1)	DP control system ⁽²⁾ 1 set Joystick system ⁽¹⁾⁽²⁾ 1 set	2 sets ⁽³⁾	1 set	1 set	1 set
DPS(2)	DP control system ⁽²⁾ 2 sets	3 sets ⁽³⁾⁽⁴⁾	3 sets ⁽³⁾	3 sets ⁽³⁾	each 3 sets ⁽³⁾
DPS(3)	DP control system ⁽²⁾ 2 sets Backup DP system ⁽²⁾ 1 set	3 sets ⁽³⁾⁽⁴⁾	3 sets ⁽³⁾	3 sets ⁽³⁾	each 3 sets ⁽³⁾
(NOTES) (1) To be provided to maintain the desired heading of the ship. (2) To be arranged to operate independently so that a failure in one control system will not render the other control system inoperative. (3) To be arranged to operate independently so that a failure in on position reference system(or environmental sensor) will not render the other position reference system(or environmental sensor) inoperative. (4) To be provided with at least two different measurement techniques.					

(2) Control system

The control system for dynamic positioning operation is to be stable throughout its operational range and is to meet the specified performance and accuracy criteria.

(3) Computer systems

(A) For DPS(2), the DP control system shall consist of at least two computer systems so that, in case of any single failure, automatic position keeping ability will be maintained. Common facilities such as self-checking routines, alignment facilities, data transfer arrangements and plant interfaces shall not be capable of causing failure of more than one computer system. An alarm shall be initiated if any computer fails or is not ready to take control.

(B) For DPS(3), the main DP control system shall consist of at least two computer systems arranged so that, in case of any single failure, automatic position keeping ability will be maintained. Common facilities such as self-checking routines, alignment facilities, data transfer arrangements and plant interfaces shall not be capable of causing failure of more than one computer system. The two or more computer systems mentioned above do not include the backup computer system; thus, in addition, one separate backup DP control system shall be arranged, see paragraph (D). An alarm shall be initiated if any computer fails or is not ready to take control.

(C) For DPS(2) and DPS(3), the DP control system shall include a software function, normally known as "consequence analysis", which continuously verifies that the vessel will remain in position even if the worst-case failure occurs. This analysis shall verify that the thrusters, propellers and rudders (if included under DP control) that remain in operation after the worst-case failure can generate the same resultant thruster force and moment as required before the failure. The consequence analysis shall provide an alarm if the occurrence of a

worst-case failure were to lead to a loss of position and/or heading due to insufficient thrust for the prevailing environmental conditions (e.g. wind, waves, current, etc.). For operations which will take a long time to safely terminate, the consequence analysis shall include a function which simulates the remaining thrust and power after the worst-case failure, based on input of the environmental conditions.

- (D) For DPS(3), the backup DP control system shall be in a room separated by an A-60 class division from the main DP control station. During DP operation, this backup control system shall be continuously updated by input from at least one of the required sets of sensors, position reference system, thruster feedback, etc. and be ready to take over control. The switchover of control to the backup system shall be manual, situated on the backup computer, and shall not be affected by a failure of the main DP control system. Main and backup DP control systems shall be so arranged that at least one system will be able to perform automatic position keeping after any single failure.
- (E) Each DP computer system shall be isolated from other on-board computer systems and communications systems to ensure the integrity of the DP system and command interfaces. This isolation may be effected via hardware and/or software systems and physical separation of cabling and communication lines. Robustness of the isolation shall be verified by analysis and proven by testing.
- (4) Measuring system
 - (A) Measuring systems are to be provided to ensure the specified area of operation and heading deviation can be effectively maintained.
 - (B) Set point for the desired heading
The deviation from the desired heading is to be adjustable, but is not to exceed the specified limits. Arrangements are to be provided to fix and identify the set point for the desired heading.
 - (C) Validation for measuring system
Suitable processing and comparative techniques are to be provided to validate the control system inputs from position reference systems and other environmental sensors, to ensure the optimum performance of the DP system.
- (5) Indicators
Indications of the following are to be provided at each station from which it is possible to control the DP system.
 - (A) The heading and location of the vessel relative to the desired reference point or course
 - (B) Vectorial thrust output of thrusters, individual and total
 - (C) Operational status of position reference systems and environmental sensors
 - (D) Environmental conditions, e.g. wind strength and direction
 - (E) Available status of standby thruster units
- (6) Alarms
Alarms are to be provided for the following fault conditions:
 - (A) Control computer system fault
 - (B) Automatic changeover to a standby control computer system
 - (C) Abnormal signal errors revealed by the validity checks required by (3) (C)
 - (D) When the ship deviates from its predetermined area of operation
 - (E) When the ship deviates from its predetermined heading limits
 - (F) Taut wire excursion limit
 - (G) Fault of position reference system
 - (H) Fault of environmental sensor
 - (I) Automatic changeover to a standby position reference system or environmental sensor

4. Auxiliary system (applies to DPS(2) and DPS(3))

- (1) General
 - (A) For class notations DPS(2) and DPS(3), the auxiliary systems that are part of the DP system are to be arranged in accordance with the redundancy requirements.
 - (B) A single failure effect analysis for the following auxiliary systems is to be included in FMEA of the DP system.
 - (a) Fuel oil system
 - (b) Lubricating oil system
 - (c) Cooling water system
 - (d) Compressed air system
 - (e) Hydraulic system

- (f) Pneumatic system
- (g) Ventilation/HVAC system
- (2) Fuel oil system
 - (A) The engine fuel supply systems, including service tanks, supply and return lines, filters, heating system(if applicable), pumps, quick closing valves and their controls, are to be arranged in accordance with the redundancy concept.
 - (B) Actuators for quick closing valves are to be installed on a per engine basis and hence any remote control system is to fail safe with respect to station keeping.
 - (C) For class notation DPS(3), a minimum of one service tank is to be provided for each redundant group. The service tanks are to be in separate compartments with A-60 partitions following redundancy concept.
- (3) Lubricating oil system
 - Lubricating oil system for engines are to be associated with one engine only.
- (4) Cooling water system
 - (A) The cooling water systems are to be arranged in accordance with the redundancy concept.
 - (B) For twin screw vessels where cooling pumps are engine driven, a duplicate spare pump carried onboard, in lieu of the standby pump, is acceptable, as long as loss of pump would maintain DP function even during the worst case failure.
- (5) Compressed air system
 - Compressed air systems for DP related functions are to be arranged in accordance with the redundancy concept. Compressed air for starting engines is to be independent to the maximum extent feasible. Control air and starting air may be taken from the same source provided any pressure drops associated with starting air do not affect the control function. Loss of air supply to the thrusters is to be alarmed and is to have no effect on thruster operation.
- (6) Pneumatic system
 - Pneumatic systems are to be designed according to required redundancy in view of the risk of leakage.
- (7) Ventilation/HVAC system
 - Ventilation and HVAC systems for spaces containing equipment essential to DP are to be arranged to comply with redundancy so that acceptable temperature can be maintained after any single fault in active components and ventilation damper actuation energy source. This requirement also applies to switchboard rooms and instrument rooms containing components that are parts of the DP system.
- (8) Power supply to auxiliary system
 - Power for auxiliary systems associated with DP systems is to be taken from within the redundancy group. Auxiliaries for thruster systems such as cooling water pumps and fans are to be powered from the same redundancy group as that providing the drives.

203. Additional requirements for DP systems

1. DPS(1)

- (1) In the event of a failure of a position reference system, the control systems are to continue operating on signals from the remaining position reference system without manual intervention.
- (2) The area of operation is to be adjustable, but is not to exceed the specific limits which are to be based on a percentage of water depth, or if applicable a defined absolute surface movement. Arrangements are to be provided to fix and identify the set point for the area of operation.
- (3) A manually initiated emergency alarm, clearly distinguishable from all other alarms associated with the DP system is to be provided at the DP control station to warn all relevant personnel in the event of a total loss of DP capability. In this respect consideration is to be given to additional alarms being provided at locations such as the master's accommodation and operational control stations.
- (4) For electrically driven thruster units, the following requirements are to be complied with: (2019)
 - (A) Indication of absorbed electrical power and available on-line generating capacity is to be provided at the main DP control station.
 - (B) Means are to be provided to prevent starting of thruster motors until sufficient electrical generating capacity is available.

2. DPS(2)

- (1) The requirements of **Par 1** above are to be complied with.

- (2) In the event of a failure of the working system the standby control system is to be arranged to changeover automatically without manual intervention and without any adverse effect on the ship's station keeping performance.
- (3) The power system is to be divisible into two or more systems such that in the event of failure of one system at least one other system will provide enough power for essential services of the DP operation. The power system may be run as one system during operation, but is to be arranged by bus-tie breakers to separate automatically upon failures which could be transferred from one system to another, including overloading and short-circuits. **【See Guidance】**
- (4) The power available for position keeping shall be sufficient to maintain the vessel in position after worst-case failure according to **101. 3**.
- (5) At least one automatic power management system (PMS) shall be provided and shall have redundancy according to the equipment class and a blackout prevention function.
- (6) For electrically driven thruster units, the following requirements are to be complied with: (2019)
 - (A) With one generating set out of action, the capacity of the remaining generating sets is to be not less than the maximum DP load with the most effective thruster inoperative together with all electrical auxiliary services necessary for maintaining the ship in normal operational and habitable conditions.
 - (B) Where generating sets are arranged to operate in parallel, the supplies to, essential services are to be protected by the tripping of non-essential loads as required by **Pt 6, Ch 1, 205. 10** and additionally, on loss of a running generating set, a reduction in thrust demand may be accepted provided the, arrangements are such that a sufficient level of DP capability is retained to permit the maneuverability of the ship.
 - (C) In relation to (A) and (B), in order not to loss of position, provision is to be made for automatic starting synchronization and load sharing of a non-running generator before the load reaches the alarm level required by **202. 2 (6)**.
- (7) Control, alarm and safety systems are to incorporate a computer based consequence analysis which may be continuous or at predetermined intervals and is to analyse the consequence of predetermined failures to verify that position and heading deviation remain within acceptable limits. In the event of a possible hazardous condition that is not possible to keep ship's position and heading in current climatic condition because of expected worst case failure being indicated from the consequence analysis an alarm is to be initiated.
- (8) Power, control and thruster systems and other systems necessary for, or which could affect, the correct functioning of the DP system are to be provided and configured such that a fault in any active component or system will not result in a loss position. This is to be verified by means of a FMEA according to (KS A) IEC 60812 (Failure Mode and Effects Analysis) or equivalent. Active components may include, but are not restricted to, the following
 - (A) Prime movers (e.g. auxiliary engines)
 - (B) Generators and their excitation equipment
 - (C) Gearing
 - (D) Pumps
 - (E) Fans
 - (F) Switchgear and control gear, including their assemblies **【See Guidance】**
 - (G) Thrusters
 - (H) Valves (where power actuated)System which are not part of the DP System but which, in the event of a fault, could affect the correct functioning of the DP System (for example, fire suppression systems, engine ventilation systems, etc.) are to be included in the FMEA.

3. DPS(3)

- (1) The requirements of **Par 2** above are to be complied with.
- (2) The power system arrangement is to comply with the following requirements :
 - (A) For DPS(3), the power system shall be divisible into two or more systems so that, in the event of failure of one system, at least one other system will remain in operation and provide sufficient power for station keeping. The divided power system is to be located in different spaces separated by A-60 class divisions.
 - (B) Where the power systems are located below the operational waterline, each power system is to be separated by independent watertight compartment.
 - (C) Bus-tie breakers are to be open during DPS operations unless it can be accepted according to **203. 2 (3)**.
- (3) The electrical power generating sets are to be arranged so that they are located in at least two

separate machinery compartments.

- (4) The switchboard supplying the DP system is to be split into at least two equal sections each fitted in a separate compartment and capable of being connected by bus section switches.
- (5) The control and indication unit of one of the position reference systems required by the **Table 9.4.1** is to be located at the emergency control station. A repeater control and indication unit from this system is to be located at the main control station.
- (6) An independent heading reference system among those required by **Table 9.4.1** is to be located at the emergency control station to provide heading reference to the emergency automatic control system.
- (7) Signals from the environmental sensors required by **Table 9.4.1** are to supply the backup DP control system.
- (8) The backup DP control system is to be supplied from its own independent uninterruptible power supplies.
- (9) Cables for redundant equipment or systems are not to be routed together through the same compartments. Where this is unavoidable such cables could run together in cable ducts of A-60 class, the termination of the ducts included, which are effectively protected from all fire hazards, except that represented by the cables themselves. Cable connection boxes are not allowed in such ducts.

Section 3 Testing and Inspection

301. Hydraulic Test

Thruster housing is to be tested at a hydraulic pressure of not less than 1.5 times the maximum service immersion head of water or 1.5 bar, whichever is greater.

302. On-board tests

After installation on board, the DP system is to be tested under the condition as close to the actual operation as practicable and confirmed that each equipment functions appropriately. However, the tests may be carried out at the sea trial, when their testing items are considered impracticable to be conducted at occasions other than the sea trials.

303. Sea trials

In the sea trials, performance tests of the DP system are to be carried out in accordance with the sea trial schedule including the followings approved by the Society.

- (1) Response of the system to simulated failures of major items of control and mechanical equipment, including loss of electrical power.
- (2) Response of the system under a set of predetermined manoeuvres for changing of the followings:
 - location of area of operation
 - heading of the ship.
- (3) Continuous operation of the system over a period of at least four hours.

304. Maintaining records and data regarding the performance capability of the DP system

Records and data regarding the performance capability of the DP system are to be maintained on board the ship and are to be made available at the time of the periodical survey.

305. Survey Assigned to Maintain Classification

Periodical survey interval and survey items of DP systems are to be applied as follows.

1. Annual survey

- (1) System maintenance documentation, including information regarding hardware and software changes, is to be reviewed.
- (2) The electrical installations comprising the DP systems, such as controllers and for DP control station and independent joystick, references systems, sensors and mode change system, are to be visually inspected.

- (3) The technical condition of the DP systems is to be verified during the survey.
- (4) If the survey is carried out when the vessel is undergoing regular operations, then tests that possibly can introduce unacceptable risks are not to be performed.
- (5) Capacity of UPS and other battery systems serving the DP control system, including its peripherals, are to be verified. If the survey is carried out during regular operations, then the capacity of the batteries need not be proven by testing. Additionally, the alarm for loss of charging power is to be verified.
- (6) For DPS(3), normal working condition of the backup DP control system is to be verified. If the survey is carried out during regular operations, then control need not be transferred to the back-up DP control system.
- (7) Emergency stop of thrusters from the DP control station is to be tested. If the survey is carried out when the vessel is undergoing regular operations, then testing is not to be performed if there is any possibility of introducing unacceptable risks.

2. Special survey

- (1) With the vessel in DP mode, a sea trial is to be performed.
- (2) The complete system is to be tested in all operational modes. The testing is to include simulation of different failure conditions to verify switching of modes, back-up systems and the alarm system.
- (3) The different modes of thruster control from the DP control station are to be tested.
 - (A) Manual control
 - (B) Joystick control(independent joystick, if installed)
 - (C) DP control
 - (D) Transfer of control
- (4) Manual override i.e. by thruster lever control and independent joystick control is to be demonstrated during normal operation and during failure conditions.
- (5) Emergency stop of DP thrusters from DP control station is to be tested.
- (6) All sensors, peripheral equipment and reference systems are to be tested.
 - (A) Verify correct operation and adequate accuracy
 - (B) Failure of sensors and reference systems is to be simulated to check the alarm system and the switching logic
 - (C) Switch-over between reference systems as input to controller is to be carried out to assure that warnings, alarms and information to operator are satisfactory.
- (7) Alarm for loss of position and heading out of limit is to be demonstrated.
- (8) The electrical installations comprising the DP systems, such as controllers and DP control stations and independent joystick, references systems, sensors and mode change system, are to be visually inspected.
- (9) Single failures in thruster control systems including signal wire breaks of thruster command and feedback signals are to be tested in order to verify safe response on the thrust output. Equivalent testing may also be required for rudders controlled by the DP control system.
- (10) Overload prevention is to be tested.
- (11) Capacity of UPS and other battery systems serving the DP control system, including its peripherals, are to be verified by testing. Alarm for loss of charging power is also to be verified.
- (12) For DPS(2) & DPS(3), the required redundancy with respect to defined single failures modes is to be verified by redundancy testing.
- (13) For DPS(2) & DPS(3), the FMEA report and FMEA test program are to be verified to ensure that they have been updated when alterations have been done.
- (14) For DPS(2) & DPS(3), correct functioning of the Consequence Analysis facility is to be verified as far as possible.
- (15) For DPS(3), testing is also to be performed on the backup DP control system. Switchover to back-up is to be tested, and monitoring of backup control system status on the main control system is to be verified. ⚓

CHAPTER 5 NAVIGATION BRIDGE SYSTEMS

Section 1 General

101. General

1. Scope

The requirements in this Chapter apply to bridge layouts and bridge working environments, navigational equipment and accident prevention systems (hereinafter collectively referred to as "navigation bridge systems") of ships classed with the Society and intended to be registered.

2. Equivalency

Navigation bridge systems which do not fully comply with the requirements of this Chapter may be accepted provided that they are deemed by the Society to be equivalent to those specified in this Chapter.

3. Navigation bridge systems with novel design features

For navigation bridge systems with novel design features, the Society may apply the requirements of this Chapter so far as practicable and other requirements as considered appropriate by the Society.

4. Modification of requirements

The Society may modify parts of the requirements specified in this Chapter taking the national requirements of the ship's flag state, kind of the ship and intended service areas of the ship into consideration.

5. Installations Characters

- (1) NBS : the ship of which bridge layout and bridge working environment and navigational equipment comply with the requirements of **Sec 3** and **Sec 4**.
- (2) NBS1 : the ship of which bridge layout and bridge working environment, navigational equipment and accident prevention systems comply with the requirements of **Sec 3** to **Sec 5**.
- (3) NBS2 : the ship of which bridge layout and bridge working environment, navigational equipment, accident prevention systems and bridge work assist systems comply with the requirements of **Sec 3** to **Sec 6**.

6. Definitions

Terms used in this Chapter are defined as follows:

- (A) **Back-up navigator** is any individual, generally an officer, who has been designated by the ship master to be on call if assistance is needed on the bridge.
- (B) **Bridge** is an area from which the navigation and control of the ship is exercised, including the wheelhouse and bridge wings.
- (C) **Bridge wings** are parts of the bridge on both sides of the ship's wheelhouse which extend to the ship's side.
- (D) **Conning position** is a place on the bridge with a commanding view and which is used by navigators when commanding, maneuvering and controlling a ship.
- (E) **Main conning position** is a conning position which is mainly used by navigators.
- (F) **Field of vision** is an angular size of a scene that can be observed from a position on the ship's bridge.
- (G) **Navigator** is a person navigating, operating bridge equipment and maneuvering the ship.
- (H) **Wheelhouse** is an enclosed area of the bridge.
- (I) **Workstation** is a position at which one or several tasks constituting a particular activity are carried out.
- (J) **Centralized bridge workstation** is a workstation at which navigational equipment needed for navigation and maneuvering are arranged centrally, including the main conning position.
- (K) **Ocean areas** are areas in which the freedom of course setting in any direction for a distance equivalent to at least 30 minutes sailing with the navigating speed of the ship is not restricted.

Section 2 Surveys of Navigation Bridge Systems

201. General

1. Kinds of surveys

Navigation bridge systems, which are registered or intended to be registered to the Society, are to be subjected to the following surveys:

- (A) Survey for classification of navigation bridge systems (hereinafter referred to as "Classification Survey")
- (B) Survey for maintaining classification of the navigation bridge systems (hereinafter referred to as "Survey Assigned to Maintain Classification"), which are:
 - (a) Special Survey
 - (b) Annual Survey
 - (c) Occasional Survey

2. Time of classification survey and intervals of survey assigned to maintain classification

- (1) Classification Survey is to be carried out when the application for classification is made.
- (2) Survey Assigned to Maintain Classification is to be carried out at the periodical survey.

202. Classification Survey

1. Drawings and data

- (1) For the classification survey of navigation bridge systems of a NBS ships, three copies of the following drawings and data are to be submitted for the approval by the Society.
 - (A) General arrangement of the bridge (showing the main conning position, other conning positions, workstations, locations of control consoles and panels, and passage ways)
 - (B) Particulars of the navigational equipment specified in **Sec 4, 402. 2.**
 - (C) Electrical wiring diagrams for the navigational equipment specified in **Sec 4, 402.**
 - (D) Schemes of on board tests and sea trials including methods of tests and test facilities provided
 - (E) Other drawings and data deemed necessary by the Society **【See Guidance】**
- (2) For the classification survey of navigation bridge systems of a NBS1 ships, three copies of the following drawings and data are to be submitted for the approval by the Society.
 - (A) The drawings and data specified in the preceding (1).
 - (B) Particulars of the accident prevention systems specified in **Sec 5, 502.**
 - (C) Electrical wiring diagrams for the accident prevention systems specified in **Sec 5, 502.**
- (3) For the classification survey of navigation bridge systems of a NBS2 ships, three copies of the following drawings and data are to be submitted for the approval by the Society.
 - (A) The drawings and data specified in the preceding (2).
 - (B) Particulars of the bridge work assist systems specified in **Sec 6, 602.**
 - (C) Electrical wiring diagrams for the bridge work assist systems specified in **Sec 6, 602.**
 - (D) Detail arrangement of the centralized bridge workstation specified in **Sec 6, 601. 3.** (dimensions of control consoles, panel arrangement, etc., are to be shown)

2. Shop tests

The equipments listed below are to be approved by the Society. However, the equipment approved by the Government of State in which the ship is registered or to be registered, other Contracting Governments of the International Convention for The Safety of Life at Sea or the parties approved by the Governments mentioned above may be accepted provided that it is deemed appropriate by the Society.

- (A) Automatic radar plotting aids (ARPA)
- (B) Electronic position-fixing systems
- (C) Radars
- (D) Gyro compass systems
- (E) Automatic steering systems
- (F) Speed log systems
- (G) Echo sounding systems
- (H) Maritime safety information receivers

- (I) VHF radio telephone installations
- (J) Other equipment deemed necessary by the Society **【See Guidance】**

3. Tests after installation on board

- (1) Bridge layouts and bridge working environments, navigational equipment, and accident prevention systems are to be, after installation on board, tested and inspected in accordance with the scheme of on board tests approved by the Society to verify that they are constructed, installed and functioning properly under the normal working conditions, as far as practicable. A part of the verification may be carried out during sea trials.
- (2) The following particulars are to be verified at the tests after installation on board.
 - (A) Bridge layouts and bridge working environments
The bridge layouts and bridge working environments are adequate to enable the navigator to perform navigational duties and other functions allocated to the bridge as well as to maintain a proper lookout from workstations on the bridge.
 - (B) Navigational equipment
 - (a) Gyro compass repeaters
Each repeater compass is installed parallel with a centre line of the ship.
 - (b) Echo sounding systems
A measuring error is within a permissible range.
 - (c) Steering pump selective control switches
The steering pumps are smoothly switched over.
 - (d) Electrical power supply
 - (i) When the main source of electrical power to the local distribution board for the navigational equipment is off, the audible and visual alarm is initiated, and the electrical power supply to the board is automatically switched over to the emergency source.
 - (ii) All primary functions of the navigational equipment are readily reinstated after 45 seconds interruption of the electrical power supply.
 - (C) Accident prevention systems (NBS1 ships and NBS2 ships)
 - (a) Bridge navigational watch alarm system
The bridge navigational watch alarm system is to initiate alarms that are able to be verified in the bridge and other places if the setting interval has elapsed.
 - (b) Alarm and warning transfer system
The alarm and warning transfer system automatically transfers an alarm and warning which requires the navigator response and which is not acknowledged on the bridge within 30 seconds to the master, to the selected back-up navigator and to the public rooms. The alarm of the bridge navigational watch alarm system is also transferred.
 - (c) System monitor
 - (i) The indicator lamps in the master room showing the bridge navigational watch alarm system, and the alarm and warning transfer system are functioning properly.
 - (ii) The audible and visual alarms are initiated on the bridge and in the master room when the bridge navigational watch alarm system, and the alarm and warning transfer system are malfunctioning.
 - (d) Electrical power supply
 - (i) When the main source of electrical power to the local distribution board for the accident prevention systems is off, the audible and visual alarm is given, and the electrical power supply to the board is automatically switched over to the emergency source.
 - (ii) All primary functions of the accident prevention systems are readily reinstated after 45 seconds interruption of the electrical power supply.
 - (D) Bridge work assist systems(NBS2 ships)
 - (a) Bridge information systems
The information display and alarm system deemed necessary for navigation and maneuvering are functioning properly.
 - (b) ECDIS
A chart, ship's position, planned route, radar and ARPA information are added to the display.
 - (c) System monitor
Audible and visual alarms for a malfunction of the bridge information systems, ECDIS and auto tracking system are given.
 - (d) Electrical power supply

- (i) When the main source of electrical power to the local distribution board for the bridge work assist systems is off, the audible and visual alarm is given, and the electrical power supply to the board is automatically switched over to the emergency source.
- (ii) All primary functions of the bridge work assist systems are readily reinstated after 45 seconds interruption of the electrical power supply.

4. Sea trials

- (1) Bridge layouts and bridge working environments, navigational equipment, and accident prevention systems are to be tested and inspected in accordance with the scheme of sea trials approved by the Society to verify that they are constructed, installed and functioning properly.
- (2) The following are to be verified during the sea trials.
 - (A) Bridge layouts and bridge working environments
 - (a) The bridge layouts and bridge working environments are adequate to enable the navigator to perform navigational duties and other functions allocated to the bridge as well as to maintain a proper lookout from workstations on the bridge under all navigating conditions day and night.
 - (b) The vibration level and the noise level satisfy the requirements of **Sec 3, 302. 2** and **3**.
 - (B) Navigational equipment

Among the tests of the navigational equipment verification of the prewarning required by **Ch 5, 501. 4** (1) (for NBS1 ships and NBS2 ships only) and the following are to be included.

 - (a) An automatic radar plotting aids (ARPA)
 - (i) Targets are acquired, and the course and speed information for acquired targets are displayed by both true and relative vectors.
 - (ii) The bearing and range of the acquired target are displayed.
 - (iii) The CPA and TCPA are displayed.
 - (iv) An audible and visual alarm is initiated when any acquired target approaches close to a range or transits a zone chosen by the navigator.
 - (b) Radars
 - (i) The bearing and range of at least two objects(one of them is to be an object on shore) which appear forward of the beam are displayed.
 - (ii) A measured error of the installed radar is not greater than the original error of the radar.
 - (c) Automatic steering systems
 - (i) The heading direction of the ship is automatically maintained at the preset course.
 - (ii) It is indicated that the rudder reaches a preset limit of angle. *(2018)*
 - (iii) An audible and visual alarm is initiated when the heading direction of the ship deviates beyond a preset amount of course deviation.
 - (d) Speed log systems
 - (i) The indicated speed is to be compared with the result of the speed trial.
 - (ii) The speed and distance are indicated during the speed trial.
 - (e) Echo sounding systems

The water depth is recorded while the ship is maneuvering.
 - (f) Whistle control systems

The fog signals are generated properly.
 - (g) Internal communication systems
 - (i) The internal communication system functions properly in the event of main electrical power failure.
 - (ii) The bridge has priority over the communication system.
 - (C) Accident prevention systems (NBS1 ships and NBS2 ships)

The system is in accordance with **3** (2) (C) (a) and (b).
 - (D) Bridge work assist systems (NBS2 ships)
 - (a) The system is in accordance with **3** (2) (D) (a) and (b).
 - (b) Auto tracking system
 - (i) The auto tracking system performs automatic steering of the ship along a planned route on an electronic chart.
 - (ii) Automatic course change occurs after acknowledgement by the navigator.
 - (iii) When there is no acknowledgement by the navigator at a waypoint, the course is maintained and the audible and visual alarm is given.
 - (iv) Change-over to manual steering mode is possible.

203. Survey Assigned to Maintain Classification

1. Special survey

- (1) At each Special Survey for navigation bridge systems of NBS ships, the following tests and examination are to be carried out.
 - (A) General examination of the systems
 - (B) Function tests of navigational equipment specified in **Sec 4, 402. 2** (1) to (5), (7) to (11) and (13) to (16).
 - (C) Verification on the capability of navigational equipment to readily reinstate after 45 seconds interruption of the electrical power supply.
- (2) At each Special Survey for navigation bridge systems of NBS1 ships, the following tests and examination are to be carried out.
 - (A) The tests and examination specified in the preceding (1).
 - (B) Function tests of accident prevention systems specified in **Sec 5, 502.**
 - (C) Verification on the capability of accident prevention systems to readily reinstate after 45 seconds interruption of the electrical power supply.
- (3) At each Special Survey for navigation bridge systems of NBS2 ship, the following tests and examination are to be carried out:
 - (A) The tests and examination specified in the preceding (2).
 - (B) Function tests of bridge work assist systems specified in **Sec 6, 602.**
 - (C) Verification on the capability of bridge work assist systems to readily reinstate after 45 seconds interruption of the electrical power supply.

2. Annual survey

- (1) At each Annual Survey for navigation bridge systems of NBS ships, the following tests and examination are to be carried out.
 - (A) General examination of the systems
 - (B) Function tests of the following equipment
 - (a) Automatic radar plotting aids (ARPA)
 - (b) Electronic position-fixing systems
 - (c) Radars
 - (d) VHF radio telephone installations
 - (e) Internal communication systems
 - (f) Other equipment deemed necessary by the Society **【See Guidance】**
- (2) At each Annual Survey for navigation bridge systems of NBS1 ships, the following tests and examination are to be carried out.
 - (A) The tests and examination specified in the preceding (1).
 - (B) Function tests of the following equipment
 - (a) Bridge navigational watch alarm systems
 - (b) Alarm and warning transfer systems
- (3) At each Annual Survey for navigation bridge systems of NBS2 ships, the following tests and examination are to be carried out.
 - (A) The tests and examination specified in the preceding (2).
 - (B) Function tests of the following equipment
 - (a) Bridge information systems
 - (b) Electronic Chart Display Information System (ECDIS)
 - (c) Auto tracking system

Section 3 Bridge Layouts and Bridge Working Environments

301. General

1. Scope

The requirements in this Section apply to bridge layouts and bridge working environments for NBS ships, NBS1 ships and NBS2 ships.

2. General

- (1) The bridge configuration, the arrangements of consoles, equipment location and the bridge working environments are to enable the navigator to perform navigational duties and other functions allocated to the bridge as well as to maintain a proper lookout from workstations on the bridge.
- (2) Navigating and maneuvering workstations are to be so arranged to enable efficient operation under normal operating conditions. All relevant instrumentation and controls are to be easily visible, audible and accessible from the workstation.
- (3) For the purpose of performing duties related to navigation and maneuvering, the field of vision from a navigating and maneuvering workstation and a conning position is to be such as to enable observation of all objects which may affect safety of the ship.
- (4) The navigator is, as far as practicable, to be able to approach close to at least one bridge front window in order to watch the area immediately in front of the bridge superstructure from the wheelhouse.
- (5) The bridge is, as far as practicable, to be placed above all other decked structures, not including funnels, which are on or above the freeboard deck.
- (6) The navigation bridge visibility of the ship is to be as follows.
 - (A) The view of the sea surface from the conning position is not to be obscured by more than two ship lengths or 500 m, whichever is less, forward of the bow to 10° on either side irrespective of the ship's draught, trim and deck cargo(e.g. containers). (See Fig 9.5.1)

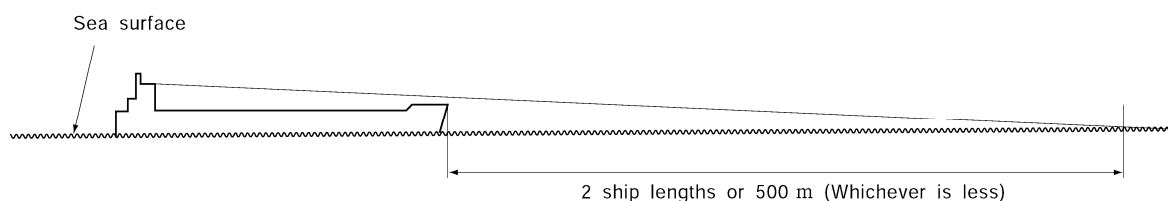


Fig 9.5.1 Forward view

- (B) The height of the lower edge of the front windows is to allow a forward view over the bow for person in a sitting position at the workstation.
The height of the lower edge of front windows above the deck is to be kept as low as possible, and is not to, as far as practicable, be more than 1000 mm.
- (C) It is to be possible to observe all objects necessary for navigation, such as ships and light-houses, in any direction from inside the wheelhouse.
 - (a) There is to be a field of view around the vessel of 360° obtained by an observer moving within the confines of the wheelhouse. (See Fig 9.5.2)

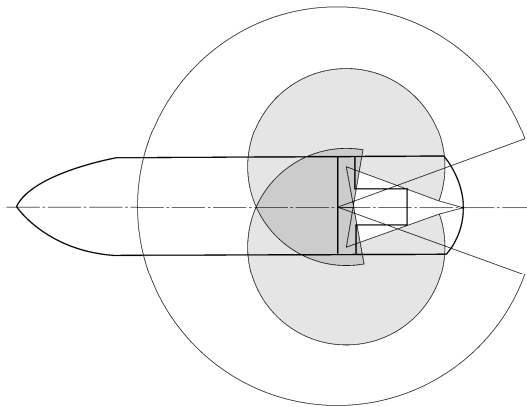


Fig 9.5.2 360° Field of vision

- (D) At the navigating and maneuvering workstation and at the conning position, the navigator's field of view is to be sufficient to enable him to comply with the International Regulations for Preventing Collisions at Sea (COLREG 72).
- (a) The horizontal field of vision from the navigating and maneuvering workstation and from the conning position is to extend at least over an arc from 22.5° abaft the beam on one side, through forward, to 22.5° abaft beam on the other side. (See Fig 9.5.3)
 - (b) From a monitoring workstation, the field of vision is to extend at least over an arc from 9° on the port bow, through forward, to 22.5° abaft the beam on starboard. (See Fig 9.5.4)
 - (c) The field of vision from a workstation on the bridge wing is to extend over an arc from at least 45° on the opposite bow through dead ahead and then aft to 180° from dead ahead. (See Fig 9.5.5)

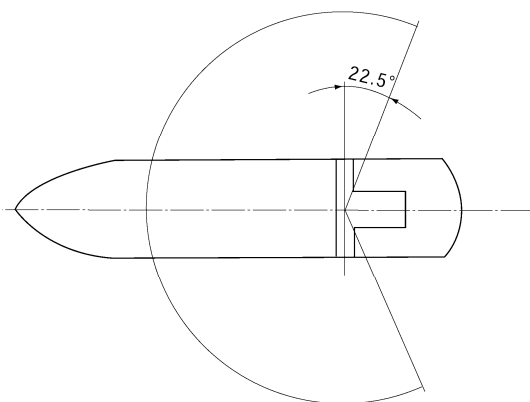


Fig 9.5.3 Navigating and maneuvering workstation and conning position

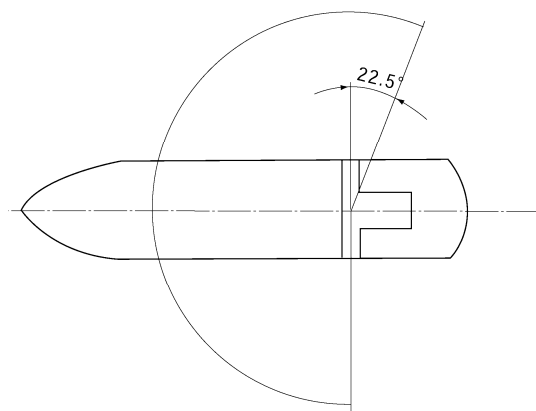


Fig 9.5.4 Monitoring workstation

- (E) The helmsman's field of vision is to be sufficiently wide to enable him to carry out his functions safely.
- (a) The helmsman's field of vision from the workstation for manual steering is to extend over an arc from dead ahead to at least 60° on each side. (See Fig 9.5.6)
 - (b) The workstation is not to be placed immediately abaft the front windows in order to obtain the required field of vision.

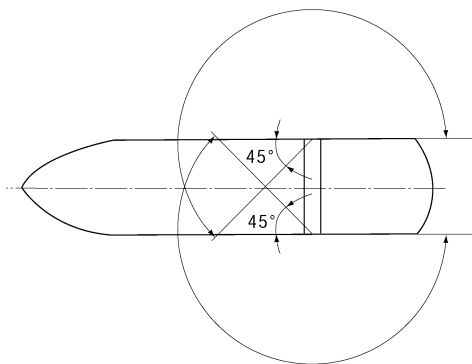


Fig 9.5.5 Bridge wing workstation

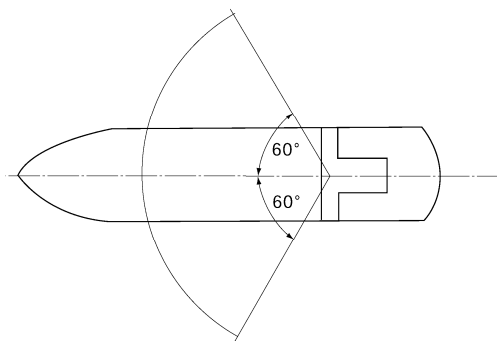
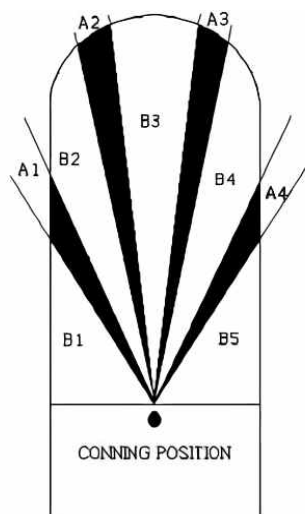


Fig 9.5.6 Helmsman's workstation

- (F) Blind sectors caused by cargo, cargo gear and other obstructions are to be as few and as small as possible, and not in any way influence a safe look-out from the navigating and maneuvering workstation and from the conning position. (See Fig 9.5.7)
- (a) The total arc of blind sectors caused by cargo, cargo gear and other obstructions outside of the wheelhouse forward of the beam which obstructs the view of the sea surface as seen from the navigating and maneuvering workstation and from the conning position is not to exceed 20°. Each individual blind sector is not to exceed 10°.
- (b) Over an arc from dead ahead to 10° on each side, each individual blind sector is not to exceed 5°. The clear sector between two blind sectors is not to be less than 5°.



- * horizontal field of vision
 $\angle(A1+A2+A3+A4+B1+B2+B3+B4+B5) = 180^\circ$
- * each individual blind sector
 $\angle(A2, A3) \leq 5^\circ$
 (over an arc from dead ahead to 10° on each side)
 $\angle(A1, A4) \leq 10^\circ$
- * total arc of blind sectors
 $\angle(A1+A2+A3+A4) \leq 20^\circ$
- * clear sectors between two blind sectors
 $\angle B2, B3, B4 \geq 5^\circ$

Fig 9.5.7 Blind Sectors of Bridge

- (G) The ship's side is always to be visible from the bridge wing especially where tugs or pilot boats come alongside and where the ship touches the jetty.
- (a) Bridge wings are to be provided out to the maximum beam of the ship. The view over the ship's side is not to be obstructed.

302. Bridge Working Environments

1. General

- (1) Through the various stages of the design of a ship, care is to be taken to ensure a good working environment for bridge personnel.
- (2) A ceiling and walls inside the wheelhouse are to be designed not to interfere with reading of the indication of instruments.
- (3) Toilet facilities are to be provided on or adjacent to the bridge.

2. Vibration

The vibration level on the bridge is not to be uncomfortable to bridge personnel.

3. Noise

The noise level on the bridge is not to interfere with verbal communication, mask audible alarms or be uncomfortable to bridge personnel.

4. External sound signals

External sound signals such as fog signals that are audible on the bridge wings are also to be audible inside the wheelhouse.

5. Lighting

- (1) The lighting required on the bridge is to be designed so as not to impair the night vision of the navigator.
- (2) The lighting used in areas and at items of equipment requiring illumination whilst the ship is navigating is to be such that night vision adaptation is not impaired, e.g. red lighting. Such lighting is to be arranged so that it can not be mistaken for a navigation light by another ship. It is to be noted that red lighting is not to be fitted over chart tables so that possible confusion in colour discrimination is avoided.

6. Air conditioning system (2017)

The wheelhouse spaces are to be provided with an air conditioning system. Setting of temperature in the bridge is to be readily available to the navigator.

7. Bridge personnel safety

- (1) There are to be no sharp edges or protuberances on surfaces of the equipment and the instruments installed on the bridge which could cause injury to bridge personnel.
- (2) Sufficient hand-rails or equivalent thereto are to be fitted inside of the wheelhouse or around equipment in the wheelhouse for safety in bad weather.
- (3) Adequate means are to be made for anti-slip of the bridge floor whether it be dry or wet condition.
- (4) Doors to the bridge wings are to be easy to open and close. Means are to be provided to hold the doors open at any position.
- (5) Where provision for seating for the navigator is made in the wheelhouse, means for securing are to be provided having regard to storm conditions.

Section 4 Navigational Equipment

401. General

1. Scope

The requirements in this Section apply to navigational equipment for NBS ships, NBS1 ships and NBS2 ships.

2. General

- (1) Navigational equipment is to be capable of continuous operation under the conditions of various sea states, vibration, humidity, temperature and electromagnetic interferences likely to be experienced in the ship which it is installed.
- (2) Where computerized equipment is interconnected through a computer network, failure of the network is not to prevent individual equipment from performing their individual functions.

3. Electrical power supply

- (1) Local distribution boards are to be arranged on the navigation bridge or adjacent to the navigation bridge for all items of electrically operated navigational equipment. These boards are to be supplied by two exclusive circuits, one fed from the main source of electrical power and one fed from the emergency source of electrical power, and these circuits are to be separated throughout their length as widely as practicable. Each item of navigational equipment is to be individually connected to the distribution board. These boards may also be used for accident prevention systems specified in **Ch 5. (2018)**
- (2) The power supplies to the distribution boards are to be arranged with automatic changeover facilities between the two sources.
- (3) Failure of the main electrical power supply to the distribution board is to initiate an audible and visual alarm on the navigation bridge. *(2018)*
- (4) Following a loss of electrical power supply which has lasted for 45 seconds or less, all primary functions of the navigational equipment are to be readily reinstated.

402. Navigational Equipment

1. General

- (1) The instrumentation and controls at the navigating and maneuvering workstation are to be arranged to enable the navigator to:
 - (A) determine and plot the ship's position, course, track and speed,
 - (B) analyse the traffic situation,
 - (C) decide on collision avoidance manoeuvres,
 - (D) alter course,
 - (E) change speed,
 - (F) effect internal communication and external communication using a VHF radio telephone installation related navigation and maneuvering,
 - (G) give sound signals,
 - (H) hear sound signals,
 - (I) monitor navigational data such as course, speed, track, propeller revolutions (pitch), rudder angle, depth of water.
 - (J) record navigational data.
- (2) Navigational equipment is to be arranged to avoid inadvertent operation.
- (3) Navigational equipment is to be designed to permit easy and correct reading by day and by night.
- (4) Each navigational equipment is to be placed with its face normal to the navigator's line of sight, or to the mean value if the navigator's line of sight varies through an angle.
- (5) Navigational equipment is to be designed and fitted to minimize glare or reflection or being obscured by strong light.

2. Navigational equipment

Navigational equipment listed below are to be provided on the bridge.

- (1) An automatic radar plotting aid (ARPA) independent or built into the radar equipment which complies with the following.

- (A) A warning is to be given to the navigator at a time which is adjustable in the range of 6 to 30 minutes, having regard to the time to danger.
- (B) True motion and relative motion modes are to be provided.
- (C) Daylight visible display is to be provided.
- (D) Capability of automatic acquisition and tracking of 20 radar targets or more is to be provided.
- (E) Guard zone system, featuring adjustable parameters, notable warning and alarm set for closest point of approach (CPA) and for time to closest point of approach (TCPA) are to be provided.
- (F) Simulator function showing the likely effects of a course or speed change in relation with tracked targets is to be provided.
- (G) Incorporated self-checking properties are to be provided.
- (2) An electronic position-fixing system appropriate to the intended service areas
- (3) Two independent radars. One of them is to operate within X-band.
- (4) Gyro compass repeaters and a calibration facility
- (5) An automatic steering system which complies with the following.
 - (A) An off-course alarm addressed to the navigator derived from a system independent from the automatic steering system is to be provided.
 - (B) An overriding control device is to be provided at the navigating and maneuvering workstation.
- (6) A speed log system
- (7) An echo sounding system
- (8) A control device of the wheelhouse air conditioning system
- (9) A NAVTEX receiver and an EGC receiver depending upon the intended service areas
- (10) Control switches and indicators of signaling lights such as navigation lights
- (11) Steering pump selector control switches
- (12) A whistle control system
- (13) A window wipe and wash control device
- (14) Control devices for the lighting of main workstation consoles
- (15) An internal communication system which complies with the following.
 - (A) At all times, even in the event of failure of the main electrical power supply, the navigator is to have access to facilities enabling two way communication with another qualified officer.
 - (B) The bridge is to have priority over the communication system.
- (16) A VHF radio telephone installation which is immediately available at the conning positions.
- (17) A main propulsion machinery remote control system which complies with the Rules for Automatic and Remote Control Systems

3. Illumination and individual lighting of equipment

- (1) The indicator lights and the illumination of all equipment are to be designed and fitted to avoid unnecessary glare or reflection or the equipment being obscured by strong light.
- (2) To avoid unnecessary light sources in the front area of the bridge, only equipment necessary for the safe navigation and maneuvering of the ship is to be located in the area.
- (3) Warning and alarm indicators are to be designed to show no light in normal conditions or in safe situations. Means are to be provided to test the lamps.
- (4) All illumination and lighting of equipment are to be adjustable down to zero, except the lighting of warning and alarm indicators and the control of the dimmers which are to remain readable.
- (5) Each equipment is to be fitted with an individual light adjustment. In addition, groups of equipment normally working together may be equipped with common light adjustment.

Section 5 Accident Prevention Systems

501. General

1. Scope

The requirements in this Section apply to systems to prevent accidents caused by the navigator's unfitness (hereinafter referred to as "accident prevention systems") for ships intended for one-man bridge operation in ocean areas under normal operating conditions.

2. General

- (1) Accidents prevention systems are to be capable of continuous operation under the conditions of various sea states, vibration, humidity, temperature and electromagnetic interferences likely to be experienced in the ship which they are installed.
- (2) Where computerized equipment is interconnected through a computer network, failure of the network is not to prevent individual equipment from performing their individual functions.

3. External sound signals

To enable the navigator inside the wheelhouse to hear external sound signals such as fog signals that are audible on the bridge wings with the doors to the bridge wings closed, a transmitting device is to be provided to reproduce such signals inside the wheelhouse.

4. Navigational equipment

- (1) Navigational equipment specified in **Sec 4, 402. 2** is to give an alarm when:
 - (A) The ship approaches a way-point.
 - (B) The ship's position is deviated from a planned route.
 - (C) The water depth beneath the ship is less than a predetermined value.
- (2) The systems or controls under **Sec 4, 402. 2** (1) to (5) and (11) to (17) are to be arranged so that the navigator has easy access to them and is able to maintain a proper lookout from the bridge.

5. Electrical power supply

- (1) Local distribution boards are to be arranged on the navigation bridge or adjacent to the navigation bridge for all items of electrically operated accident prevention systems. These boards are to be supplied by two exclusive circuits, one fed from the main source of electrical power and one fed from the emergency source of electrical power, and these circuits are to be separated throughout their length as widely as practicable. Each item of accident prevention systems is to be individually connected to the distribution board. These boards may also be used for navigational equipment specified in **Sec 4. (2018)**
- (2) The power supplies to the distribution boards are to be arranged with automatic changeover facilities between the two sources.
- (3) Failure of the main electrical power supply to the distribution board is to initiate an audible and visual alarm on the navigation bridge. *(2018)*
- (4) Following a loss of electrical power supply which has lasted for 45 *seconds* or less, all primary functions of the accident prevention systems are to be readily reinstated.

502. Accident Prevention Systems

1. General

- (1) Indicator lamps are to be provided in the ship master's room which indicate the bridge navigational watch alarm system specified in **Sec 5, 502. 2** and the alarm and warning transfer system specified in **Sec 5, 502. 3** are functioning properly.
- (2) Audible and visual alarms for a malfunction of the bridge navigational watch alarm system specified in **Sec 5, 502. 2** and the alarm and warning transfer system specified in **Sec 5, 502. 3** are to be provided on the bridge and in the ship master's room.

2. Bridge Navigational Watch Alarm System

A bridge navigational watch alarm system which complies with the following is to be provided.

- (1) The bridge navigational watch alarm system is to be a vigilance system to verify periodically that the alert navigator is present on the bridge.

- (2) The bridge navigational watch alarm system is not to cause undue interference with the performance of bridge functions.
- (3) The bridge navigational watch alarm system is to be so designed and arranged that it could not be operated in an unauthorized manner.
- (4) The bridge navigational watch alarm system is to be adjustable of its verification period up to 12 minutes intervals and constructed, fitted and arranged so that only the ship master has access to the component for setting the appropriate intervals.
- (5) The bridge navigational watch alarm system is to initiate alarms that are able to be verified in the bridge and other places if the setting interval has elapsed. **【See Guidance】**
- (6) The bridge navigational watch alarm system is to provide for the acknowledgement by the navigator at the navigating and maneuvering workstation and other appropriate locations on the bridge from where a proper lookout may be kept.
- (7) The bridge navigational watch alarm system is to be connected to the alarm and warning transfer system specified in **Sec 5, 502. 3.**

3. Alarm and warning transfer system **【See Guidance】**

An alarm and warning transfer system which complies with the following is to be provided.

- (1) Acknowledgement of alarms and warnings that require the navigator response is to only be possible from the bridge.
- (2) Any alarm and warning that requires the navigator response is to be automatically transferred to the ship master, to the selected back-up navigator and to the public rooms if not acknowledged on the bridge within 30 seconds. **【See Guidance】**
- (3) The alarm and warning transfer is to be operated through a fixed installation.
- (4) Provision which initiates a call-alarm clearly audible in the spaces specified in (2) is to be provided on the bridge for the operation of the navigator. The fixed installation required under (3) may serve the purpose.

Section 6 Bridge Work Assist Systems

601. General

1. Scope

The requirements in this Section apply to systems to assist navigator's works for one-man bridge operation under normal operating conditions (hereinafter referred to as "bridge work assist systems").

2. General

- (1) Bridge work assist systems are to be capable of continuous operation under the conditions of various sea states, vibration, humidity, temperature and electro-magnetic interference likely to be experienced in the ship which they are installed.
- (2) Where computerized equipment is interconnected through a computer network, failure of the network is not to prevent individual functions.

3. Centralized bridge workstation

- (1) The centralized bridge workstation is to be arranged to enable a navigator to perform navigating and maneuvering works specified in **Sec 4, 402. 1** (1) and also two or more navigators to do those works together.
- (2) The systems or controls under **Sec 4, 402. 2** (1), (5), (11) to (17), **Sec 6, 602. 2** and **3** are to be arranged centrally to enable the navigator to operate them easily at the centralized bridge workstation.

4. Electrical power supply

- (1) Local distribution boards are to be arranged on the navigation bridge or adjacent to the navigation bridge for all items of electrically operated bridge working assist systems. These boards are to be supplied by two exclusive circuits, one fed from main source of electrical power, and these circuits are to be separated throughout their length as widely as practicable. Each item of bridge working assist systems is to be individually connected to the distribution board. These boards may also be used for navigational equipment and accident prevention systems specified in **Sec 4** and **Sec 5**. (2018)
- (2) The power supplies to the distribution boards are to be arranged with automatic changeover facilities between the two sources.
- (3) Failure of the main electrical power supply to the distribution board is to initiate an audible and visual alarm on the navigation bridge. (2018)
- (4) Following a loss of electrical power supply which has lasted for 45 seconds or less, all primary functions of the bridge work assist systems are to be readily reinstated.

602. Bridge Work Assist Systems

1. General

- (1) Audible and visual alarms for a malfunction of the bridge information systems specified in **Sec 6, 602. 2**, ECDIS specified in **Sec 6, 602. 3** and the auto-trucking system specified in **Sec 6, 602. 4** are to be provided on the bridge and in the master's room.
- (2) Electronic charts deemed appropriate by the Society are to be used for the ECDIS.
[See Guidance]

2. Bridge information system

Bridge information system which complies with the followings is to be provided.

- (A) The system is to be capable of displaying at least the following information a) to l) for easy viewing from centralized bridge workstation.
 - (a) Ship's actual and planned course
 - (b) Rudder angle including its order value or direction
 - (c) Ship's speed (against water)
 - (d) Main engine revolution and direction (in the case of Controllable Pitch Propellers, main engine revolution and propeller pitch angle)
 - (e) Ship's position (longitude and latitude)
 - (f) Depth of water
 - (g) Wind direction (relative direction)

- (h) Wind speed (relative speed)
- (i) Rate of turn (10,000 GT or more)
- (j) Side thruster pitch angle or its motor amperes and its thrust direction (if any)
- (k) Onboard time
- (l) Distance to a way-point and estimated time of arrival
- (B) In order to display the information appropriate for each navigation areas, the system is to be capable of changing-over between harbor, ocean and other mode (if any). In addition, the system is to be capable of displaying the minimum information necessary for all modes at all times.
- (C) The system is to be capable of displaying at least following information for harbor and ocean mode specified in the preceding (B) at all times.
 - (a) Harbour mode
Information of the preceding (A) (a) to (k).
 - (b) Ocean mode
Information of the preceding (A) (a) to (e), (g), (h), (k) and (l).
- (D) The system is to be capable of acknowledging alarms and warnings which requires the navigator response.
- (E) Other functions deemed necessary by the Society are to be provided. **【See Guidance】**

3. Electronic chart display and information system (ECDIS)

An ECDIS, including associated back-up arrangements, which complies with the following is to be provided.

- (A) The ECDIS is to be capable of displaying an electronic chart at centralized bridge work station.
- (B) The ECDIS is to be capable of ship's position and vector on the electronic chart.
- (C) The ECDIS is to be capable of displaying the electronic chart in a north-up and course-up orientation.
- (D) The ECDIS is to be capable of carrying out route planning.
- (E) The ECDIS is to be capable of adding a chart, ship's position, planned route, radar and ARPA information to the display.
- (F) Other functions deemed necessary by the Society are to be provided. **【See Guidance】**

4. Auto tracking system

An auto tracking system which complies with the following is to be provided.

- (A) Auto tracking system is to be capable of performing automatic steering of the ship along a planned route on an electronic chart.
- (B) The system is to provide means for the officer of the watch to confirm the course change at W/H.
- (C) With or without confirmation, the ship is to follow automatically the track. When there is no confirmation at a waypoint, the audible and visual alarm is to be initiated after through the point. In the case, the audible alarm is to be distinguished from the pre-warning at the approach of a way point specified in **Sec 5, 501. 4**. If the actual course change alarm is not confirmed by the officer of the watch within 30s of W/H, a back-up navigator alarm is to be given.
- (D) It is to be possible to adjust a width of planned route within one mile.
- (E) When the position of ship cannot be received continuously, the course of ship is to be maintained and the audible and visual alarm is to be initiated.
- (F) Change-over to manual steering mode is to be easily possible.
- (G) Other functions deemed necessary by the Society are to be provided. **【See Guidance】** ⚓

CHAPTER 6 HULL MONITORING SYSTEMS

Section 1 General

101. Definition

Hull monitoring system (hereinafter referred to as "systems") are to monitor a behavior of hull girder during navigation, loading and unloading, and to provide real-time information on stress level due to longitudinal bending moment and acceleration level due to ship's motion. The systems will give warning when stress levels and acceleration of ship motions approach levels which require corrective action.

102. General

1. Application:

The requirements in this Chapter apply for a ship that the class notations assigned to the hull monitoring system to be classed or intended to be classed with the Society.

2. Class notations:

Ships complying with this Chapter may be assigned with one of the following class notations:

HMS : This notation will be assigned when the ship has been provided with a basic hull stress monitoring system in accordance with **Sec 2, 201.** and **202.**

HMS1: This notation will be assigned when the ship has been provided with the **Sec 2, 203.** in addition to HMS.

3. Liability:

This system is intended as an aid to the Master's judgement and not as a substitute for it. Accordingly, any failure of the system does not, in anyway, remove the master from his/her absolute responsibility to take correct action in operation the ship.

103. Information and Plans

The following plans and information are to be submitted or approval:

(1) Drawings

- arrangement and layout of the system
- block diagram of the electric system
- flowchart of functions of sensors and the system

(2) Information

- list of instruments and equipment (name, kind, type, manufacturer, etc.)
- operating manual including procedures of maintenance, fault detection and management ad setting up and calibration
- in-service test program
- list of software modules and the description of the calculation method
- sensor specifications (accuracy, range, frequency response, etc.)
- description of the method to display the output

Section 2 System Requirements

201. General

All components are to be replaceable and designed for easy maintenance. Sensors are to be approved by this Society or to be approved by the other recognized organization.

202. System Requirements

1. Sensors

(1) Long based strain gauge

- (A) Each long strain gauge is instrument for measure the longitudinal bending stress of ship. It is to be able to measure the strain which is characteristic for the structural response considered.
- (B) The type and installation are in general to exclude the effects of local stress concentrations. The length of the long based strain gauge is recommended to be between 1.5 m and 2.5 m.
- (C) The position of the long based strain gauge is to be planned to measure longitudinal hull girder bending stress. The minimum required number and approximate position of the strain gauges are as follows:
 - (a) Tankers, Bulk Carriers and General dry cargo ships:
 - 2 at midship (one port, one starboard on deck)
 - 1 at L/4 from the bow(on deck)
 - 1 at L/4 from the stern(on deck)
 - (b) Container ship :
 - 4 at midship in a ring around the section(two port, two starboard; on deck and upper turn of bilge)
 - 1 at L/4 from the bow(on deck)
- (D) Strain gauges are to have an accuracy better than $\pm 20 \mu\epsilon$. The linear range of each strain gauge is to be in excess of the full range of expected still water and dynamic stress variation. For dynamic stress range each strain gauge is to have a frequency response capable of measuring strain in the frequency range 0 to 5 Hz.
- (E) When measuring longitudinal bending stresses of ship and corresponding loads the effects of temperature variations due to the daily environmental changes are to be considered. If possible, these effects are to be removed from any display of still water loading.
- (F) Thermal loads due to cargo temperatures are to be considered separately. Consideration as to whether or not the thermal loads should be included in the still water or water loads are to be determined when taking into account the type of vessel and cargo and the approved ship's scantlings and their conditions of approval. (The data of calculation were to be submitted of the Society.)

(2) Accelerometer

- (A) The vertical acceleration is to be measured on the centerline, at the main deck level within the forward 0.01 L of the ship.
- (B) Accelerations are to be measured over a range of ± 1 g. The measurement uncertainty of the acceleration is to be less than 1 % of the measured value in the frequency range of 0 to 5 Hz.

(3) Pressure Transducer

- (A) If possible, the pressure transducers may be installed to measure the number of slam.
- (B) Pressure gauge where fitted through the hull are to be arranged so that the pressure diaphragm is flush with the outside of the plating. The gauge is to be arranged with a suitable valve to enable the gauge to be removed and refitted with the vessel in the water at an operational draft.

(4) Clinometer

In order to measure the motion characteristics, the clinometer may be installed.

2. Data Processing and Output Display

(1) Display and alarm devices

- (A) The hull monitoring system is to be able to provide real-time information to the bridge of the measured values while at sea and during loading and unloading operations. The system is to be able to record and display the following sets of data for each strain gauge and accelerometer:

- the peak value of the longitudinal hull girder bending stress or vertical acceleration
 - the mean value of the longitudinal hull girder bending stress or vertical acceleration
 - the standard deviation of the longitudinal hull girder bending stress or vertical acceleration
 - (B) The system is to include a computer that can process sensor signals and compare these with threshold levels approved by the Society. When values exceed these pre-set threshold values, the system is to give visual and audible alarm on the bridge.
 - (C) In order to verify intermediate and final stages of loading and unloading operations, the hull monitoring system is to have a direct link or easy connection to the loading computer.
 - (D) Each update of the display is to be based on statistics of the recorded data within 30 minutes interval. The sensor readings are to be displayed in a manner that enables the trends in the data over at least the last 1 hours to be seen.
 - (E) The number of acceleration peak exceeding a pre-set acceleration level, which indicates a slam in the bow are to be recorded and displayed. The pre-set acceleration level is to be reported.
 - (F) The recordings from strain sensors are to be processed using a type of cycle count method (e. g. "rain flow" method) to produce response histogram. The stress spectra may be used as basis for fatigue life predictions. The size of strain interval is not to exceed 50 $\mu\epsilon$. The cycle count method is to be reported and submitted.
- (2) Signal processing
- (A) The sampling rates are to be suitable for the frequency response of the transducer and the use of the signal. In general the sampling rate is not to be less than 3 times the required frequency response. Special attention is to be paid to the sampling rate if it is intended to capture transient components of signals.
 - (B) The measured signal induced by wave is to be statistically calculated with the time interval of between 5 minutes and 30 minutes.

3. Storage device

- (1) General
- (A) For the purpose of verifying that all sensors are working under sea-going conditions the system is to have a minimum recording capability. This requires that a semi-permanent data storage medium is to be used to record, at least once per month and the following information processed over a period of 5 minutes.
 - maximum peak to peak value of stress/acceleration
 - mean value of stress/acceleration
 - standard deviation of stress/acceleration
 - average zero crossing period of stress/acceleration
 - time reference
 - (B) Automatic post-processing of data on-board or ashore is to be available on shore or on the vessel to enable the data to be evaluated. Proposals will be considered for recording to be replaced by sending the data ashore via satellite on a regular basis.
 - (C) Where manual input, for example via a computer keyboard, is used, the input procedures are to be included in the operating manual and are to be submitted for review. This data is to be checked regularly against the criteria described in the checking procedure.

4. Electrical and mechanical equipment

- (1) Flame proof
- All electrical and mechanical equipments associated with the hull monitoring system located in hazardous areas is to be in accordance with the requirements in **Pt 7, Ch 1, Ch 5 and Ch 6**.
- (2) Uninterruptible Power Supply (UPS)
- (A) The monitoring system is to be powered through an Uninterruptible Power Supply (UPS).
 - (B) In case of failure of the main input voltage the battery capacity is to be sufficient to maintain normal operation of the monitoring system for at least 10 minutes. Failure of any power supply to the system is to initiate an audible and visual alarm.
 - (C) In the case of power failure the system software and recorded data is stored safely. The system is to be able to return automatically to normal operating condition when the power is restored.

203. Additional Requirement for Hull Monitoring System(HMS1)

1. General :

Ship assigned with the class notation of HMS1 is to be complying with the sea environment and voyage data in accordance with the term **203. 2** in addition to **201.** and **202.** The necessary information suitable for this additional requirement is to be displayed and stored.

2. Additional requirement

(1) Ship position

The ship position is to be informed by Global Position System(GPS).

(2) Wind speed and direction

The system is to indicate the wind speed and direction provided by wind speed indicator and anemoscope.

(3) Ship speed and direction

The system is to indicate the real-time information of ship speed and direction provided by GPS and speed and distance indicator onboard.

Section 3 Approval for Plans and Documents, Installation and Installation Survey

301. Approval for plans and documents

(1) Instruction manuals

Instruction manuals are to be described in relevant language and kept on board. The manuals are to contain necessary instructions on:

- instruction of system
- interpretation of measuring results
- systematic maintenance and function testing
- identification of faults and repairs
- procedures of installation
- procedures of initial calibration and checking
- checking procedure
- components list

(2) Checking procedure

The plan for systematic maintenance and function testing is to show how components and systems are to be tested and what is to be observed during the tests. The procedure is to describe how to check the normal operation of the signal acquisition and analysis and display. The check list of checking procedure is to be included in instruction manuals.

302. Installation

1. General:

Information on how to initialize the sensors is to be verified by the Society. The system is to be installed with attendance of a surveyor.

2. Installation of the sensors

- (1) Sensors are to be protected from mechanical damage, humidity by the sea water, effects of very high and low temperature and damage due to local vibration.
- (2) Sensors mounted on deck of the ship are to be protected from heavy sea condition. For container ship, the system is to be located in the safety area where it is not disturb to remove/install the dropped container securing appliances during loading/unloading operation.
- (3) Deck mounted strain gauge is to be protected from green sea on deck by appropriate siting of by using substantially constructed breakwaters or similar means. Attention is to be paid to the possibility of green water damage to other gauge, junction boxes, cable conduits, etc.
- (4) Motion sensors to measure motions are to be placed in positions where their functioning will not be affected by vibrations. Accelerometers and motion monitoring devices are to be mounted on a hard structural point where local structural vibration will be minimal. If resilient mounts are used, it is to be demonstrated that they have frequency characteristics that do not affect the

- signal in the frequency range of interest.
- (5) When gauges are welded to the hull welding procedures are to comply with Class Rules of the Society. Consideration is to be given to the damage and repair of coatings.
 - (6) Pressure gauges where fitted through the hull are to be constructed in accordance with the Class Rules of the Society.

303. Installation survey

1. Initial calibration and test

- (1) Initial calibration
 - (A) Each long based strain gauge is to be initially set to a stress calculated in an associated loading condition.
 - (B) This calculated stress is to be compatible with the output of the loading instrument and calculations made using the loading manual. The set-up is not to be carried out when dynamic stresses are present and are to be made when temperature effects are minimized and in absence of large gradients due to loading condition. In the case of measuring local stresses the sensor stress is to be set to the stress calculated through the detailed structural analysis.
 - (C) Also, the motion measuring device is to be set according to the ship condition.
- (2) Checking of the initialized value
 - (A) After installation, the initial set-up of each long strain gauge is to be checked at least one time within 6 months.
 - (B) This is to be undertaken by the ships operating personnel taking the relevant values from the Loading Instrument and the Hull Condition Monitor in accordance with the Verification Procedure and submitting them to the Surveyor.
 - (C) In the event that differences greater than 10 % of the calculated value occur, the set-up and subsequent checking procedure are to be repeated.

3. Sensor re-calibration

Each strain gauge is to be re-calibrated annually in accordance with the manufacturer's recommendations. The certificates of calibration, signed by an authorized person, are to be kept on-board the ship.

4. Other survey

In the case of set-up sensor on exposed deck, to be carried out hose test according to **Pt 3, Ch 1, Sec 2**.

Section 4 Periodical Survey

401. General

Periodical survey for the systems is to be carried out at the time of Annual/Intermediate/Special Survey specified in **Pt 1, Ch 2**.

402. Survey items

The general conditions of electrical, mechanical and hazardous area equipment are to be carried out so far as practicable on hull monitoring systems, with special attention being paid to the following;

- 1. The verification of location of sensors.
- 2. The operation of the system is to be verified in accordance with the approved verification procedure.
- 3. Current calibration certificates for the sensors and Operating Manual is to be established on board.
- 4. The protection of sensors is to be inspected. ⚠

CHAPTER 7 DIVING SYSTEMS

Section 1 General

101. General

1. Application

- (1) The requirements of this Chapter apply to the design, construction and testing of the main equipment which form diving systems such as diving bells, decompression chambers, etc. which are permanently installed or installed with limited period as required by the operating conditions on a ship or a similar floating structure classed with or intended to be classed with the Society. The requirements not specified in this Chapter are to be in accordance with the relevant parts of the Rules. **【See Guidance】**
- (2) The requirements do not cover diving techniques or procedural requirements for the instruction of diving techniques.

2. Equivalence

For the equivalence of alternatives to the Rules or novel design principles are to be in accordance with Pt 1, Ch 1, 105.

102. Definition

For the purpose of this Rule, the terms used have the meaning defined in the followings unless expressly provided otherwise;

1. Diving system (2017)

A diving system means the whole plant and equipment necessary for the conduct of diving operations using transfer under pressure techniques which includes diving bells, decompression chambers and ancillary equipment thereof and to be divided as following table.

	SUR (Surface Diving)	BOU (Bounce Diving)	SAT (Saturation Diving)
maximum depth and maximum operation time	$d_{\max} < 60 \text{ msw}^*$ $T_{\text{op}}^* < 8 \text{ hours}$	$d_{\max} < 125 \text{ msw}^*$ $T_{\text{op}}^* < 24 \text{ hours}$	None, except those imposed by the requirements and assumptions in the certificate.
<p>* msw is meters of sea water. * T_{op} is the maximum operation time of chambers when a diver lives in chamber</p>			

2. **Deck decompression chamber** means the part of a diving system which is equipped with the pressure vessel for human occupancy with means of controlling and monitoring the pressure within the chamber.
3. **A mating device** means that the equipment necessary for the connection or disconnection of diving bell to a surface compression chamber.
4. **Hyperbaric Evacuation System (HES)** means the whole plant and equipment necessary for the evacuation of divers in saturation from a deck decompression chamber to the Hyperbaric Reception Facility(HRF) where decompression can be carried out. The main components of a hyperbaric evacuation system include the Hyperbaric Rescue Unit (HRU), its handling system, the Hyperbaric Reception Facility and the evacuation procedures.
 - (1) Hyperbaric rescue unit(HRU) or hyperbaric evacuation unit (HEU) means a unit whereby Divers under pressure can be safely evacuated from a ship or floating structure to a place where decompression can be carried out. This can be included a hyperbaric rescue chamber(HRC) or self-propelled hyperbaric lifeboat(SPHL).
 - (2) Hyperbaric reception facility (HRF)

- (3) Hyperbaric rescue chamber (HRC)
5. **CO₂ Scrubber** means for removal of the carbon dioxide from the breathing gas.
 6. **Partial pressure** means pressure of gas within a mixture which would prevail if the gas would fill by itself alone, the full volume occupied by the mixture. The sum of the partial pressures of the consistent parts of the mixture, proportional to volumetric fractions, is equal to the total absolute pressure of the mixture.
 7. **Oxygen system** is to be intended for a gas with a higher oxygen percentage than 25.
 8. **Life support system** means the equipment used to maintain a suitable life environment for the divers in the pressurized compartments (DDC, closed bell, HRU) and prepare the breathing gas mixtures, supply the gases to the pressurized compartments, adjust the temperature and the humidity and monitor the life support parameters.
 9. **Umbilical cable** means the link between the diving support unit and the diving bell(wet and closed) or the diving stage which is the assembly containing surveillance, communication and power supply cables, breathing gas and hot water hoses and covered by protective enclosure. The strength member for hoisting and lowering the diving bell may be part of the umbilical. However, umbilicals connected in the wet bell or the diving stage mean bunches of individual hose.
 10. **A depth** means that the pressure, expressed in metres of seawater, to which the diver is exposed at any time during a dive or inside a surface compression chamber or diving bell.
 11. **A pressure vessel** means a container capable of withstanding an internal working pressure of 0.1 MPa and over which allows gas transfer and storage under pressure.
 12. **Built In Breathing System (BIBS)** means a system of gas delivery to masks located in the decompression chambers and diving bells (closed), used for oxygen decompression during surface decompression and caisson disease treatment and supplying breathing air in case of fire or gas pollution.
 13. **A diving bell** means a submersible compression chamber, including its ancillary equipment, for transfer of divers under pressure between the work location and the surface compression chamber. However, wet bell means an open chamber to be transferred between underwater working place and deck.
 14. **Gas reclaim unit** is used on saturation diving systems to recover the helium from the breathing gas.
 15. **Bail-out gas** is Diver's emergency gas supply cylinder used as a backup system in case of a failure of the primary source of breathing gas.
 16. **Launch and Recovery System (LARS)** means plant and equipment necessary for raising, lowering and transporting the diving bell between the work location and the surface compression chamber.
 17. **A maximum operating depth** means that the depth in metres of seawater equivalent to the maximum pressure for which the diving system is designed.
 18. **Minimum Breaking Load (MBL)** means the Minimum Breaking Load of wire ropes and fibre ropes are provided by the manufacturer in accordance with applied Standards.
 19. **Breathing gas or breathing mixture** means that all gases or mixed gases which are used for breathing of divers during diving operation.
 20. **Metres of sea water (MSW)** means metres of sea water are sometimes used to express a water depth equivalent to a pressure. For the purpose of the design and testing of pressure vessels, the values in msw are to be converted into pressure units.
 21. **Saturation condition** means when the nitrogen or inert gas breathed by a diver dissolves into the body's tissues maximally at the specific pressure, i.e., no more gas can be absorbed by the tissues.
 22. **Medical lock** means the living compartment and other compartments intended to be used for decompression should have a lock through which provisions, medicine and equipment may be passed into the chamber while its occupants remain under pressure.

Section 2 Classification Surveys [See Guidance]

201. General

1. Kinds of surveys

Kinds of surveys are as follows:

- (1) Surveys for Classification (hereinafter referred to as "Classification Surveys")
 - (A) Classification Surveys during Construction
 - (B) Classification Surveys after Construction
- (2) Surveys for Classification Maintenance
 - (A) Annual Surveys
 - (B) Intermediate Surveys
 - (C) Special Surveys
 - (D) Occasional Surveys

2. Survey intervals

Surveys are to be carried out in accordance with the following requirements.

- (1) A Classification Survey is to be carried out at the time when application for registration is made.
- (2) Classification Maintenance Surveys are to be carried out at the times as prescribed below.
 - (A) Annual Surveys are to be carried out at intervals specified in **Pt 1, Ch 2, 201.**
 - (B) Intermediate Surveys are to be carried out at intervals specified in **Pt 1, Ch 2, 301.**
 - (C) Special Surveys are to be carried out at intervals specified in **Pt 1, Ch 2, 401.**
 - (D) An Occasional Survey: at a time falling on any of mentioned below, independently of Special Surveys and Annual Surveys.
 - (a) When main parts of the systems have been damaged, repaired or renewed
 - (b) When the systems are modified or altered
 - (c) Whenever considered necessary by the Society

3. Preparation for surveys and others

- (1) All such preparations as required for the Survey to be carried out as well as those which may be required by the Surveyor as necessary in accordance with the requirements in the Rules are to be made by the applicant of the survey. The preparations are to include provisions of an easy and safe access, necessary facilities, certificates and records for the execution of the survey, opening up of equipment, removal of obstacle and cleaning. Inspection, measuring and test equipment, which Surveyors rely on to make decisions affecting classification are to be individually identified and calibrated to a standard deemed appropriate by the Society. However, the Surveyor may accept simple measuring equipment(e.g. rulers, measuring tapes, micrometers, etc.) and gauge fitted on machinery(e.g. pressure gauges, temperature gauges, rpm gauges, etc.) without individual identification or confirmation of calibration, provided they are properly maintained and periodically compared with other similar equipment.
- (2) The applicant for survey is to arrange a supervisor who is well conversant with the survey items intended for the preparation of the survey to provide the necessary assistance to the Surveyor according to his requests during the survey.
- (3) The survey may be suspended where necessary preparations have not been made, any appropriate attendant mentioned in the previous (2) is not present, or the Surveyor considers that the safety for execution of the survey is not ensured.
- (4) Where repairs are deemed necessary as a result of the survey, the Surveyor will notify his recommendations to the applicant of survey. Upon this notification, the repair is to be made to the satisfaction of the Surveyor.

202. Classification surveys

1. Drawings and data

- (1) General
 - (A) Before the start of manufacture, plans and drawings of all components subject to compulsory inspection, to the extent specified below, are to be submitted to the Society with 3 copies .
 - (B) The drawings are to contain all the data necessary to check the design and loading of the equipment. Wherever necessary, calculations relating to components and descriptions of system are to be submitted.

(2) Diving system

(A) For approval

No.	Drawings and data
1	Firefighting equipment details
2	Description of the fire detection and alarm systems
3	Drawings/data of the securing of diving equipment

(B) For reference

No.	Drawings and data
1	Design basis <ul style="list-style-type: none"> – Maximum operating depth and equivalent allowable working pressure – Maximum operating time – maximum numbers of divers in water and in the deck decompression chambers – maximum operating time of occupancy expected in the deck decompression chambers – maximum operational wave height – minimum/maximum sea temperature and air temperature
2	Specification of the diving system <ul style="list-style-type: none"> – system description, emergency evacuation plan and other relevant technical specification – equipment list and manufacturer
3	The design loading conditions of the bell, its connection to the LARS and the umbilical
4	Installation and commissioning <ul style="list-style-type: none"> – installation manual – commissioning procedure
5	Operating and maintenance <ul style="list-style-type: none"> – user manual, maintenance instruction and service record book
6	FMEA (Failure Modes and Effects Analysis) report
7	General arrangement of diving system
8	Material specification for inside the hyperbaric chambers

(3) PVHO

(A) For approval

No.	Drawings and data
1	Specification of the thermal and fire insulation material
2	Description welding procedure and welding details
3	Drawing of the pressure vessel structure
4	Drawing of the supporting structure and padeyes
5	Drawing of doors, clamping systems, mating devices and locks
6	Drawing of the penetrations
7	Specification and extent of non-destructive examination(NDE)
8	Description of marking

(B) For reference

No.	Drawings and data
1	Design basis and general specification <ul style="list-style-type: none"> – Maximum allowable working pressure (internal/external) – Design temperature (maximum/minimum) – Testing pressure (hydrostatic test pressure) – Local loads – Accelerations due to handling loads defined in 402. 4 – Number of design load cycles
2	Material, structure and geometric description of the pressure vessel
3	Description of the viewports and their material
4	Specification of the coating system
5	Specification of the heat treatment
6	Specification of the safety valves and the pressure relief valves
7	Justification of the means for expansion allowance of the interconnected pressure vessels
8	Inspection and testing procedure

(4) Deck decompression chamber

(A) For approval

No.	Drawings and data
1	Justification of the means for expansion allowance of the interconnected chambers
2	Electrical and communication wire description
3	Description of fire detection, alarm and fire fighting system
4	Description of environmental control system
5	Description of sanitary system
6	Description of CO2 scrubber system
7	Description of deck chamber supports and padeyes

(B) For reference

No.	Drawings and data
1	Design basis including characteristics, limitations and loading conditions, etc.
2	Specification including follows : <ul style="list-style-type: none"> – internal dimensions, volume and weight – communication systems – interface with the diving bell – interface with the HRU – interface with the life support system – equipment list
3	General arrangement of deck chamber
4	Inspection and testing procedure
5	Drawing defined in (3)

(5) Diving bell

(A) For approval

No.	Drawings and data
1	Description of the control panel in the bell <ul style="list-style-type: none"> – layout of the control panel – single line diagram of the piping, electrical and communication systems
2	Description of the electrical installations and control systems
3	Drawings of the diving bell structure including padeyes

(B) For reference

No.	Drawings and data
1	Design basis including characteristics, limitations and loading conditions, etc.
2	Specification including follows : – internal dimensions, volume and weight – communication systems – interface with the diving bell – interface with the HRU – interface with the life support system – equipment list
3	Calculation note of buoyancy and stability
4	General layout
5	Description of the heating system
6	Inspection and testing procedure
7	Drawing defined in (3)

(6) Life support system

(A) For approval

No.	Drawings and data
1	Breathing gas single line diagram and piping details
2	Structural drawings of the gas cylinders
3	Description of the safety relief valves
4	Description of the valves and fittings
5	Description of the material, scantling and welding details for piping
6	Description of the flexible hoses (reference standard, testing procedure, etc)

(B) For reference

No.	Drawings and data
1	Description of the gas storage arrangement
2	Description of the oxygen piping cleaning procedure
3	Description and FAT procedure of the environmental control system
4	Description and FAT of the fresh water unit
5	Description and FAT of the breathing gas reclaim unit
6	Description and FAT of the gas transfer system
7	Description and FAT of the diving hot water unit
8	Description of the diving umbilical – specification, drawing, reference standard – flexible hose description (see above table (A)) – electrical and communication wire description

(7) Electrical equipment and communication system

(A) For approval

No.	Drawings and data
1	Single line distribution diagram and detailed diagram of the installation, including description and characteristics of cable, fuse and switchgears
2	Description of the automation system
3	Descriptions and details of the communication means between diving control station and diving systems, including single line diagram

(B) For reference

No.	Drawings and data
1	General layout of the control stations and their control panels
2	General description of the electrical installations and control systems
3	Description of electrical supply principles, failure scenarios, redundancy principles, emergency arrangement, load balance, storage batteries capacity etc.
4	General layout showing the electrical equipment, batteries, lighting and cable trays

(8) Launch and Recovery System

(A) For approval

No.	Drawings and data
1	General arrangement of the handling system and showing the working area and the different path of the rope
2	Structure drawings
3	Material specifications
4	Power unit and driving system specifications and general drawings
5	Hydraulic and electric system specifications
6	Drawings of the load carrying hydraulic cylinders

(B) For reference

No.	Drawings and data
1	Operational limitation, when relevant
2	Weight of diving device to be lifted in air and in water
3	Maximum hoisting speed
4	Safe working load
5	The specification of the steel wires or fiber ropes including end termination details and minimum breaking load
6	Calculation of the design loads for the handling system including rope data.
7	Description and characteristics of the winches, general drawing, structure drawing, main component list and relevant calculation data
8	Description and characteristics and design basis for guide wire and winch relating clump weight handling system

(9) HRU

(A) For approval

No.	Drawings and data
1	General layout of the life support control panel, single line diagram of the piping, electrical and communication systems
2	Description of the electrical installations
3	Description of the environmental control system
4	Description of the carbon dioxide scrubber system
5	Description of the sanitary system

(B) For reference

No.	Drawings and data
1	Design basis including characteristics, limitations and loading conditions, etc.
2	Specification including follows : – communication systems – life support system – internal dimensions and volume – interface with the hyperbaric reception facility
3	IMO Life saving appliance certificate for the lifeboat and its launching system (SPHL only)
4	Calculation note of buoyancy and stability
5	General layout
6	Inspection and testing procedure
7	Drawing defined in (3)

203. Classification maintenance surveys

1. Special surveys

(1) Diving test

- (A) Special survey is to include a diving test with the diving bell/basket lowered to the rated depth.
- (B) The bell/basket is to be weighted to its maximum rated weight.
- (C) During the diving test, the bell is to be tested for gas leakage by close visual inspection at depth, function test of electrical and communication system including through-water communication at maximum depth and function test of breathing gas supply.

(2) Portable diving systems

- (A) The Owner is to inform the Society about any installation and decommissioning operations of a portable diving system.
- (B) As a rule, the diving system is to be inspected and tested in accordance to the commissioning procedures before it is put back into service.

2. Lay-up and recommissioning of diving system

- (1) When the diving system is not used for a long period, the Owner may apply for a lay-up procedure.
- (2) Requirements for diving system to maintain classification during lay-up and to be recommissioned after laid-up are to be in accordance with **Pt 1, Annex 1-17**.

Section 3 Inspection and Testing

301. General

1. Application

- (1) This section provides requirements for the initial inspection and testing of diving systems.
- (2) References are made to **IMCA D 004, IMCA D 018, IMCA D 023, IMCA D 024, IMCA D 037, IMCA D 040** for the inspection and testing.
- (3) Other recognized standard may be accepted subject to the approval of the Society.
- (4) For series-manufactured parts, test procedures other than those prescribed may be agreed with the Society provided that they are recognized as equivalent by the Society. **【See Guidance】**

302. Tests at the manufacturers works

1. Penetration

The testing protocol for penetration of cables is to be submitted to the Society. **【See Guidance】**

2. Compressor

- (1) Any part of the compressor under pressure is to be pressure tested in accordance with the **Pt 5**, unless otherwise specified.
- (2) Functional test for delivery rate and pressure are to be performed.
- (3) The outlet gas from the compressor is to be tested for pollution content according to EN 12021.

3. Gas cylinder

Gas cylinder is to be tested in accordance with **Pt 5** or the standard applied for their design and construction.

4. Flexible hose

- (1) Flexible hose is to be tested in accordance with **Pt 5, Guidance for Approval of Manufacturing Process and Type Approval, etc** or the technical standard applied for their design and construction.
- (2) The tests generally include:
 - (A) internal pressure strength test (proof test) at a minimum testing pressure equal to 1,5 times the design pressure
 - (B) bursting pressure test
 - (C) tensile test
 - (D) resistance to low and high temperature
 - (E) low temperature flexibility test
 - (F) ambient temperature flexibility test
 - (G) resistance to ozone
 - (H) resistance to external pressure
 - (I) chemical inertia
 - (J) dimensional tolerances.

When the applied standard requires an internal oil resistance test, this may be omitted when the flexible hoses carry only gas or water.
- (3) Flexible hoses intended to carry gas containing more than 25% of oxygen are to be shock tested in accordance with a recognized standard.

5. Umbilical cable

- (1) Umbilicals are to be tested in accordance with the technical standard applied for their design and construction and the manufacturer's testing program.
- (2) The Society may require to witness the manufacture of the umbilical.
- (3) Flexible hoses are to be tested in accordance with the technical standard applied for their design and construction.
- (4) The qualification tests generally include:
 - (A) bending test on a sample of umbilical, with the bending radius encountered in the normal service. No permanent strain is to be observed
 - (B) cycling load test on a sample of umbilical. To be conducted from zero to the design load. The number of cycle should be related to the category of the LARS. No permanent strain is

- to be observed
- (C) tensile breaking test on a sample of umbilical.
- (5) Flexible hoses used in umbilicals are to be tested in accordance with paragraph 4 before to be assembled in the umbilical.
- (6) After assembly in the umbilical, the following tests are to be performed:
 - (A) overpressure test at 1,5 times the maximum working pressure taking into account that:
 - (a) all flexible hoses are to be pressure tested simultaneously
 - (b) the electrical cables are to be checked for damage after testing.
 - (B) leak test at the maximum working pressure The internal cleanliness is to be verified as appropriate to the intended duty.

303. PVHO

1. The inspection and testing of the PVHO is to include:

- (1) pressure testing in accordance with 303. 2
- (2) gas leak testing in accordance with 303. 3
- (3) testing of the viewports in accordance with 303. 4
- (4) testing of the doors, hatches and medical locks
- (5) visual examination of the signs of corrosion on the shell of the PVHO and particularly the bottom part inside and outside
- (6) visual examination of the shell penetrators. All penetrators are to be marked to show their function
- (7) visual examination of the supporting structure
- (8) visual examination of the windows
- (9) visual examination of the markings
- (10) visual examination of the insulation, if any
- (11) visual examination of the doors, hatches and their locking mechanisms
- (12) visual examination of the medical lock
- (13) visual examination of the associated piping and fittings
- (14) visual examination of the valves and flow fuses. All valves are to be marked to show their function
- (15) visual examination of the connecting flanges between chambers
- (16) visual examination of the bilge drain
- (17) visual examination of the protectors on the outlet lines.

2. Pressure test

Hydraulic pressure test at 1.5 times the Maximum Allowable Working Pressure (MAWP) is to be conducted and witnessed by the Society.

3. Gas leak test

- (1) Gas leak tests are to be conducted in accordance with an agreed procedure.
- (2) Gas leak test are to be conducted at maximum working pressure for medical/equipment locks and all doors, hatches, valves, pipe work, fittings and penetrations on each compartment of the PVHO.
- (3) The maximum allowable gas leak rate is 0.25% of the PVHO volume over a period of 6 hours, calculated at constant temperature
- (4) The PVHO is to be pressurized for a minimum of 6 hours. The pressure and the temperature are to be noted on a record chart every hour or less.
- (5) All part of pressure vessel, door, window, piping, valve and fittings are to be sprayed with a snoopers leak detection liquid.
- (6) When a leak presents a risk of escalation (e.g. through a crack in a weld) it is deemed not to be acceptable.
- (7) When helium is intended to be used in the breathing gas, the gas leak test is to be conducted with a gas mixture containing 10% Helium as a minimum.

4. Viewport

Viewports are to be tested at a pressure equal to 1,25 times Maximum Allowable Working Pressure.

304. Deck decompression chambers

1. The following inspection and tests are to be conducted on the DDC, as a minimum:
 - (1) testing of the PVHO in accordance with **303**.
 - (2) testing of the breathing gas system in accordance with **306. 2**
 - (3) testing of the sanitary systems (toilets, sewage and fresh water)
 - (4) testing of the fire safety systems
 - (5) testing of the gas regeneration system (CO₂ removal)
 - (6) testing of the breathing gas reclaim system, if fitted
 - (7) testing of the environmental control unit in accordance with **306. 3**
 - (8) testing of the instrumentation
 - (9) testing of the communication
 - (10) testing of the BIBS in accordance with **306. 6**
 - (11) testing of the bilge drain system

305. Diving bell and wet bell

1. The following inspection and tests are to be conducted on the diving bell/basket as a minimum:
 - (1) weighing in air and in water
 - (2) testing of the PVHO in accordance with **303**.
 - (3) testing of the breathing gas system in accordance with **306. 2**
 - (4) testing of the ballast release system in water, when relevant
 - (5) testing of the emergency systems
 - (6) testing of the location and communication systems
 - (7) testing of the diving bell heating system
 - (8) testing of the gas regeneration system (CO₂ removal)
 - (9) testing of the diver reclaim system, if fitted
 - (10) testing of the BIBS in accordance with **306. 6**
2. The following inspection and tests are to be conducted on the wet bell/basket as a minimum:
 - (1) weighing in air and in water
 - (2) testing of the breathing gas system in accordance with Article [9]
 - (3) testing of the ballast release system in water, when relevant
 - (4) testing of the emergency systems

306. Life support system

1. Control station

The following inspection and tests are to be conducted on the control stations, as a minimum:

- (1) functional testing of the fire safety systems
- (2) switching from main to emergency power source
- (3) functional testing of the communication and CCTV systems
- (4) functional testing of the gas distribution panel
- (5) functional testing of the gas analyzers
- (6) functional testing of the alarms
- (7) verification of the markings and diagrams.

2. Breathing gas system

- (1) Testing of piping systems carrying breathing gas is to comply with **Pt 5** as applicable for piping Class 1.
- (2) An overpressure test at 1,5 times the design pressure is to be conducted on all piping systems carrying breathing gas.
- (3) A gas leak test in accordance with **303. 3** be conducted on all pressure vessels and piping carrying breathing gas.
- (4) Each supply source of breathing gas is to be tested separately.
- (5) The breathing gas supply system is to be tested during commissioning on-board for pollutant content according to EN 12021.
- (6) Breathing gas samples are to be taken at the gas cylinders, in relevant parts of the breathing gas piping, inside the chambers, at the BIBS supply line and at the gas reclaim unit.

- (7) The cleanliness of the breathing gas piping system is to comply with a recognized standard such as **ASTM G93** or an equivalent standard.
- (8) Safety features against overpressure and accidental decompression of the deck chambers (e.g. alarms, relief valves, bursting disks) are to be tested in accordance with an agreed program.

3. Environmental control unit

- (1) Testing of the ECU is to be conducted in accordance with an approved testing program.
- (2) The accuracy of heating/chilling system in the DDC is to be tested. A maximum difference of $\pm 1^{\circ}\text{C}$ between the setting value and the measured value is allowed.
- (3) The 100% redundancy of the heating/chilling and humidity system is to be tested.

4. Carbon dioxide removal system

- (1) The carbon dioxide removal systems of the DDC and the diving bell are to be tested for performance and endurance according to an agreed program.
- (2) The carbon dioxide levels are to be maintained under the partial pressure defined in **706.1 (3)**.

5. Breathing gas reclaim system

- (1) The breathing gas reclaim system is to be tested for performance and endurance according to an agreed program.
- (2) The alarms and pressure relief valve on the gas bag are to be tested.

6. Built-in breathing system (BIBS)

The BIBS in the DDC and diving bell are to be tested in accordance with an approved procedure.

7. Divers hot water unit

The divers' heating units are to be inspected and tested as per an approved procedure.

8. Sanitary systems inside deck chamber

The toilet flush is to be function tested.

307. Electrical installation

1. All electrical installations are to be tested in accordance with **Pt 6**.
2. The following inspection and tests are to be conducted on the electrical installations, as a minimum:
 - (1) functional test of each sub-system
 - (2) testing of main and emergency power supply
 - (3) insulation resistance test on every electrical circuit.

308. Launch and recovery system

1. General

- (1) In addition to the inspection and testing defined in this section, launch and recovery systems are to be surveyed in compliance with **Ch 2** as applicable.
- (2) If fitted, heave compensation systems are to be function tested in the presence of the surveyor.
- (3) The static load test is to be carried out equal to design load.

2. Umbilical cable winch

- (1) Functional testing of the winch umbilical is to be witnessed by the Society.
- (2) Pressure testing of the swivel is to be witnessed by the Society.

309. Hyperbaric rescue unit

1. General

- (1) The Hyperbaric Rescue Unit is to be inspected and tested in accordance with an agreed testing program.
- (2) The following inspection and tests are to be conducted:
 - (A) weighing in air
 - (B) testing of the evacuation procedure
 - (C) testing of the launching system

- (D) testing of the sanitary systems
 - (E) testing of the fire safety systems
 - (F) testing of the CO₂ removal system
 - (G) testing of the environmental control unit (heating / chilling)
 - (H) testing of the instrumentation
 - (I) testing of the communication system
 - (J) sea trials including propulsion, steering and towing tests, as relevant
 - (K) examination of the towing line
 - (L) examination of the markings as defined in **Sec 11**.
 - (M) inspection and testing applicable to lifeboats as per SOLAS/LSA requirements.
- (3) The launching system of the HRU is to be inspected and tested in accordance with IMCA D004.
- (4) An overload test at full outboard position is to be conducted.

310. On-board test and Commissioning

1. General

- (1) The initial testing of the complete diving system and of each sub-system are to be carried out in accordance with the commissioning procedures agreed by the Society.
- (2) The commissioning is to include at the minimum:
- (A) verification of the conformity of the installation with regard to the layout drawings and specification
 - (B) verification of the certificates of the diving system components and the marking plates
 - (C) verification of the cleanliness of the breathing gas piping in accordance with **306. 2 (7)**
 - (D) verification of the marking of the breathing gas piping in accordance with the colour code in **703. 4**
 - (E) verification of the oxygen gas storage area, piping, valves and alarms
 - (F) examination and testing of each sub-systems in accordance with the procedures listed in **310. 2**.
 - (G) final diving test as described in **310. 3**.

2. On-board test

- (1) PVHO pressure testing and gas leak testing (chamber complex, diving bell, HRU) as per **303**.
- (2) Breathing gas system testing (piping, fittings and gas cylinders) as per **306**.
- (A) pressure testing
 - (B) gas leak testing
 - (C) purity and cleanliness testing
 - (D) BIBS testing
 - (E) gas transfer system.
- (3) diving control panel and life support control panel testing as per **306. 1** and including:
- (A) gas distribution arrangement
 - (B) pressure rate
 - (C) pressure testing
 - (D) leak testing
 - (E) functional tests
 - (F) gas analyzers
 - (G) electrical, communication and video equipment.
- (4) depth gauges calibration and testing
- (5) sanitary system: toilets, sewage and fresh water
- (6) gas regeneration testing (CO₂ removal in chambers and diving bell) as per **306. 4**
- (7) environmental control unit (temperature and humidity) as per **306. 3**
- (8) gas reclaim system, if fitted, as per **306. 5**
- (9) diver heating system as per **306. 7**
- (10) launch and recovery system as per **308**.
- (11) diving bell as per **305**.
- (12) deck decompression chamber as per **304**.
- (13) hyperbaric rescue Unit as per **309**.
- (14) diving test procedure as per **310. 3**

3. Diving sea trial

- (1) The final commissioning is to include a non-manned diving test with the diving bell/basket lowered to the rated depth. **[See Guidance]**
- (2) The bell/basket is to be weighted to its maximum rated weight.
- (3) During the diving test, the bell is to be tested for:
 - (A) gas leakage by close visual inspection at depth
 - (B) function test of electrical and communication system including through-water communication at maximum depth
 - (C) function test of breathing gas supply.

Section 4 Design and Construction

401. General

1. This Section provides general requirements for the design and construction of diving systems.
2. HRU should comply with the requirements of IMO Guidelines.
3. Metallic materials are to comply with the requirements of **Pt 2** and **Pt 5** for materials and welding, unless otherwise specified.

402. General Design Requirements

1. General

- (1) As far as reasonable and practicable, a diving system should be designed to minimize human error and constructed so that the failure of any single component.
- (2) Diving systems and components thereof should be designed for the conditions under which they are certificated to operate.
- (3) Materials for diving system components should be suitable for their intended use.
- (4) All components in a diving system should be so designed, constructed and arranged as to permit easy cleaning, disinfection, inspection and maintenance.
- (5) A diving system should include the control equipment necessary for safe performance of diving operations.
- (6) The diving system should be capable of allowing the safe transfer of a person under pressure between the diving bell to the deck compression chambers.

2. General Layout

- (1) The diving system is to be so arranged as to ensure that centralized control of the safe operation of the system can be maintained under all weather conditions.
- (2) The control station is to provide control of diving operations and deck chambers, either in a unique location or in two distinct control stations with suitable means of communication.
- (3) Requirements for the arrangements of the control stations are given in **Sec 8**.
- (4) The foundations of the diving systems and their handling systems are to be strong enough to sustain the efforts arising from operating, emergency and stowage conditions.
- (5) Provision should be made to ensure that the diving system and auxiliary equipment are securely fastened to the ship or floating structure and that adjacent equipment is similarly secured. Consideration should be given to the relative movement between the components of the system. In addition, the fastening arrangements should be able to meet any required survival conditions of the ship or floating structure.
- (6) When bolts are used for load carrying connections, the bolts characteristics and the reference technical standard are to be submitted.

3. Failure Modes and Effects Analysis (FMEA)

- (1) A FMEA is to be conducted at an early stage of the project.
- (2) Reference is made to IMCA D039 – FMEA guide for diving systems, which is a recognized guidance to conduct FMEA.

4. Design conditions

- (1) Any component of the diving system is to be designed to operate under the design conditions.
- (2) Unless an hydrodynamic analysis of the diving support unit is performed to assess the maximum motions and accelerations, the rule values given **Table 9.7.1** are to be considered.
- (3) Athwartships and fore-and-aft inclinations may occur simultaneously.
- (4) Static inclination and dynamic inclination may occur independently.
- (5) Any components and systems are to be available at all condition defined in **Annex 9-5**.

Table 9.7.1 Inclined position

Install location	Angle of Inclination (°)			
	Athwartships		For-and-aft	
	Static	Dynamic	Static	Dynamic
Compression chambers and other deck installation on ships	± 15	± 22.5	± 5	± 10
Mobile offshore units	± 15	–	± 15	–
Diving bells (Closed) or diving stage	± 22.5	± 45	–	–

- (6) Unless otherwise specified, temperature and humidity conditions are given **Table 9.7.2**.

Table 9.7.2 Environmental conditions

Location	Temp (°C)	Humidity (%)	Other Condition
in chambers	5 ~ 55	100	Salty Air
outside chambers in air ^{1) 2)}	–10 ~ 55	100	
outside chambers in water	–2 ~ 32	–	Salt water containing 3.5% Salt
Control room	5 ~ 55	80	
NOTES : 1) In the case of facilities installed on the open deck, allowance is to be made for icing and temporary inundation with salt water and spray. 2) Other values may be permitted for installation in closed space			

Section 5 PVHO

501. General

1. This section provides requirements for the design and construction of Pressure Vessels for Human Occupancy (PVHO) intended for diving systems.
2. For the design and construction of PVHO are to be followed ASME-PVHO or EN13445. Other recognized standard may be accepted subject to the approval of the Society.
3. Inspections and tests are in accordance with **Sec 2**.

502. Door, hatch and locking devices

1. General

- (1) In the design of pressure vessels, including accessories such as doors, hinges, closing mechanisms and penetrators, the effects of rough handling and accidents should be considered in addition to design parameters such as pressure, temperature, vibration, operating and environmental conditions.
- (2) The design of doors and hatches is to comply with the following:
 - (A) the clear opening diameter is to be at least 600 mm
 - (B) means of opening and closing is to be operable from both sides
 - (C) reverse over pressurization of the door is not to cause catastrophic failure of the locking device
 - (D) opening is not possible if the pressure is not equal on both sides
 - (E) means for securing the door in fully open position is to be provided
 - (F) a safety interlock system is to be fitted if pressure acts to open or unseat the hatch or door. This interlock system is not to allow pressurization of the door or hatch unless it is fully engaged.

2. Locking devices

- (1) Locks should be designed to prevent accidental opening under pressure and, where necessary, interlocks should be provided for this purpose.
- (2) The interlock system should have a safety device to prohibit the opening of the clamp when a pressure above atmospheric pressure remains in the trunk or the lock and to make it impossible to obtain a gas tight seal if the interlock is not properly closed.
- (3) The locking device is to be fitted with an approved mechanical locking system.
- (4) A safety device is to prevent un-locking if the internal pressure of the hub is not balanced with respect to ambient pressure.

3. Medical locks

- (1) Pressure gauges on medical locks are to be so arranged that if the exhaust line of the medical lock is obstructed from the inside, the gauge will still indicate the correct pressure inside the lock.
- (2) The size of the medical locks are to be adapted to the size of the equipment which may be transferred.
- (3) Safety device is to be provided in accordance with the requirement **2 (2)**.

503. Piping system

1. Penetration

- (1) Hull penetrations are not to create weak points in the pressure resistant shell. Requirements from a recognized standard regarding location of openings are to be complied with.
- (2) All hull penetrators on chambers should be fitted with two shut off devices as close to the penetration as practicable. Where appropriate, one device should be a non-return valve. **[See Guidance]**
- (3) The valve of the penetrations are to be used other than screw-down valve. (ex. ball valve)
- (4) These valves are to be mounted directly on each side of the chamber shell plating or close to the chamber shell provided that the piping between the valve and the shell complies with the design standard of the PVHO.
- (5) The position of each of these valves is to be clearly visible. They are to be secured in open po-

sition for normal operation but it is to be possible to override this locking.

- (6) Where high diameter hull penetrations, likely to induce an hazardous decompression in case of breakage of the piping, are used in an external regeneration system, the internal safety isolating valves are to be replaced by a non-return for the in-coming piping, by an excess flow valve for the out-going piping (flow-fuse or flow rate sensitive valve).
- (7) Requirements for electrical penetrators are given in **Sec 8**.

2. Piping and fittings

- (1) Piping and fittings are to comply with applicable requirements of **Sec 7**.
- (2) Any open ended exhaust pipe work is to be fitted with guards for finger protection, including those located in transfer trunkings and medical locks. The design of the guards should minimise the risk of injury the divers using the trunk.
- (3) The use of flow-fuse or flow rate sensitive valve is to be considered to limit the exhaust rate.
- (4) Any gas inlet pipe work are to be fitted with some form of diffuser inside the PVHO, except those located in transfer trunkings.
- (5) Pipe systems should be so designed as to minimize the noise inside the diving bell and the deck decompression chambers during normal operation.

3. Pressure relief valves

- (1) All PVHO are to be fitted with a pressure relief valve rated to the design pressure. As an alternative, overpressure alarm may be provided as allowed by (2).
- (2) All deck decompression chambers and diving bells which may be pressurized separately should be fitted with overpressure alarms or pressure relief valves.
- (3) If pressure relief valves are fitted, a quick-operating manual shut off valve should be installed between the chamber and the pressure relief valve and should be wired opened with a frangible wire. This valve should be readily accessible to the attendant monitoring the operation of the chamber. All other pressure vessels and bottles should be fitted with a pressure relief device.

504. Viewports

1. General

- (1) Viewports are to be designed and constructed in accordance with ASME PVHO-1.
- (2) The term viewport means both the window and its sealing.
- (3) The certification process of the viewports includes:
 - (A) design review
 - (B) fabrication procedure
 - (C) material certification
 - (D) material testing
 - (E) pressure testing.(The pressure test may be done with the viewport installed on the chamber.)
- (4) Operating limitations
The viewports are subject to the following operating limitations:
 - (A) Maximum pressure ratio for acrylic plastic viewports(or windows) : 10 bar/sec
 - (B) the number of pressure cycles is not to exceed 10,000 or the total duration is not to exceed 40,000 hours
 - (C) the minimum design temperature is -18°C and the maximum design temperature is +66°C.
- (5) The design life of the viewports is not to exceed 10 years from the date of fabrication unless otherwise allowed in accordance with ASME PVHO-1 Safety standard for pressure vessels for human occupancy.

2. Marking

- (1) The marking of viewports is to give the following indications (units used are to be specified):
 - (A) design pressure
 - (B) maximum and minimum operating temperatures
 - (C) referenced certification standard
 - (D) name or symbol of the certification body
 - (E) serial number or equivalent
 - (F) year and month of fabrication.
- (2) The marking is to be performed by means of a stencil in a legible and indelible way, preferably on the edge of the viewport and in accordance with ASME PVHO-1. The marking is not to cause any damage to the viewport which may cause a crack propagation.

- (3) If the serial number or other identifying mark for each viewport is not visible when fitted in situ then it is to be prominently marked on the outside of the chamber adjacent to each viewport.

505. Material and Fabrication

1. The referenced standard is to be complied with regarding:

- (1) material
- (2) structural scantling
- (3) welders qualification
- (4) welding procedure and testing
- (5) testing
- (6) marking.

2. Material

- (1) The construction of the PVHO is to be such as to minimize hazard of smoke and fire. Systems shall be designed and equipped to avoid sources of ignition and minimize flammable materials. Toxicity of combustion products and flame-spread characteristics shall be considered in material selection.
- (2) All the materials used in the inner spaces and likely to be in contact with the atmosphere, such as coating, adhesives and lubricants are to be selected in order not to give off toxic, irritant or disagreeable gases or which may become so after passing through the regeneration system.

3. Fabrication

The welds are to be tested according to the standard applied for the design and construction of the PVHO.

Section 6 Deck Decompression Chambers and divers transfer system

601. General

1. This Section provides the requirements for the design and fabrication of Deck Decompression Chambers (DDC), closed diving bell and divers transfer system.
2. Inspections and tests are in accordance with **Sec 3**.
3. The pressure vessel forming the deck chamber should be designed as a pressure vessel for human occupancy according to **Sec 5**.
4. The requirements given in this Section are additional to the requirements given in relevant section.

602. Deck decompression chambers

1. General

- (1) There is to be one bunk for each intended occupant. Each bunk should be well designed and firmly supported. They should also be wide and long enough to allow a normal person to lie in comfort.
- (2) A diving system should, as a minimum, include either one deck decompression chamber with two separate compartments, or two interconnected separate chambers so designed as to permit ingress or egress of personnel while one compartment or chamber remains pressurized. All doors should be designed so that locking mechanisms, if provided, can be operated from both sides.
- (3) Where a deck decompression chamber is to be used in circumstances in which a person is intended to remain under pressure for a continuous period of more than 12 hours, it should be so arranged as to allow most divers to stand upright and to stretch out comfortably on their bunks. The smaller of the two compartments should be large enough for at least two persons. One of these compartments should be a living compartment. Deck decompression chamber used for saturation diving are to have a minimum diameter of 1800 mm.
- (4) A deck decompression chamber should provide a suitable environment and facilities for the persons who use it, having regard to the type and duration of the diving operation. Where the

chamber is intended to be occupied for more than 12 hours, toilet and sanitary facilities should also be provided. Toilet facilities capable of discharging the waste to the outside should be fitted with suitable interlocks and safety devices.

- (5) Deck decompression chambers in surface diving are to comply with general provisions regarding deck chambers. Their conditions of use are as follow:
 - (A) the filling gas is compressed air or mixed gas
 - (B) the regeneration of the hyperbaric atmosphere is performed by ventilation
 - (C) built-in Breathing Systems (BIBS) are available for breathing over oxygenated mixes and pure oxygen
 - (D) an oxygen analyzer is to be available
 - (E) if the chamber is not installed in a temperate room, it is to be fitted with a thermal protection and environmental control unit, as relevant.
- (6) The supporting structure of the DDC is to be designed to withstand the motions and accelerations of the supporting unit as defined in **402. 4** and the loading conditions due to internal load.
- (7) The volume of the deck chamber is to be accurately known to allow gas calculations to be carried out.

2. Medical lock

Each pressure compartment should have medical lock as defined **502. 3**.

3. Viewports

Each pressure compartment should have viewports to allow observation of all occupants from the outside.

4. Protection against overpressure

- (1) Penetrations for safety valves shall be provided with shut-off valves on both sides of the shell plating. These shut off valves shall be sealed in the open position.
- (2) Visual and audible overpressure alarm alerting the operators at the control station shall be provided.

5. Transfer under pressure and Mating device

- (1) Saturation and bounce diving systems should be capable of allowing the safe transfer of a person under pressure from the diving bell to the deck decompression chamber (and vice versa).
- (2) When the transfer is vertical (bell coming above the deck chamber) a safety device is to be fitted to retain the door that may fall onto the personnel.
- (3) For saturation and bounce diving systems where a power actuating system is used for mating operations, an auxiliary power actuating system or an appropriate means should be provided to connect a diving bell to the deck decompression chambers, in the event of failure of the normal power actuating system.
- (4) Safety device for mating device or mating clamp is to be provided in accordance with the requirement **502. 2 (2)**.
- (5) A display of the internal pressure of the hub is to be available at the control station of the opening.

6. Gas analysis

- (1) Gas analyzers are to be provided in deck decompression chambers.
- (2) Gas piping used for analysis purpose is to be kept to the minimum diameter.

7. Control system

- (1) The deck decompression chambers are to be equipped with gauges and other fittings necessary to indicate and control the internal pressures of each compartment from outside the deck chambers and inside each compartment.
- (2) Deck decompression chambers should be equipped with such valves, gauges and other fittings as necessary to control and indicate the internal pressure and safe environment of each compartment from outside the chamber at a centralized position.
- (3) A secondary system is to be available for controlling the internal environment of the chamber.

8. Temperature and humidity control, Carbon dioxide removal and Breathing gas reclaim

- (1) Regeneration system used for the removal of the carbon dioxide is to comply with **706. 1**.

- (2) A secondary system is to be available for removing the carbon dioxide.
- (3) Temperature and humidity control units are to comply with **708**.
- (4) A secondary system is to be available for temperature and humidity control inside the deck chamber.
- (5) The breathing gas reclaim system, when fitted, is to comply with the requirements of **706. 2**.

9. BIBS

- (1) BIBS are to comply with requirements defined in **705**.
- (2) In each compartment of the chamber there is to be at least one BIBS (Built-in Breathing System) connection and mask for each intended occupant plus one spare.

10. Sanitary Equipment

- (1) The sanitary equipment is to comply with **707**.
- (2) Deck decompression chambers used for saturation diving are to be provided with a sanitary room accessible by each diver in saturation.
- (3) The toilet bowl is to be designed in order not to be sealed when a person is seated on it.
- (4) Flush type toilet are to be fitted with sufficient interlocks to stop it being flushed while occupied.
- (5) Hot and cold potable water are to be provided in each sanitary room with washing facilities including shower.
- (6) An hyperbaric toilet is to be provided in each sanitary room.

11. Electrical installations and control systems

The electrical installations and control systems are to comply with the requirements of **Sec 8**.

12. Fire safety

Fire safety requirements inside the hyperbaric chambers are given in **Sec 9**.

603. Closed Diving Bell

1. General

- (1) The diving bell should be provided with adequate protection against mechanical damage during handling operation.
- (2) The diving bell should be equipped with means whereby each diver using the bell is able to enter and leave it safely as well as with means for taking an unconscious diver up into a dry bell.
- (3) The diving bell should provide a suitable environment and facilities for the persons who use it, having regard to the type and duration of the diving operation.
- (4) Diving bells should be so designed as to provide adequate space for the number of occupants envisaged, together with the equipment.
- (5) A seat with safety belt is to be available for each occupant.
- (6) Diving bells should have a volume of at least 1.5 m³ per diver.
- (7) Volume of the bell is to be accurately known to allow breathing gas and stability calculations to be carried out.
- (8) The diving bell is normally designed in order to have a resistance against external pressure at least equal to the one against internal operating pressure. If not, restrictive operational conditions are to be taken into account.
- (9) The diving bell should be fitted with a manifold at a suitable point close to the main lifting attachment which should include connections for the following services:
 - (A) ¾ inch NPT (female) – for hot water
 - (B) ½ inch NPT (female) – for breathing mixture.The manifold should be clearly marked and suitably protected.
- (10) The duration of working of all survival means embarked is to be at least 24 hours. The survival means should include at least: **[See Guidance]**
 - (A) reserves of breathing gas
 - (B) beverage
 - (C) food
 - (D) breathing gas regeneration means
 - (E) thermal protection
 - (F) lighting

- (G) emergency communications
 - (H) ultra-sonic pinger
 - (I) visual beacon.
- This assessment is to be carried out at the maximum immersion, in fully disconnected situation.
- (11) Locations are to be provided for the storage of the following safety equipment:
 - (A) emergency breathing equipment
 - (B) first aid kit
 - (C) sanitary bags
 - (D) reserve food and beverage
 - (E) appropriate thermal protection means
 - (F) adequate repair tools
 - (G) checks, instructions and safety procedures lists
 - (H) reserves of products for regeneration (soda lime/sorb)
 - (I) emergency lighting.
 - (12) When means to control the water level inside the bell are fitted, it is to automatically limit the upper level in order to protect the equipment which may be damaged when immersed. The valve actuating the water level is to be accessible to a diver inside the access hub.
 - (13) Means are to be provided to empty a tilted bell partially filled with water.

2. Viewports

- (1) Each diving bell should have view ports that as far as practicable allow an occupant to observe divers outside the bell.
- (2) At least one viewport is to allow internal/external vision. Viewports are to be protected from mechanical damages and excessive heat.

3. Access doors

- (1) Diving bell doors should be so designed as to prevent accidental opening during normal operations. All doors should be so designed that locking mechanisms, if provided, can be operated from both sides.
- (2) Where doors are not autoclave, these may be operated from both sides, a safety device is to prevent un-locking if the pressure of both sides is not balanced.
- (3) The handling of doors of vertical accesses is to be assisted.
- (4) A safety device is to be fitted to allow the coming-in going-out of the divers even if the bell is standing on the seabed.
- (5) The lower opening devoted to the going-out of divers should have a minimum passing through diameter of 800 mm.
- (6) The lower outer hatch may be closed from the inside of the bell.

4. Protection against overpressure

Means are to be provided to avoid over-pressurization of the diving bell. This may be a relief valve or an overpressure alarm.

5. Mating system

- (1) Mating devices should enable easy and firm connection or disconnection of a diving bell to a deck decompression chamber, even under conditions where the supporting unit is rolling, pitching or listing to predetermined degrees.
- (2) For saturation and bounce diving systems where a power actuating system is used for mating operations, an auxiliary power actuating system or an appropriate means should be provided to connect a diving bell to the deck decompression chambers, in the event of failure of the normal power actuating system.
- (3) Safety device for mating device or mating clamp is to be provided in accordance with the requirement 502. 2 (2).

6. Medical lock

Each pressure compartment should have medical lock as defined 502. 3.

7. Breathing gas system

- (1) There is to be a means by which the divers in the bell can analyze the atmosphere for O₂ and CO₂ independent of the surface.
- (2) Consideration should be given to providing a means of monitoring the bell atmosphere for hy-

drocarbons and H₂S.

- (3) There is to be a powered scrubber unit to provide primary CO₂ removal from the atmosphere.
- (4) Each diver's gas supply is to be arranged so that if one line fails then this does not interfere with the gas supply to another diver.
- (5) There should be an alarm fitted to alert the bellman if the diver(s) supply switches over to the on-board gas.
- (6) The externally carried oxygen supply is to be fitted with a means whereby it is regulated to a low pressure before it enters the bell. High pressure oxygen is not to be available inside the bell.
- (7) The oxygen coming into the bell is to be fitted with a system which limits either the rate of flow or the volume which can enter in order to minimize the risk of excess O₂ building up in the bell.

8. Gas reserve

- (1) The diving bell should be designed with a self-contained breathing gas system capable of maintaining a satisfactory concentration of breathing gas for the occupants for a period of at least 24 hours at its maximum operating depth.
- (2) The reserves of breathing gas outside the bell are to be sufficient:
 - (A) to empty the bell filled with 50% of water at the maximum operating depth, or
 - (B) to support each working diver plus the bellman outside the bell for a minimum of 30 minutes at a breathing rate of 40 liters/minute at the maximum depth of the diving operation.
- (3) The pressure of all on-board gases are to be reduced to a maximum of 30 bar over ambient pressure before it enters the bell interior.
- (4) Sufficient oxygen is to be available for metabolic consumption by the maximum number of divers at 0.5 liters/minute per diver for at least 24 hours at the end of a bell run.

9. BIBS

- (1) BIBS are to comply with requirements defined in **705**.
- (2) An oral/nasal or full face BIBS mask is to be supplied for each occupant of the bell. This should be capable of providing breathing gas either from the surface or from the on-board cylinders

10. Piping, valves, fitting and hoses

- (1) Piping bringing fluids in the bell are to be fitted inside with isolating valves and outside with non-return valves.
- (2) Wall penetrations devoted to the passage of hot sea water are to be protected against corrosion.
- (3) Internal compression and decompression controls are to be made by means of "dead man" safety valves which close when the handle is released.
- (4) The system of injection of pure oxygen is to be such that an unintentional addition may not induce an unacceptable rise of the partial pressure of oxygen.
- (5) The piping of the safety valve is to be fitted, inside with an isolating valve sealed in open position.
- (6) Valves are to be free of corrosion and should move freely through their full range of operation.
- (7) Any open ended exhaust pipe work is to be fitted with guards to prevent suction hazard.
- (8) Any gas inlet pipe work should be fitted with some form of diffuser.
- (9) There should be a valve fitted to allow partial flooding of the bell by the bellman. This should be in an easily accessible position and clearly visible. This valve should be in addition to the internal hull stop valve.

11. Instrumentation

- (1) General requirements regarding life support instrumentation are given in **Sec 7**.
- (2) Valves, gauges and other fittings should be provided outside the bell as necessary to control and indicate the pressure and safe environment within the diving bell. The external pressure on the diving bell should also be indicated inside the bell.
- (3) Gauges are to be provided inside the bell to let the divers know both the internal and external pressure.
- (4) The relative pressure of gas supplies (normal and emergency) may be read inside the bell.
- (5) The temperature (and possibly the flow rate) of hot water devoted to the heating of the diver may be read inside the bell.

12. Umbilical cable

- (1) Diving bells are to be provided with a main supply umbilical for supplying breathing gases, hot

water, electrical power, communication, etc., to the bell.

- (2) Umbilicals are to be securely attached to the bell by means of a strength member or strain relief fitting so that the individual connections are not subjected to loads.

13. Temperature and humidity control, Carbon dioxide removal and Breathing gas reclaim

- (1) Regeneration system used for the removal of the carbon dioxide is to comply with **706. 1**.
- (2) A secondary system is to be available for removing the carbon dioxide.
- (3) Temperature and humidity control units are to comply with **708**.
- (4) As required in **603. 1**, there should be means to maintain the divers within the diving bell in thermal balance in an emergency for at least 24 hours. Such requirements may be satisfied by use of passive means carried in the bell.
- (5) The breathing gas reclaim system, when fitted, is to comply with the requirements of **706. 2**.

14. Electrical installations and Communication

- (1) The electrical installations and control systems are to comply with the requirements of **Sec 8**.
- (2) An autonomous flashing light located on the emerged part of the diving bell when floating at the surface is to be provided.
- (3) Sufficient internal lighting are to be provided to allow valves and controls to be operated safely.
- (4) The diving bell is to be equipped with an emergency locating device with a frequency of 37.5 kHz designed to enable personnel on the surface to establish and maintain contact with the submerged diving bell if the umbilical to surface is served. The locating equipment must conform to the relevant requirements of the **IMO Res. A.831(19)**.

15. Structure

- (1) The structure of the diving bell is to be checked against lifting loads.
- (2) The lifting rope attachment to the diving device is to be a properly designed lifting padeye.
- (3) The diving bell should be equipped with one extra lifting point designed to take the entire dry weight of the bell including ballast and equipment as well as the weight of the divers staying on in the bell.
- (4) There should be a secondary attachment point on the diving bell if the main one is damaged. This secondary point should also be a properly designed pad eye or similar (it may be a second hole in the same pad eye).
- (5) The connection of the lifting rope to the padeye is to have two retaining means for the removable pin (eg: nut locked with a split pin).

16. Emergency recovery means

- (1) In the event of single component failure of the main handling system, an alternative means should be provided whereby the bell can be returned to the deck decompression chamber.
- (2) In addition, provisions should be made for emergency retrieval of the bell if the main and alternative means fail. If this involves buoyant ascent, the bell should have sufficient stability to maintain a substantially upright position and means should be provided to prevent accidental release of the ballast weights.
- (3) Provisions are to be taken in order that it will be possible to release suspension ropes, guide ropes and umbilical from the inside of the bell. These systems are to be actuated through two voluntary actions from the personnel and are to be efficiently protected against undue actions. One of these systems is to be of mechanical type, for each release system.
- (4) A ballast release system may be fitted and designated for use as an emergency recovery means.
- (5) The release of the ballast weight is to work in a safe way in the most unfavorable attitudes specified for the bell.
- (6) At least, one mechanical system is to be fitted. This release system may be actuated through two voluntary actions from the personnel and is to be efficiently protected from undue actuation.
- (7) If the release mechanism is operated by means of pressurization (gas or hydraulic) then isolations need to be in place such that they cannot be activated accidentally by external water pressure or internal gas pressure.
- (8) The ballast weights are not to be capable of being shed accidentally, for example if the bell is inadvertently tilted.
- (9) If the system uses only one weight then there is to be no single component whose failure could cause the weight to become detached. This requirement does not apply if there are two or more weights operating independently.

- (10) The amount of positive buoyancy is to be carefully considered in case of ballast release in order that the bell is not moving up too fast.
- (11) When buoyant ascent of the diving bell may be used as an emergency means of recovery, the bell ability to remain in upright position is to be checked.

604. Wet bell and diving basket

1. General

- (1) Arrangements are to be in place to recover an injured or unconscious diver from the water to the deck.
- (2) Wet bells /diver baskets should be designed for the carriage of at least two divers, including their equipment. The bells are to have suitable dimensions to carry the divers in an uncramped position.
- (3) Wet bells /diver baskets are to be provided with internal handholds to support the divers.
- (4) Each wet bell/ diving basket is to be provided with a handling system to ensure safe transportation between the subsea work location and the surface. Handling systems for wet bell/diving baskets are to meet the applicable requirements of **Sec 10**.
- (5) There is to be a main lift point to attach the lift wire to the wet bell / diving basket. This can be a padeye, a shackle point or a captive ring. There is to be a suitable place to attach a secondary lift wire if the main lift point fails (the secondary lift does not need to be fitted).

2. Diving basket

- (1) Diving baskets are to be fitted with a gate or chain to prevent divers from falling out.
- (2) Diving baskets are to be fitted with protection at the top to prevent injury to the divers from dropped objects.
- (3) There is to be at least one emergency air cylinder fitted in the basket, fitted with a content gauge and a first stage regulator.
- (4) An individual diving equipment is to be provided including SCUBA mouthpiece and valved flexible hose connection for air supply.

3. Wet Bell

- (1) Wet bells are to be provided with an enclosed upper section that provides an envelope capable of maintaining a bubble of breathing gases for the divers.
- (2) Wet bells are to be fitted with a gate or chain to prevent divers from falling out.
- (3) The wet bell is to be fitted with masks for each diver plus one spare.
- (4) The wet-bell is to be fitted with an exhaust system operated by a spring-loaded valve that closes when the valve handle is released.
- (5) In addition to the main umbilical supply, wet bells are to be provided with emergency supplies of breathing gas sufficient to supply the divers at nominal diving depth for a period covering the recovery of the divers including decompression (minimum two hours) and with an emergency breathing mask for each diver.
- (6) There is to be at least two emergency air cylinder fitted in the wet bell, fitted with a content gauge and a first stage regulator.
- (7) An individual diving equipment is to be provided including SCUBA mouthpiece and valved flexible hose connection for air supply.
- (8) Wet bells are to be provided with a main supply umbilical for supplying breathing gases, hot water, electrical power, communication, etc., to the bell. The umbilical is to be securely attached to the bell by means of a strength member or strain relief fitting so that the individual connections are not subjected to loads.
- (9) The wet bell is to be provided with a depth gauge.
- (10) Main and emergency lighting are to be provided to allow the divers to see and operate all controls.
- (11) A visual monitoring of the wet bell and the operating site by video system is recommended.
- (12) An emergency communication system is to be fitted on the wet bell to communicate with the surface.

605. Rescue chambers (transportable)

1. General

- (1) This article is to be applicable to transportable rescue chambers.
- (2) Pressure vessels for human occupancy are to comply with the requirements specified **Sec 4**.

2. PVHO

- (1) In addition to the diver the transport chamber shall be capable of accommodating an accompanying person.
- (2) The main chamber shall be provided with a supply lock. The dimensions of the supply lock shall not be less than 200 mm in diameter and 300 mm in length. The means of closure of the supply lock shall be interlocked in such a way that they cannot be opened simultaneously. Pressure equalizing apertures shall be safeguarded to prevent them from being rendered ineffective by obstructions. The pressure in the supply lock shall be indicated by a pressure gauge or a suitable device mounted externally at the lock controls.
- (3) All open penetrations for gas, measurements and analysis shall be protected by replaceable filters mounted on the inside of the pressure chamber.
- (4) It shall be possible to lodge the diver in the transportable chamber securely enough to prevent injury due to motions during transfer. Suitable holding devices respectively belts shall be provided.
- (5) Transportable chambers shall have an inside length of at least 2.0 m and shall have an access port with a clear diameter of at least 0.5 m.
- (6) Transportable chambers shall regarding their total weight and dimensions be designed such that they can be carried or moved otherwise by helpers over short distances and loaded onto a transport vehicle without the assistance of a crane.
- (7) Transportable chambers shall be equipped with lifting handles, at least two fastening eyes and the necessary hoisting sling.
- (8) Transportable chambers shall be fitted with observation windows giving a good view to the head of the occupant in the chamber.

3. Mating system and medical lock

- (1) Transportable chambers shall be fitted with a bayonet flange connection as per EN 14931 (NATO flange) to enable them to be coupled to a treatment chamber. It shall be secured that the bayonet flange connection cannot get under impermissible overpressure.
- (2) The design has to ensure that, for operation according to instructions; the means of closure of the transportable chamber can only be opened until the closure is subjected to the same pressure from inside and outside.
- (3) The main chamber shall be provided with a medical lock. The dimensions of the medical lock shall not be less than 200 mm in diameter and 300 mm in length. The size of the medical lock may smaller and shall be agreed with the Society.

4. Piping

- (1) Chambers are to be equipped with a suitable safety device which automatically prevents the maximum permissible working pressure from being exceeded by more than 10 %. In addition, diver pressure chambers are to be equipped with a reliable safeguard against any inadmissible pressure drop.
- (2) Safety valves are to be so designed that they respond only when the maximum permissible working pressure has been exceeded and close before the pressure drops below this level. Safety valves are to be mounted in such a way that they are protected from mechanical damage and accidental operation. The connection of safety valves on diver pressure chamber are to be so designed that they cannot be sealed off unintentionally. **[See Guidance]**
- (3) Instead of the pressure relief device, equipment may be fitted which automatically interrupts the pressure supply when the maximum permissible working pressure is exceeded and simultaneously trips a visual and audible alarm. The alarm signal shall be such that it is at all times clearly perceptible to the operating personnel.
- (4) Each pressurized gas supply and exhaust line shall at least be fitted with a shut-off valve immediately at the pressure chamber wall. This shut-off valve may be dispensed if the connection to the first valve is short and well protected.

5. Breathing gas supply

- (1) Diver pressure chambers shall be so designed that a working pressure of at least 5 bar can be reached and maintained without fail. Provision shall be made for raising the working pressure from 0 bar to 5 bar within 6 minutes. A pressure reduction from 0.4 bar to 0.2 bar shall be possible within one minute.
- (2) Transportable chambers shall be equipped with compressed air containers with at least 8000 litres (at atmospheric pressure) air supply. This supply of air is intended for the sole purpose of flushing the atmosphere in the event of an interruption of the normal air supply. Adequate flushing of the atmosphere means 25 litres per minute and person measured at the maximum pressure in the chamber.
- (3) A flow of flushing air of at least 25 L/min and person (measured at the chamber pressure) shall be secured at each pressure stage.
- (4) Each person to be accommodated shall be provided in the main chamber with a source of oxygen supplying at least 75 L/min at atmospheric pressure. The oxygen shall be supplied to the breathing connection via a demand breathing system at the pressure prevailing in the chamber. The exhaled gas shall not be introduced in the chamber atmosphere.

6. Electrical equipment and communication

- (1) The electrical installations and communication are to comply with the requirements of **Sec 8**.
- (2) A communication system with loudspeakers shall be provided between the inside of the transportation chamber and the outside controls. On the outside, the system shall be permanently switched to "receive", and reversal of the direction of communication shall only be possible by the operation of a self-resetting switch mounted on the outside. On the outside the communication system is also to be equipped with a head-set.

7. Control system and Instrumentation

- (1) Transportable chambers shall be equipped with at least the following controls and monitoring instruments:
 - (A) air inlet valve
 - (B) exhaust air valve
 - (C) flushing air valve
 - (D) pressure gauge (class 0.25) for chamber pressure
 - (E) pressure-reducing valve, with inlet and outlet pressure gauge, to which the compressed air containers called for in **5 (1)** are connected
 - (F) an additional means of connection, with shut-off device, comprising a suitable high-pressure hose at least 1.5 m in length for connecting the operational compressed air supply to the pressure-reducing valve
 - (G) measuring instrument for monitoring of the oxygen volume concentration or partial pressure.
- (2) When the transportable chamber is connected to the pressure chamber, the controls and indicating instruments shall be capable of being operated or observed. They shall be located close to a window in the vessel in such a way that the operating personnel can observe the persons in the transportable chamber without changing position.

Section 7 Life Support System

701. General

1. This Section provides requirements for the design and construction of the life support system intended for diving systems.
2. The life support system includes the following functions and installations:
 - (1) breathing gas storage, mixture and distribution
 - (2) oxygen installations
 - (3) breathing gas analysis
 - (4) breathing gas regeneration
 - (5) pressure control
 - (6) temperature and humidity control
 - (7) fresh water installations
 - (8) sewage installations
 - (9) umbilicals from surface to diving bell
 - (10) gas cylinders
 - (11) piping, valves and fittings
 - (12) filters and compressors.
3. Inspection and test requirements are provided in **Sec 3**.
4. When relevant, the machinery and piping systems are to comply with the requirements of **Pt 5**, in addition to this Section.

702. Breathing gas supply

1. General

- (1) Each deck decompression chamber and diving bell should be fitted with adequate equipment for supplying and maintaining the appropriate breathing mixtures to its occupants at all depths down to maximum operating depth. When adding pure oxygen to the chamber, a separate piping system should be provided.
- (2) Piping systems containing gases with more than 25% oxygen should be treated as systems containing pure oxygen. Such piping systems are to comply with **710**, in addition to the present Article.
- (3) Any diving bell or deck chamber is to be supplied with two independent sources of breathing gas.
- (4) When automatic, the commutation from one gas source to the other is to trigger an alarm.
- (5) On PVHO designed for operation in a continuous ventilation mode, means of indicating the rate of flow of ventilation gas are to be provided.
- (6) The distribution is to be so arranged as to allow isolation of any filter, regulator and valve without interrupting gas supply.
- (7) Inlet end inside the chambers Exhaust lines should be fitted with an anti-suction device on the inlet side. Anti-suction devices in deck chambers are to comply with requirements defined in **503. 2**.
- (8) Gases vented from the diving system should be vented to the open air away from sources of ignition, personnel or any area where the presence of those gases could be hazardous.
- (9) Every breathing gas piping system is to be provided with means for manually reducing the pressure.
- (10) Minimum rate of gas supply is to be ensured in order to compensate for any leak.
- (11) Decompression rate of the deck chamber is to be in accordance with specified decompression tables (e.g. US NAVY diving tables).

2. Protection against overpressure

- (1) Piping systems which may be subjected to a higher pressure than designed for should be fitted with a pressure relief device.
- (2) The flow rates of the safety valves or the discharge valves fitted to pumps and compressors are to be determined so that the pressures in these units are not exceeding by more than 10% the design pressure when operating with the discharge shut.

3. Gas mixing equipment

- (1) Efficient ventilation of the breathing mixture is to be provided for in order to obtain a proper homogeneity of the breatheable mixture.
- (2) The oxygen content at the gas mixing equipment location is to be measured in compliance with 704. 3 (6).
- (3) In case of oxygen content failing to comply with the tolerances set, the gas supply is to be switched to a secondary source. This should be documented in the FMEA of the diving system.

703. Breathing gas storage

1. Location

Breathing gas storage and associated equipment should not be located in a machinery space not associated with the diving system.

2. Gas storage capacity

- (1) It shall be ensured that there are enough spaces to store permanent or portable gas containers and the capacity of gas storage containers is enough to store breathing gas to supply to divers at maximum operating depth for both normal and emergency modes. **【See Guidance】**
- (2) As a minimum, the gas storage capacity should be sufficient to pressurize twice all the deck chambers and the HRU to the maximum rated pressure.

3. Protection against overpressure

- (1) Pressure vessels and gas cylinders are to be fitted with relief valves and shut-off valves.
- (2) Any relief valves or bursting discs should be piped to dump overboard and not in to the enclosed space.

4. Marking

For piping systems and gas storage bottles/pressure vessels, the colour codes defined in Tab 1 are to be used. In addition, each bottle/pressure vessel is to be marked with the name and symbol of the gases it contains. The marking and colour coding of the gas storage bottles is to be visible from the valve end.

Table 9.7.4 Marking of gas system

Gas	Chemical symbol	Colour
Oxygen	O ₂	white
Nitrogen	N ₂	gray
Air	–	black
Helium	He	brown
Oxygen/Helium gas mixture	O ₂ /He	white and brown

704. Control of pollutants

1. General

- (1) The breathing gas delivered from compressors has to meet the requirements of EN 12021 Respiratory protective devices – Compressed air for breathing apparatus, or an equivalent standard.
- (2) Deck decompression chambers should be equipped with such valves, gauges and other fittings as necessary to control and indicate the internal pressure and safe environment of each compartment from outside the chamber at a centralized position. (See Table 9.7.5)

Table 9.7.5 Operating parameters to be monitored

Parameter	Compression chamber compartment	Diving bell
Pressure or depth ⁽¹⁾	O	O ⁽²⁾
Temperature ⁽¹⁾	O	
Humidity	O	
Oxygen partial pressure ⁽¹⁾	O	O
CO ₂ partial pressure	O	O
(Note)		
(1) These parameters are to be displayed continuously		
(2) The pressure or depth inside and outside the diving bell are to be indicated		

2. Pressure gauge

- (1) Pressure gauges are to comply with a recognized standard.
- (2) The scale of gauges used for depth indication or pressure in the deck chambers are to be appropriate to the duty and large enough to be read easily and accurately. Pressure gauges are to normally operate in the range 25 to 75% of full scale deflection and in the 0 to 25% range if used for decompression. If used for the final stages of decompression they are to have scale divisions of no more than 0.5msw. When pressure gauges are digital, reading is to be displayed with one decimal point.
- (3) All pressure gauges are to have the same unit marking system (metric or imperial or both).

3. Breathing gas analysis

- (1) The composition, pressure and temperature of the breathing mixture, especially where dangerous gases are likely to be emitted, are to be subject of the utmost attention.
- (2) Suitable devices are to be provided to analyze the following content in the breathing gas:
 - (A) oxygen content
 - (B) carbon dioxide content
 - (C) content of each dangerous gas likely to occur (eg: carbon monoxide)
 - (D) An appropriate sensor, in the diving bells which contain batteries, and in working enclosures where explosive mixtures (hydrogen and hydrocarbons) are likely to originate.
- (3) The following oxygen analyzers are to be provided:
 - (A) 1 analyzer in the diving bell
 - (B) 2 analyzers in each compartment of the deck decompression chamber
 - (C) 1 analyzer on each gas distribution panel
 - (D) 1 analyzer in the gas supply panel
 - (E) 1 analyzer directly at the output of the gas reclaim system.
- (4) The oxygen analyzer for the oxygen partial pressure (PPO₂) is to have an accuracy of ± 0.015 bar of partial pressure (PPO₂) of O₂ or $\pm 1\%$ in concentration of O₂ at atmospheric pressure.
- (5) In case of long missions (exceeding 24 hours), a calibration system of the checking devices by means of known and stables mixtures or a device of equivalent reliability is to be provided.
- (6) Oxygen analyzers are to comply with a recognized standard (EU directive on marine equipment).
- (7) The analyzer for the carbon dioxide partial pressure (PPCO₂) is to have an accuracy of ± 0.001 bar of CO₂ partial pressure.
- (8) Carbon dioxide gas is to be provided for calibration purpose.

705. BIBS

1. General

- (1) In addition to the main breathing gas system, each deck decompression chamber and diving bell should contain a separately controlled built-in breathing system (BIBS) for oxygen, therapeutic gas or bottom mix gas. Means are to be provided to prevent any dangerous accumulation of gases.
- (2) BIBS are to be overboard dump type with exhausts piped outside the PVHO and also outside the compartment containing the PVHO.

706. CO₂ Scrubber and Breathing gas reclaim system

1. CO₂ Scrubber

- (1) Closed diving bell and each compartment of the deck chambers are to be provided with carbon dioxide (CO₂) removal systems.
- (2) CO₂ scrubber is to be redundant for each separately pressurized PVHO.
- (3) CO₂ removal systems are to have the capacity to maintain a CO₂ partial pressure of less than 0,005 bar in the DDC and less than 0,02 bar in the diving bell, taking into account a production rate of 59 grammes per occupant per hour (or 30 litres/hour/occupant at standard temperature and pressure).

2. Breathing gas reclaim system

- (1) A reclaim system may be fitted in order to recover the breathing gas from divers and/or deck chambers.
- (2) When fitted, gas reclaim systems are to be designed to reduce the content of bacteria and contaminants in the reclaimed gas below the maximum allowable.
- (3) When used, gas bag are to be fitted with an overpressure protection device.

707. Sanitary installations

1. General

- (1) Sanitary installations are to be provided in deck decompression chambers intended to be occupied for more than 12 hours.
 - (A) When the DDC is intended to be occupied for less than 24 hours, hand washing facilities and handling sanitary waste are to be provided.
 - (B) When the DDC is intended to be occupied for more than 24 hours, the flushing toilet, shower, hand-washing sink and external holding tank is to be provided.

2. Fresh water

The fresh water system includes the means for pressurizing and heating the fresh water to be delivered to the deck chamber.

3. The sanitary and sewage installations

- (1) The sanitary and sewage installations are to comply with ASME PVHO-1 or an equivalent standard.
- (2) The toilet arrangement is to prevent flushing while somebody is sitting on the toilet.

708. Temperature and humidity control

1. General

- (1) The diving system should include adequate plant and equipment to maintain the divers in safe thermal balance during normal operations.
- (2) For saturation diving systems, the heating and cooling systems are to be 100% redundant in case of power failure.

2. Deck decompression chambers

- (1) There is to be suitable means to provide heating/cooling and humidity control inside each deck chamber.
- (2) Means for controlling the humidity content is to be provided in the deck chambers.
- (3) External heating coils are to be fitted with 2 temperature indicators.

3. Divers and diving bell

- (1) For saturation diving, means for heating the breathing gas of the divers are to be provided.
- (2) Means for reading the heating medium temperature and its flow rate are to be provided inside the diving bell.
- (3) The diver heating system is to include a low and high temperature level alarm at the diving control station.

709. Piping and fittings

1. General

- (1) Piping arrangement and materials used for breathing gas is to comply with Class I of **Pt 5**.
- (2) Protection against mechanical damage All high-pressure piping is to be protected against mechanical damage.
- (3) Piping carrying breathing gas is to be kept away from electrical cables.
- (4) Valves used on the breathing gas system are to comply with a recognized standard.
- (5) Pressure regulators used on breathing gas systems are to meet the standard EN 738.

2. Material and welding

- (1) The materials of the piping system is to comply with the relevant provisions of **Pt 2** and **Pt 5**.
- (2) As a rule, ordinary bronze is not permitted for accessories where the design pressure exceeds 15 bars.
- (3) Copper and copper alloy pipes are to be of a type without longitudinal seam.
- (4) Welding material and welders qualification are to comply with the relevant requirements of the **Pt 2** and **Pt 5**.

3. Flexible hoses

- (1) Flexible hoses are to be designed and constructed in accordance with **Pt 5** and a recognized standard.
- (2) Flexible hoses, except for umbilicals, should be reduced to a minimum.
- (3) Flexible hoses are to be kept as short as practically possible.
- (4) Shut-off devices are to be provided to allow isolating the flexible hose.
- (5) Provisions are to be taken in such a way that flexible hoses may not accidentally un-tie and whip in case of rupture.
- (6) All flexible hoses other than charging whips are to be appropriately supported and secured at intervals not exceeding 2,0 m.
- (7) When carrying oxygen, flexible hoses are to comply with the relevant requirements of **710**.
- (8) Flexible hoses and associated couplings are to be selected with a minimum burst pressure the greatest of:

$$PB = 4 \cdot DP + 5$$

$$PB = 20$$

where:

PB : Minimum burst pressure, in bar

DP : Design Pressure, in bar

- (9) As a rule, flexible hoses intended to carry breathing gas at a pressure greater than 10 bar, as well as those carrying oil, are to be metal braided. In addition to its mechanical strength, the function of the metal braid is to conduct heat in case of fire. The metal braid is to be made of stainless steel.
- (10) The radius of curvature of the flexible hose is not to be less than the minimum recommended by the manufacturer.

710. Oxygen installations

1. General

- (1) A recognized standard is to be applied for the design of the oxygen installation and submitted to the Society for approval.
- (2) Special attention should be paid to the design and choice of material for the construction of pressure vessels containing oxygen.
- (3) Breathing gas mixtures containing more than 25% of oxygen are to be considered like pure oxygen for installation purpose.

2. Oxygen supply

- (1) Any material used in a plant which is intended to carry oxygen is to be compatible with oxygen at working pressure and flow rate.
- (2) The use of high-pressure oxygen piping is to be minimized by the fitting of pressure reducing devices, as close as practicable to the storage cylinders.

- (3) Ball valves should not be used for oxygen supply.
- (4) Oxygen systems with pressure greater than 1,72 bar are to have slow-opening shutoff valves except pressure boundary shutoff valves.
- (5) Hoses for oxygen are to be of fire-retardant construction and type approved.
- (6) The partial pressure of oxygen on the breathing gas is to be maintained within physiologically acceptable limits taking into account the duration of the mission.

3. Oxygen storage

- (1) Oxygen and gases with an oxygen volume percentage higher than 25 per cent should be stored in bottles or pressure vessels exclusively intended for such gases.
- (2) Oxygen bottles should be installed in a well-ventilated location.
- (3) Oxygen bottles are not to be stored near flammable substances.
- (4) As far as practicable, oxygen should be stored on an open deck or in enclosed space specially intended for that purpose.
- (5) A visual and audible high-low oxygen alarm is to be fitted when oxygen is stored in an enclosed space in order that any personnel is warned before entering the space. This alarm is to be repeated on the ship command center.
- (6) The pressure of oxygen or mixes containing over 25% oxygen should be regulated down at the quad or cylinder to a maximum of 40 bar for breathing gas or 60 bar for supplies to gas blenders.

4. Oxygen cleaning

- (1) Any materials used in a plant which is intended to carry oxygen is to be cleaned of hydrocarbons and debris to avoid explosions.
- (2) Reference is to be made to ASTM G93 – Oxygen cleaning method – or an equivalent standard.
- (3) All valves and pipe work are to be cleaned for oxygen service when used for gas mixes containing more than 25% oxygen. This may be demonstrated by means of a suitable procedure to ensure cleanliness which is applied when any components are new or after there has been any significant alteration.

711. Gas cylinder

1. General

- (1) Gas cylinders shall be designed, constructed and tested according to **Pt 5** or recognised international standards.
- (2) Cylinders and quads are to be colour coded and marked with the name and chemical symbol of the contents, in accordance with **703. 4**.
- (3) Gas cylinders intended for oxygen storage are to comply with **710..**
- (4) Thickness increment of the cylinder shell of typically 1 mm is to be considered for wastage allowance.
- (5) Individual cylinders or multiple cylinders grouped together by means of a manifold, are to be provided with:
 - (A) an isolation valve rated for the maximum allowable working pressure of the cylinder
 - (B) a protective device to relieve excess pressure
 - (C) means for eliminating moisture when used for gas reclaim purpose.

712. Compressor

1. General

- (1) Compressors are to comply with **Pt 5**.
- (2) Diaphragm type compressors are to be fitted with a cracked plate detector which will automatically stop the compressor in the event of failure.
- (3) Any compressor or pump intended for pumping oxygen or any gas mixture containing more than 25% oxygen are to be designed for that purpose.
- (4) Any compressor used for gas transfer, and not intended for use with gases containing over 25% oxygen, should be fitted with a protective device which will shut the compressor down if the oxygen percentage entering the compressor exceeds 25%.
- (5) Safety relief valves are to exhaust to a safe location.
- (6) The intakes of all air compressors are to be sited in an area where they are not exposed to any pollution – particularly exhaust fumes.

2. Pollutant content

The breathing gas delivered from compressors has to meet the requirements of EN 12021 or an equivalent standard.

713. Umbilical cable

1. General

- (1) As a rule, umbilicals are to be designed and constructed in accordance with a recognized standard (ISO 13628- 5, API 17E, ISO 15333).
- (2) The following information are to be submitted to the Society:
 - (A) applied technical standard
 - (B) mechanical properties including minimum breaking strength
 - (C) design load envelope: maximum tension, bending etc.
 - (D) minimum Bending Radius (MBR) with respect to applied tensile load
 - (E) design life
 - (F) arrangement and diameter of sheaves and winch drum.
- (3) Flexible hoses used in umbilicals are to comply with the provisions of **709. 3**.
- (4) Electrical cables used in umbilicals are to comply with the provisions of **Sec 8**.
- (5) Hoses and electrical cables used in umbilicals are not to have any intermediate connection.
- (6) Sheathing is to be such that internal overpressure arising from the leakage of a hose be prevented from being built-up.

2. Main bell umbilical

- (1) The main bell umbilical ensures the connection between the diving bell and the surface.
- (2) The main bell umbilical is to be securely attached to the bell by means of a strength member or strain relief fitting so that neither the individual components or any bell penetrations are subject to load.
- (3) The diving bell umbilical may include means for the transfer of:
 - (A) breathing gas
 - (B) hot water
 - (C) communication, video and controls
 - (D) electrical power.
- (4) When the main bell umbilical is paid out manually, it is to be marked at regular intervals in order for the operator to know exactly the amount paid out at any time during the diving operation.

3. Diver's umbilical

- (1) The diver's umbilical ensures the connection between the diving bell and the diver.
- (2) Umbilicals are to be marked for length at least every 10 meters using a recognized system which allows easy visual identification of the length paid out.
- (3) Any hoses carrying concentration of oxygen greater than 25% are to be oxygen compatible.

Section 8 Electrical, Control and Communication Systems

801. General

1. This Section provides requirements for the design and construction of electrical installations and control systems, in addition to the requirements defined in the **Pt 6**.

802. General design requirements

1. Environment

- (1) All electrical equipment and installations, including power supply arrangements, should be designed for the environment in which they will operate to minimize the risk of fire, explosion, electrical shock and emission of toxic gases to personnel, and galvanic corrosion of the deck decompression chamber or diving bell.
- (2) Reference is made to IMCA D045 Code of practice of the safe use of electricity under water, as amended.

2. Electricity under water and inside hyperbaric chambers

- (1) The use of electricity inside hyperbaric chambers is to be kept to a minimum. Equipment used is to be of adequate design and construction against hyperbaric and oxygen enriched environment.
- (2) Electrical receptacles installed inside the deck chambers are to be waterproof.

3. Maximum voltages

- (1) Inside the deck chambers, the voltage should not exceed:
 - (A) 30 V D.C for plugs, portable equipment and communication, monitoring and remote control
 - (B) 250 V A.C for power system: A.C Systems with voltage between 7,5 V and 250 V are to be protected against accidental touching and fitted with suitable earth leakage protection.
 - (C) Higher voltage may be allowed provided that effective protection is fitted and subject to agreement from the Society.
- (2) Inside the bell, the voltage should not exceed 30 V D.C.

4. Lighting

- (1) Main and emergency lighting is to be provided in spaces containing diving equipment.
- (2) Each deck decompression chamber and diving bell should have adequate means of normal and emergency lighting to allow an occupant to read gauges and operate the system within each compartment.
- (3) Lighting equipment installed inside PVHO are to be rated at a pressure equal to 1,5 times the MAWP.
- (4) Illumination levels within the diving system are to be adequated for the tasks to be performed. Sufficient internal lighting are to be provided to allow valves and controls to be operated safely.

5. Electric motors

Electrical motors inside the deck chambers or diving bell are to be suitable for the intended use as required in **2**.

803. Power source

1. General

The electrical installations are to be supplied from two independent sources of electrical power, a main and an emergency source of power.

2. Emergency source of power

- (1) In the event of failure of the main source of electrical power supply to the diving system, an independent source of electrical power is to be available for the safe termination of the diving operation. It is admissible to use the unit's emergency source of electrical power as an emergency source of electrical power if it has sufficient electrical power capacity to supply the diving system and the emergency load for the vessel at the same time.
- (2) The emergency source of electrical power is to be located outside the machinery casings to en-

- sure its functioning in the event of fire or other casualty causing failure to the main electrical installation.
- (3) As a minimum, the emergency source of power is to be of sufficient capacity to supply the following emergency services:
 - (A) the breathing gas supply, analysis and regeneration systems
 - (B) the emergency communication system
 - (C) the emergency lighting in the deck decompression chambers, the diving bell and the control stations
 - (D) the launch and recovery system of the diving bell
 - (E) the handling system required for emergency launching of the HRU
 - (F) any emergency system necessary for life support.
 - (4) The emergency source of power is to be capable of supplying the emergency services for a minimum period in accordance with the intended procedure to decompress or evacuate the divers in a safe manner, and as defined in the operating manual.
 - (5) The emergency source of electrical power is to be self-contained and independent of the main electrical installation and may be either a generator or an accumulator battery.
 - (6) The following emergency services are to remain available during switching from main to emergency source of power:
 - (A) emergency lighting
 - (B) alarm systems (diving and life support system)
 - (C) emergency communication systems.
 - (7) Where the emergency source of electrical is a generator, it is to be started automatically upon failure of the main source of electrical power in order to supply the required emergency loads in less than 45s.
 - (8) A transitional source of emergency electrical power is to be provided, so arranged as to supply automatically and for half an hour the services referred to in (6) or for which a permanent or temporary degradation may occur during the switchover period.
 - (9) When an accumulator battery is used as the emergency source of power or as a transitional source of power, it shall operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal tension.
 - (10) When switching from the main source of power to the emergency source of power, an audible and visible alarm is to be actuated in the diving and life support control stations, with the indication of the source of power connected.

3. Accumulator batteries

- (1) Storage batteries are not to be located inside the diving bells nor the deck decompression chambers.
- (2) Any battery devoted to supply essential services is to be fitted with an indicator of the status of charging and a low level alarm.
- (3) When batteries are used within an hyperbaric enclosure, reference is made to IMCA D002 Battery packs in pressure housings, as amended. In particular, the following is to be observed when using batteries in pressure housing:
 - (A) battery terminals/leads are to be adequately insulated to protect against short circuit
 - (B) periodic examination, testing and renewal of the cells as necessary should be included within the planned maintenance system
 - (C) as a general rule shunt diodes should be provided across each cell of a primary battery to avoid the possibility of polarity-reversal occurring in any cell under discharge conditions
 - (D) the battery housing is to be fitted with an appropriate pressure relief device
 - (E) the battery casing should not be opened in a confined space and should be fully vented
 - (F) lead acid batteries should not be used in a hyperbaric environment.

804. Distribution system

1. General

- (1) The distribution system is to be of an insulated neutral type (IT).
- (2) The structure or hull return distribution system is not permitted.
- (3) The distribution system is to be such that the failure of a single circuit will not endanger or render any other circuit inoperative for longer periods.
- (4) When the system is supplied through a distribution board, at least two sections of this board

are to be supplied by two independent electrical power circuits.

- (5) Every insulated distribution system for power, heating or lighting, shall be provided with a device capable of continuously monitoring the insulation level to earth (i.e. the values of electrical insulation to earth) and of giving an audible and visual indication of abnormally low insulation values.

2. Circuit protection

- (1) Circuit breakers and fuses are to be provided on all conductors in order to protect the circuit against overload and short-circuit.
- (2) Fuses and circuit breakers are not to be fitted within the bell or the deck decompression chambers.

3. Earthing

Deck chambers and bells are to be provided with earthing connection.

4. Distribution panel

- (1) Distribution panels are to comply with the requirements of the Pt 6.
- (2) The distribution panel is to be readily accessible from the control stations.
- (3) It is to be possible to disconnect each deck decompression chamber separately.

5. Electrical penetrators for pressure vessels

- (1) Electrical penetrators on the boundary of the pressure vessels are to be specially designed and manufactured for that purpose and approved by the Society.
- (2) Electrical penetrators in pressure vessels are to remain gas tight and watertight under the design pressure of the vessel, even if the electrical cable passing through the penetrator is damaged.

6. Electrical cables

- (1) Electrical cables and wiring are to comply with Pt 6.
- (2) Electrical cables are to be separated from piping installations carrying breathing gas.

805. Diving control station and Life support control station

1. Diving control station

- (1) The control station of the diving bell is to provide the diving supervisor with all information, controls, monitoring systems and means of communication needed for the command of the diving operation and the diving bell.
- (2) When there are two diving bells, two diving control stands are to be provided.
- (3) The control panel is to be provided with the diagram of the gas flow lines.
- (4) The information on the control panel is to include:
 - (A) internal pressure of the bell
 - (B) depth of immersion of the bell: by measurement of the external pressure and by measurement of the paid-out suspension rope length
 - (C) indications on the proper paying-out of the umbilical (information on the length paid-out, view on the pay-out device, information from the bell etc.)
 - (D) depth of immersion of each divers working outside the bell
 - (E) pressure of the gases supplied at the diving bell
 - (F) pressure before and after all pressure reducers on the gas flow lines
 - (G) pressure in the storage gas cylinders
 - (H) results of the breathing gas analysis defined in Sec 3:
 - (a) partial pressure of oxygen served out in umbilical
 - (b) partial pressure of oxygen in the bell
 - (c) partial pressure of carbon dioxide
 - (d) partial pressure of helium (in case of 3 gases mix)
 - (e) content of pollutants if any.
 - (I) controls parameters of heating means: temperature of the hot water being supplied to the divers and flow rate.
 - (J) alarms including:
 - (a) low and high level alarm for the oxygen partial pressure of the breathing gas supplied to the divers
 - (b) low and high level alarm for the oxygen partial pressure in the diving control station

- (c) alarm when the water temperature used as a diver heating medium moves outside the pre-set limits
- (d) alarm when main source of power is failing
- (e) alarm for electrical insulation fault with an indication of the concerned circuit
- (f) alarm for the failure of the station keeping system.
- (K) indication of the source of electrical power connected
- (L) communication and video watching of the diving bell.
- (5) Provisions should be made within the bell for an independent means of monitoring oxygen and carbon dioxide levels.
- (6) Any audio alarm is to be capable of being muted if it is so obtrusive that it does not allow to hear other means of communications.
- (7) A monitoring system is to be provided to continuously record the oxygen and carbon dioxide content in the bell.
- (8) The diving control station is to include the following direct and remote controls:
 - (A) electrical controls of the bell (lighting, video, communication, gas reclaim systems, etc)
 - (B) controls of the supply of the umbilical: breathing gas for each diver, hot water, etc.)
 - (C) control of the sources of energy for the tools.
- (9) When emergency source of power is to be manually actuated, the manual switch is to be provided in the control station.
- (10) When fitted, cross-over valves on breathing gas supply or depth gauge lines are either be fixed in one position or to indicate very clearly which source they are connected to. In any event any gauge fitted with a cross-over valve is to indicate very clearly at all times exactly what it is reading.
- (11) For surface diving, the diving control station where the diving supervisor operates is to gather:
 - (A) the information needed for the control of the dive:
 - (a) communication and video
 - (b) measurement of the immersion of the wet bell/diving basket
 - (c) Pressure of the breathing gas storage
 - (d) partial pressure of oxygen (for surface mixed gas diving)
 - (e) clock.
 - (B) controls actuating:
 - (a) main and emergency supply
 - (b) pure oxygen supply (if needed).
 - (C) the input pressure of the umbilical of the wet bell/diver basket if the umbilical is independent from the supply of the divers.
- (12) Indicators and analyzers are to comply with **Sec 7**.
- (13) Oxygen analyzers are to be provided in control stations.

2. Life support control station

- (1) The control station of the deck decompression chambers is to provide the operator with all information, controls and means of communication needed for the command of the life support operations.
- (2) The control panel is to be provided with the diagram of the gas flow lines.
- (3) The information on the control panel is to include:
 - (A) pressure in each compartment of the deck chambers including the trunks with at least one separate gauge for each compartment
 - (B) pressure inside the diving bell
 - (C) pressure of supply of the breathing gases into the deck chambers
 - (D) pressure of the storage gas cylinders
 - (E) pressure before and after all pressure reducers on the gas flow lines
 - (F) results of the breathing gas analysis defined in Sec 3:
 - (a) partial pressure of oxygen in each compartment
 - (b) partial pressure of carbon dioxide in each compartment
 - (c) partial pressure of oxygen served out at Built-in Breathing Apparatus (BIBS)
 - (d) content of pollutants if any.
 - (G) alarms including:
 - (a) low and high level alarm for the oxygen partial pressure
 - (b) alarm when main source of power is failing
 - (c) alarm for electrical insulation fault with an indication of the concerned circuit
 - (d) alarm for the failure of the station keeping system

- (e) alarm for oxygen content in oxygen storage areas
- (H) indication of the source of electrical power connected
- (I) temperature and humidity content in each compartment of the deck chambers and indication whether each environmental control unit is running or not
- (J) video watching of each compartment of the deck chambers.
- (4) A monitoring system is to be provided to continuously record the oxygen, the carbon dioxide content, the helium content if a 3 gases mix is used, the temperature and humidity in each compartment.
- (5) The life support control station is to include the following controls:
 - (A) compression and decompression of each compartment
 - (B) command of valves for each gas supply
 - (C) gas supply for the Built-in Breathing Apparatus (BIBS)
 - (D) switching on and off the electrical equipment of the chamber:
 - (a) lighting, video, communication
 - (b) regeneration
 - (c) addition of oxygen
 - (d) electrical sensor (pressure, ppO₂...).
 - (E) switching on and off the electrical power (1 general electrical switch for each chamber)
 - (F) actuation of the fixed fire-fighting system in the deck chambers
 - (G) selection of the gas bank
 - (H) amount of oxygen supply for each compartment
 - (I) manual switching from main to emergency electrical power, when applicable
 - (J) control of the opening of the transfer from the bell to the deck chambers.
- (6) Indicators and analyzers are to comply with **Sec 7**.
- (7) Oxygen analyzers are to be provided in control stations.

806. Communication

1. General

- (1) Communication means described in this Article are to be provided in control stations, diving bell and DDC. Direct two-way communication are to be provided in control station, diving bell and DDC.
- (2) Alternative means of communication with divers in the deck decompression chamber and diving bell should be available in case of emergency.
- (3) Each deck decompression chamber and diving bell should be connected to a speech unscrambler when used with gas systems, including helium.

2. Diving control station

- (1) The communication system should be arranged for direct 2-way communication between the diving control station and:
 - (A) the diver in water
 - (B) the diving bell
 - (C) each compartment of the chambers
 - (D) diving system handling positions
 - (E) dynamic positioning room
 - (F) bridge, ship's command centre or drilling floor.
- (2) The diving control station is also to include communication with the bell and divers through an ultra-sonic system in damaged condition.
- (3) There is to be both primary and secondary means of communication between the diving control station and:
 - (A) the ship command centre
 - (B) the life support control stationThe primary link is to be hard wired, immediately available and unable to be interrupted. One of these links is to be able to operate without the need for external power supply.
- (4) A recording system is to be fitted to record all communications between divers and supervisor.

3. Life support system control station

- (1) The life support control station is to include the following means of communication with:
 - (A) each compartment of the deck chambers, including interphone with unscrambler, when relevant

- (B) the exterior of each medical lock fitted on the deck decompression chambers
- (C) the diving control station
- (D) the ship command centre
- (E) the launching station of the hyperbaric rescue unit
- (F) inside the hyperbaric rescue unit (inside and outside the PVHO).
- (2) There is to be two-way communications between the divers inside each compartment of the chamber.
- (3) A secondary (back up) communication system (such as a sound powered phone) should exist between the divers inside each compartment of the chamber and those outside at the life support control station.

4. Diving bell

A self-contained through-water communication system should be provided for emergency communication with diving bells when operating under water.

5. Visual control

- (1) For saturation diving systems, means for visual control of the divers in the diving bell (e.g. CCTV) from the diving control stand are to be provided.
- (2) All compartments of the deck chambers are to be provided with means for visual control.
- (3) Means for visual control of the launch and recovery area from the diving control stand (directly or through CCTV) are to be provided.

Section 9 Fire Protection, Extinction and Detection

901. General

- 1. This Section provides design and construction requirements regarding the fire protection, detection and extinction applicable to diving systems.
- 2. Inspections and tests are in accordance with **Sec 2**.

902. Fire Protection

1. Material

- (1) All materials and equipment used in connection with the diving system should be, as far as is reasonably practicable, of fire-retardant type in order to minimize the risk of fire and sources of ignition.
- (2) All materials used in the diving system and especially in the inner area of the hyperbaric chambers, are to be selected so as to offer a minimum risk of combustion and a flame propagation velocity as slow as possible, particularly the wall coating, taking into account high partial pressure of oxygen.
- (3) Where selecting materials, particularly plastics, the toxicity and the quantity of noxious gases likely to escape during combustion of the chosen materials is to be taken into account.
- (4) Requirements regarding materials for oxygen installations are given in **Sec 7**.
- (5) Lubricants are to be approved for use in over-oxygenated environment.
- (6) The choice of materials is to be justified and submitted to the Society for approval; the Society reserves the right to call for tests.
- (7) Requirements regarding the electrical equipment are given in **Sec 8**.
- (8) Electrical equipment are to be selected so as to prevent static electricity to build up and the risk of spark.

2. Area of installation of diving system

- (1) The ship or floating structure on which the diving system is installed is required to conform to the fire protection regulations of the classification society responsible and, where applicable, to the relevant requirement of **Pt 8**.
- (2) Where pressure vessels are situated in enclosed spaces, a permanently installed water spray system having an application rate of 10 l/m^2 related to the horizontal projected area is to be provided for cooling in the event of fire. These water spray systems may be manually activated

and operated. For pressure vessels installed on the open deck, cooling by means of fire hoses connected to the general fire extinguishing system is permitted.

903. Fire detection

1. Fire detection and alarm

- (1) In outer spaces where no regular human supervision is ensured, a fire detection system allowing to signalize automatically any incipient fire and its location is to be provided for.
- (2) In each compartment of the deck chambers, a fire detection and alarm system is to be provided.
- (3) The alarm is to be audio and visual both locally and at the life support control station.

904. Fire extinction

1. General

- (1) Each compartment in a deck decompression chamber should have suitable means of extinguishing a fire in the interior which would provide rapid and efficient distribution of the extinguishing agent to any part of the chamber.
- (2) The fire extinguishers provided for are to be suitable for operation at the pressure prevailing within the enclosure.
- (3) The fire-fighting equipment is to be permanently available.

2. Saturation diving system

- (1) Each compartment of the deck chambers in a saturation diving system is to be provided with a fixed fire-extinguishing system.
- (2) The fixed fire-fighting system is to be operable from both inside and outside of the deck chambers.
- (3) The fire extinguishing agent is to be atomized water. The use of other product is to be submitted to the Society for approval.
- (4) In addition to the fixed fire-fighting system, portable fire extinguishers are to be provided.
- (5) Reference is made to NFPA 99 – Health care facilities code – for the fire-fighting system inside hyperbaric chambers. Other standard may be accepted subject to approval of the Society.

3. Surface diving system

Portable extinguishers may be sufficient in deck decompression chambers of surface diving systems.

905. Other fire protection equipment

Emergency breathing apparatus are to be available at diving and life support control stations.

Section 10 Launch and Recovery System [See Guidance]

1001. General

1. This Section provides requirements for the design and construction of launch and recovery systems of diving bells.
2. The requirements given in the present Section are additional to the requirements given in **Ch 2**.
3. Inspections and tests are in accordance with **Sec 3**.

1002. General design requirements

1. General

- (1) A diving system should be equipped with a main handling system to ensure safe transportation of the diving device between the work location and the deck decompression chamber.
- (2) The handling system should be designed with adequate safety factors considering the environmental and operating conditions, including the dynamic loads which are encountered while handling the diving bell through the air-water interface.
- (3) The handling system should enable smooth and easily controllable handling of the diving bell.
- (4) The lowering of diving devices under normal conditions should not be controlled by brakes, but by the drive system of the winches.
- (5) The handling system is to be suitable for man riding.
- (6) Handling systems should enable easy and firm connection or disconnection of a closed diving bell to a deck decompression chamber, even under conditions where the support ship or floating structure is rolling, pitching or listing to predetermined degrees.
- (7) The SWL is to be clearly marked on every winch and on the A frame, trolley or similar.
- (8) When the LARS is powered by hydraulics, the hoses used are to be suitably supported and secured at intervals not exceeding 2 m.
- (9) If a heave compensation system is fitted, a warning (light) is to be visible at the dive control stand and the LARS control stand when the system is in operation.

2. Calculations

- (1) The 'working load' of the handling system comprises the weight of the diving bell, the total weight of the fully equipped divers at 150 kgf each, the weight of the equipment and the ballast weights. The 'dead load' is the weight of the handling system.
- (2) Regardless of the type of handling system and the size of the working load, the dimensional design of the handling system is to allow for a working load factor $Y = 2.0$ and a dead load factor F of 1.5. It is assumed here that the use of the system in a seaway will be limited to significant wave heights of 2 m or less. Where it is proposed that handling operations should be performed in even more unfavourable conditions, previous agreement with the Society is necessary.
- (3) Calculations are to be based on the assumption that the angle of engagement of the hoisting and lowering strength member may be 12° off perpendicular in any direction.
- (4) The maximum static tensile stress imposed on steel wire ropes by the working load may not exceed 12.5% of the proven rupture strength of the ropes.
- (5) Where ropes made of natural or synthetic fibres are used, the maximum static tensile stress imposed by the working load may not exceed 10% of the proven rupture strength of the ropes.
- (6) The stress limits for components are specified in guidance.
- (7) Rope tension shall not exceed the design load below.
 - (A) Wire rope's safety factor is 4 times design load factor. (Design load shall not exceed 1.5 times working weight.)
 - (B) Synthetic fiber's safety factor is 5 times design load factor.
- (8) All interchangeable components such as blocks, hooks, shackles etc. are to be complied with the recognized standards and are to be designed for twice the working load.

1003. Machinery and electrical equipment

1. Winch

- (1) The winch rated pull capacity is to take into account allowance for dynamic effects.

- (2) The winch raise/lower control is to be designed to return to the neutral position when released by the operator.
- (3) If any sort of clutch mechanism is fitted to the winch, there is to be a positive means of preventing it becoming disengaged during operation.
- (4) The winch drum is to be able to accept the full length of wire being used. This means that there should be a clear space between the outside of the top layer of wire and the edge of the drum flange of at least 2,5 times the wire diameter.
- (5) Any winch used to handle the diving bell is to have:
 - (A) a second motor
 - (B) means to ensure that the wire being recovered is correctly spooled
 - (C) means by which the winch operator can see how much of the main bell lift wire and main bell umbilical have been paid out. This may be by line-out meters or at its simplest by marking the bell wire and umbilical at 10 metres intervals, using the same marking system.

2. Brake

- (1) If the energy supply to the handling system fails or the operating lever is returned to neutral position, brakes should be engaged automatically.
- (2) Winch for personnel hoisting is to be provided with double brakes.
- (3) In addition to the normal brake, the winch shall be equipped with a mechanically and operationally independent secondary brake with separate control system.

3. Secondary means of recovery

- (1) In the event of single component failure of the main handling system, an alternative means should be provided whereby the bell can be returned to the deck decompression chamber.
- (2) In case of failure of the main handling system, there is to be a secondary means of recovering the diving device to the surface, bringing it on-board and mating it to the chamber system. This is to be independent of the main recovery system.
- (3) The secondary recovery system is to have a certified SWL which is at least equal to the weight of the fully loaded diving device in air and in water, in addition to its main task when relevant.

4. Emergency power source

- (1) An independent (secondary) power source is to be available in case of failure of the primary power.
- (2) The emergency power source is to comply with the requirements provided in **Sec 8**.

1004. Ropes and padeyes and umbilical handling system

1. Lifting rope and guide wires

- (1) The lifting rope is to be of non-rotating type.
- (2) Operating the release system of the main lifting rope is to be dependent on 2 independent self-willed actions.
- (3) The wire rope is to be adequately protected against corrosion.
- (4) For saturation diving systems, a system is to be provided to restrict excessive lateral or rotational movement of the diving device in the water. Usually, this system consists in a pair of guide wires stabilized with a weight.
- (6) This system may be used as an emergency means of recovery. In this case, the guide wires and their winch are to be suitable for man riding.
- (7) The lifting rope attachment to the diving device is to be a properly designed lifting padeye.
- (8) The connection of the lifting rope to the padeye is to have two retaining means for the removable pin (eg: nut locked with a split pin).

2. Umbilical handling system

- (1) Provisions should be made in order that the handling system of the umbilical is not used to lift the diving device, unless it is designed for that function.
- (2) The winding diameter (reel, sheave) should be at least 3 times the umbilical natural curvature radius.
- (3) Umbilicals in surface diving systems are to be marked in order for the LARS operator to know the amount of umbilical paid out at any time during the diving operation.

Section 11 Hyperbaric Rescue Unit

1101. General

1. This Section provides requirements for the design and construction of Hyperbaric Rescue Units (HRU) including:
 - (A) self-propelled hyperbaric lifeboat (SPHL)
 - (B) hyperbaric rescue chamber (HRC) non propelled.
2. Saturation diving systems are to be provided with an hyperbaric rescue unit.
3. Where the hyperbaric evacuation system permanently connected to the diving system is provided it is to be applied with the 'Guidelines and Specifications for Hyperbaric Evacuation Systems', **Res. A.692(17)**. Other standard may be accepted subject to approval of the Society.
4. Inspections and tests are in accordance with **Sec 3**.

1102. Evacuation system

1. General

- (1) An evacuation system should be provided having sufficient capacity to evacuate all divers under pressure, in the event of the ship having to be abandoned, and should be in accordance with the provisions of IMO Guidelines and specifications for hyperbaric evacuation systems Resolution A692.
- (2) The design and construction of the hyperbaric evacuation system should be such that it is suitable for the environmental conditions envisaged, account being taken of the horizontal or vertical dynamic snatch loads that may be imposed on the system and its lifting points particularly during evacuation and recovery.
- (3) On floating units intended for drilling, production or storage of hydrocarbon, the HRU is to have means of propulsion or other method to ensure it can rapidly move clear of the site.
- (4) Arrangement is to be provided to enable an unconscious diver to be taken into the unit.
- (5) Various methods are available for evacuating divers and the suitability of the various options depends on a number of factors including geographical area of operation, environmental conditions, and any available offshore or onshore medical and support facilities. Options available to diving system operators include:
 - (A) hyperbaric self-propelled lifeboats
 - (B) hyperbaric rescue chambers which may or may not be towable suitable for off loading on to an attendant facility
 - (C) transfer of the diving bell to another facility
 - (D) transfer of the divers from one diving bell to another when in the water and under pressure
 - (E) negatively buoyant unit with inherent reserves of buoyancy, stability and life support capable of returning to the surface to await independent recovery.
- (6) The Hyperbaric Rescue Unit (HRU) can be an Hyperbaric Rescue Chamber or a Self-Propelled Hyperbaric Lifeboat.

2. Hyperbaric rescue chamber (HRC)

- (1) The hyperbaric rescue chamber is a deck chamber specially fitted to be launched and to work continuously and passively during the specified minimum autonomy. This implies:
 - (A) an interface with handling means
 - (B) a stability study
 - (C) a protection against impact
 - (D) a specific thermal protection
 - (E) means of making vital and communication functions autonomous in flotation condition.The set of drawings and calculations notes corresponding to these items are to be submitted to the Society for approval.

3. Self-Propelled hyperbaric lifeboat (SPHL)

- (1) The SPHL is to comply with international regulations applicable to rescue craft (IMO LSA code).
- (2) A non-pressurized steering and control station is to be provided for at least one sailor and one deck chamber operator.
- (3) The deck chamber operator is to be able to watch inside the chamber from its control panel through a viewport.

1103. General design requirements

1. General

- (1) The HRU is to be capable of maintaining the divers at the correct pressure and with life support for a minimum of 72 hours.
- (2) Assessment of reserves in soda lime, heating/ refrigerating means, survival rations, reserves of gas, etc. is to be made considering the required autonomy.
- (3) Breathing gas reserves and gas reclaim are to cover the consumption of the designed number of persons as well as the compensation of possible leaks. The embarked gas reserve is to allow at least to keep the chamber of the HRU at its operating pressure during the survival duration.
- (4) Where hyperbaric rescue units are designed to be placed on board a rescue vessel, attachment points should be provided on the unit to enable it to be secured to the deck.
- (5) Hyperbaric rescue units designed to float should be provided with adequate stability for all envisaged operating and environmental conditions and be self-righting. In determining the degree of stability to be provided, consideration should be given to the adverse effects of large righting moments on the divers. Consideration should also be given to the effect which equipment and rescue personnel, required to be placed on the top of the system to carry out a recovery from the sea, may have on the stability of the hyperbaric rescue unit.
- (6) Towing attachment points should be so situated that there is no likelihood of the hyperbaric rescue unit being capsized as a result of the direction of the tow line. Where towing harnesses are provided they should be lightly clipped or secured to the unit and, so far as is possible, be free from snagging when pulled free.
- (7) Hyperbaric rescue units designed to float should have sufficient reserves of buoyancy to enable the necessary rescue crew and equipment to be carried.
- (8) The access trunk is to be part of the resistant structure. It should allow the personnel to easily pass through.
- (9) There is to be emergency means of lighting of the access trunk.
- (10) The evacuation route should be such that access for divers to the HRU is possible in all normal circumstances. This should include the possibility of an injured diver requiring evacuation by stretcher. If it is necessary to use a pulley type system to move the stretcher then the pulley is to be of a length that allows connection at the furthest extremity of the trunk. The attachment point of the pulley(s) inside the HRU is to be submitted.
- (11) The means provided for access into the HRU chamber should be such as to allow safe access to or from the deck decompression chambers. Interlocks should be provided to prevent the inadvertent release of the hyperbaric rescue unit from the deck decompression chamber while access trunking is pressurized. The mating flange should be adequately protected from damage at all times including during the launch and recovery stages.
- (12) The design and construction of the interface between the HRU and HRF should comply with the recommended standard defined in IMCA D051 Hyperbaric Evacuation Systems (HES) – Interface Requirements.

2. Marking

- (1) Dedicated hyperbaric rescue units should be coloured orange (internal distress orange) and be provided with retro-reflective material to assist in their location during hours of darkness.
- (2) Each hyperbaric rescue unit designed to be waterborne should be marked with at least three identical signs. One of these markings should be on top of the unit and be clearly visible from the air and the other two be mounted vertically on either side and as high as possible and be capable of being seen while the unit is afloat. **[See Guidance]**
- (3) Where applicable, the following instructions and equipment should be clearly visible and be kept readily available while the unit is afloat:
 - (A) towing arrangements and buoyant towline
 - (B) all external connections, particularly for the provision of emergency gas, hot/cold water and communications
 - (C) maximum gross weight of unit in air
 - (D) lifting points
 - (E) name of the parent ship and port of registration and
 - (F) emergency contact telephone.
- (4) Where appropriate, the following instructions should be permanently displayed on every hyperbaric rescue unit in two separate locations so as to be clearly visible while the unit is afloat,

“Unless specialised diving assistance is available:

- (A) do not touch any valves or other controls
- (B) do not try to get occupants out
- (C) do not connect any gas, air, water or other supplies
- (D) do not attempt to give food, drinks or medical supplies to the occupants and
- (E) do not open any hatches”.

3. Pressure vessel for human occupancy

- (1) Pressure vessels for human occupancy used in HRU and access to HRU are to comply with the requirements specified Sec 5.
- (2) Hyperbaric chambers used for hyperbaric evacuation are to have a minimum diameter of 1750 mm.
- (3) A medical lock should be provided and be so designed as to prevent accidental opening while the HRU chamber is pressurized. Where necessary, interlock arrangements should be provided for this purpose. The dimensions of the medical lock should be adequate to enable essential supplies, including CO₂ scrubber canisters, to be transferred into the HRU chamber, and be of such dimensions as to minimize the loss of gas when the lock is being used.

4. Life support system

- (1) Life support systems are to comply with the relevant provisions of **Sec 7**.
- (2) Two separate distribution systems should be provided for supplying oxygen to the decompression chamber. Components in the system should be suitable for oxygen service.
- (3) A Built-In Breathing System should be provided with a sufficient number of masks for all the occupants under pressure plus one spare. BIBS should be overboard dump type with exhausts piped both outside the chamber and outside the enclosed cockpit area in the case of lifeboat type.
- (4) Where it is intended that divers may be decompressed within the hyperbaric rescue unit, provision should be made for the necessary equipment and gases, including therapeutic mixtures, to enable the decompression process to be carried out safely.
- (5) Provision should be made external to the hyperbaric rescue unit, and in a readily accessible place, for the connection of emergency hot or cold water and breathing therapeutic mixture. The dimensions of the connections provided should be as follows:
 - (A) 3/4 in. NPT (female) – hot or cold water
 - (B) 1/2 in. NPT (female) – breathing mixture.The connections are to be clearly and permanently marked and be suitably protected.
- (6) The decompression chamber should provide a suitable environment and adequate facilities, including, where appropriate, seat belts, for the maximum number of persons for which the unit is designed. The seating or other arrangements provided should be designed to provide an adequate degree of protection to the divers from impact collisions during launch and while the unit is afloat.
- (7) Where the HRU is intended to be occupied for more than 12 h, arrangements for the collection or discharge of human waste should be provided. Where discharge arrangements are provided they should be fitted with suitable interlocks.
- (8) In addition to any controls and equipment fitted externally, decompression chambers should be provided with adequate controls within for supplying and maintaining the appropriate breathing mixtures to the occupants, at any depth down to the maximum operating depth. The persons operating the chamber, whether they are within or outside it, should be provided with adequate controls to provide life support. As far as practicable, the controls should be capable of operation without the person who operates them having to remove his/her seat belt.

5. Electrical installations, control systems and Communication

- (1) Communication means are to be provided between the HRU decompression chamber and:
 - (A) the HRU launching station
 - (B) the DDC control station.
- (2) If breathing mixtures containing helium or hydrogen are used, a self-contained primary communication system fitted with an unscrambler device should be arranged for direct two-way communication between the divers and those outside the compression chamber. A secondary communication system should also be provided.
- (3) The HRU is to be fitted with: flashing light and radar deflector.
 - (A) radar deflector

- (B) strobe light
- (C) radio location devices (EPIRB or similar).

- (4) Where a power-actuated system is used for the connection or disconnection of the hyperbaric rescue unit and the deck decompression chambers, then a manual or stored power means of connection or disconnection should also be provided.
- (5) A standard bell emergency communication tapping code should be provided which meets the requirements of the diving bell in Sec 2. Copies of the tapping code should be permanently displayed inside and outside the hyperbaric rescue unit

6. Fire safety

- (1) Fire-extinguishing system should be provided in the hyperbaric rescue unit which should be suitable for exposure to all depths down to the maximum operating depth.
- (2) Hyperbaric rescue units on supporting units required to be provided with fire-protected lifeboats should be provided with a similar degree of fire protection.

7. Launch and Recovery System

- (1) The launching system of the HRU is to comply with IMO SOLAS Convention and IMO International Life Saving Appliances Code (LSA Code).
- (2) Where the primary means of launching depends on the ship's main power supply, then a secondary and independent launching arrangement should be provided.
- (3) If the power to the handling system fails, brakes should be engaged automatically. The brake should be provided with manual means of release.
- (4) The launching arrangements provided should be designed to ensure easy connection or disconnection of the hyperbaric rescue unit from the surface and for the transportation and removal of the unit from the ship under the same conditions of trim and list as those for the ship's other survival craft.
- (5) The hyperbaric rescue unit should be capable of being recovered by a single point lifting arrangement and means should be provided on the unit to permit a swimmer to hook on or connect the lifting arrangement.
- (6) Special arrangements and instructions should be provided externally to enable the hyperbaric rescue unit to be recovered safely. The instructions should be located where they will be legible when the hyperbaric rescue unit is floating. ⚓

CHAPTER 8 HIGH VOLTAGE SHORE CONNECTION SYSTEMS

Section 1 General

101. General

1. **Application** The requirements in this Chapter apply to the ships classed with or intended to be registered under the Society, which are equipped with high voltage shore connection system in accordance with IEC/IEEE 80005-1 and apply for the class notation. (2022)
2. **Objectives** Objective is to provide requirements for the design, installation and survey of high voltage shore connection systems.
3. **Related requirements** In addition to complying with the requirements in this Chapter, those are to be applied respectively such as follows: For electrical equipment, **Pt 6, Ch 1**; For control systems, **Pt 6, Ch 2**.
4. **Class notation** Ships having high voltage shore connection systems which complies with requirements of this section may be assigned with the class notation HVSC. **[See Guidance]**

102. Definitions

Terms used in this Chapter are defined as follows:

- (1) **High Voltage Shore Connection (HVSC) System** A high voltage shore connection system is designed to receive power from a high voltage shore supply system, and consist of high voltage plugs and sockets, high voltage shore connection switchboard, step-down transformer or isolation transformer, high voltage cable, incoming panel and associated instrumentation. HVSC is often referred to as Cold Ironing or Alternative Marine Power (AMP).
- (2) **High Voltage** Nominal voltage is considered to be in the range above 1kV up to and including 15kV.
- (3) **Equipotential bonding** Provision of electric connections between conductive parts, intended to achieve equipotentiality.
- (4) **Cable Management System** The cable management system is all equipment designed to control, monitor and handle the HV-flexible cable, control cables and their connection devices.
- (5) **Shore Connection Switchboard** The shore connection switchboard is the ship's interface point with the shore power system. HV shore power is connected to this shore connection switchboard by means of an HV plug and Socket arrangement. The shore connection switchboard is provided with a shore power connecting circuit breaker with circuit protection devices.
- (6) **Onboard Receiving Switchboard** The receiving switchboard is normally a part of the ship's main switchboard to which the shore power is fed from the shore connection switchboard.

103. Drawings for approval (2022)

1. **General** In the case of the ships intended to be registered as ships provided with high voltage shore connection systems, the drawings to be submitted for approval before the commencement of work are generally as follows:
 - (1) Drawings
 - (A) Load analysis
 - (B) Short circuit current calculation (If necessary)
 - (C) Wiring diagram for high voltage shore connection systems
 - (D) General arrangement for electrical equipment of the high voltage shore connection systems
 - (E) Manufacturing drawing for shipboard elements of the high voltage shore connection systems as follows:
 - (a) High voltage shore connection switchboard
 - (b) Transformer
 - (c) Cable reel
 - (d) Control & monitoring system
 - (e) Onboard receiving switchboard

104. Drawings and data for reference (2022)

- (1) Drawings
 - (A) Manufacturing drawings for shipboard elements of the high voltage shore connection systems as follows;
 - (a) H.V plugs & sockets
 - (b) H.V cable
- (2) Data
 - (A) Operation manuals (including details of the high voltage shore connection systems)

Section 2 Requirements of High Voltage Shore Connection (HVSC) systems

201. General

1. The ships intended to be registered as ships provided with high voltage shore connection (HVSC) systems are to be provided the high voltage shore connection (HVSC) systems specified in this section.

2. Equipotential bonding

An equipotential bonding between the ship's hull and shore earthing electrode is to be established.

3. Protection against moisture and condensate

Effective means, for example space heaters or air dryers, are to be provided in high voltage shore connection equipment to prevent accumulation of moisture and condensate.

4. Emergency shutdown

- (1) The emergency shutdown facilities are to be activated in the event of:
 - (A) loss of equipotential bonding, via the equipotential bond monitoring relays (as appropriate) (2022)
 - (B) over-tension on the flexible cable (mechanical stress) (as appropriate) (2022)
 - (C) loss of any safety circuit
 - (D) activation of any manual emergency stop
 - (E) activation of protection relays provided to detect faults on the high voltage connection cable or connectors
 - (F) disengaging of power plugs from socket-outlets while high voltage connections are live
- (2) Emergency stop push buttons, activating emergency shutdown facilities, are to be provided at:
 - (A) an attended on board ship control station during HVSC
 - (B) in the vicinity of the socket outlet
 - (C) at active cable management system control locations (as appropriate) (2022)
 - (D) at the circuit-breaker locations for shore connections (as appropriate) (2022)

202. Ship to shore connection and interface equipment

1. General (2022)

Where ship-to-shore connection and interface equipment or system is installed onboard, it is to comply with 202. of this section.

2. Cable management system

- (1) The cable management system is to:
 - (A) be capable of maintaining an optimum length of cable which minimizes slack cable, and prevents the tension limits from being exceeded.
 - (B) be positioned to prevent interference with ship berthing and mooring systems, including the systems of ships that do not connect to shore power while berthed at the facility.
 - (C) maintain the bending radius of cables above the minimum bending radius recommended by the manufacturer during deployment, in steady state operation and when stowed.
 - (D) be capable of retrieving and stowing the cables once operations are complete.
- (2) Monitoring of cable tension
 - (A) The cable management system is not to permit the cable tension to exceed the permitted design value.

- (B) A means to detect maximum cable tension are to be provided, or where an active cable management system that limits cable tension is provided, means to detect the shortage of available cable length are to be provided with threshold limits provided in two stages:
 - Stage 1 : alarm
 - Stage 2 : activation of emergency shutdown facilities
- (3) Monitoring of cable length
 - (A) The cable management system is to enable the cables to follow the ship movements over the entire range of ship draughts and tidal ranges, and the maximum range of allowable motion forward, aft or outward from the dock.
 - (B) Where the cable length may vary, the remaining cable length is to be monitored and threshold limits are to be arranged in two stages:
 - Stage 1 : alarm
 - Stage 2 : activation of emergency shutdown facilities
- (4) Equipotential bond monitoring
The equipotential bond created by the ship to shore connection cables is to be constantly monitored.

3. Plugs and socket-outlets

- (1) General
 - (A) Details including general arrangement of plug and socket-outlet are to be in accordance with IEC/IEEE 80005-1 Annex, IEC 62613-1 and IEC 62613-2. (2022)
 - (B) The plug and socket-outlet arrangement is to be fitted with a mechanical-securing device that locks the connection in the service position.
 - (C) The plugs and socket-outlets are to be designed so that an incorrect connection cannot be made.
 - (D) Socket-outlets are to be interlocked with the earth switch so that plugs cannot be inserted or withdrawn without the earthing switch in the closed position.

4. High voltage cable

The high voltage cable is to be in accordance with IEC 60092-353, IEC 60092-354 or relevant standards which the Society considers appropriate.

- (1) Runs of cables
In accommodation spaces, high voltage cables are to be run in enclosed cable transit systems.
- (2) Segregation
High voltage cables are to be segregated from cables operating at different voltage ratings each other; in particular, they are not to be run in the same cable bunch, nor in the same ducts or pipes, or, in the same box. Where high voltage cables of different voltage ratings are installed on the same cable tray, the air clearance between cables is not to be less than the minimum air clearance for the higher voltage side in **Pt 6, Ch 1, 1502. 3 (1)**. However, high voltage cables are not to be installed on the same cable tray for the cables operating at the nominal system voltage of 1kV and less.
- (3) Installation arrangements
High voltage cables, in general, are to be installed on carrier plating when they are provided with a continuous metallic sheath or armour which is effectively bonded to earth; otherwise they are to be installed for their entire length in metallic castings effectively bonded to earth.
- (4) Marking
High voltage cables are to be readily identifiable by suitable marking.

203. Ship requirements

1. Shore connection switchboard

- (1) General
 - (A) The shore connection switchboard is to be in accordance with IEC 62271-200.
 - (B) The switchboard is to include a circuit-breaker to protect the ship electrical equipment downstream.
- (2) Circuit-breaker, disconnecter and earthing switch
 - (A) In order to have the installation isolated before it is earthed, the circuit-breaker, disconnecter and earthing switch are to be interlocked in accordance with the requirements of IEC

62271-200.

- (B) The rated breaking capacity of every protective device is not to be less than the maximum value of the short-circuit current which can flow at the point of installation at the instant of contact separation.
 - (C) The making capacity of every circuit-breaker or switch intended to be capable of being closed, if necessary, on short-circuit, is not to be less than the maximum value of the short-circuit current at the point of installation.
 - (D) Circuit breaker is to be remotely operated.
- (3) Instrumentation and protection
- The shore connection switchboard is to be equipped with at least the following measuring equipment and indicators:
- (A) Voltmeter: all three phases, voltage measurement between each phase
 - (B) Short-circuit protection devices: tripping and alarm
 - (C) Overcurrent protection devices: tripping and alarm
 - (D) Earth-fault indicator: alarm
- (4) The protection systems are to be provided with battery back-up adequate for at least 30 minutes.

2. Transformer

Where transformers are provided, transformers are to be in compliance with the requirements for transformers in **Pt 6, Ch 1, Sec 6** and **Sec 15**.

3. Onboard receiving switchboard

- (1) General
- The high voltage onboard receiving switchboard is to be in accordance with IEC 62271-200.
- (2) Circuit-breaker and earthing switch
- (A) The rated breaking capacity of every protective device is not to be less than the maximum value of the short-circuit current which can flow at the point of installation at the instant of contact separation.
 - (B) The making capacity of every circuit-breaker or switch intended to be capable of being closed, if necessary, on short-circuit, is not to be less than the maximum value of the short-circuit current at the point of installation.
 - (C) Circuit breaker is to be remotely operated.
- (3) Instrumentation
- (A) If load transfer via parallel connection is chosen, the following instrumentation is to be provided:
 - (a) Two voltmeters, all three phase, for the shipboard power and the shore power
 - (b) Two frequency meters for the shipboard power and the shore power
 - (c) One ammeter with an ammeter switch to enable the current in each phase to be read, or an ammeter in each phase
 - (d) Phase sequence indicator
 - (e) one synchronising device
 - (B) If load transfer via blackout is chosen, the following instrumentation is to be provided:
 - (a) One voltmeter for shore power
 - (b) One frequency meter for shore power
 - (c) One ammeter with an ammeter switch to enable the current in each phase to be read, or an ammeter in each phase
 - (d) Phase sequence indicator

204. High voltage shore connection system control and monitoring

1. General

Load transfer is to be provided via blackout or automatic synchronization.

2. Load transfer via blackout

- (1) Interlocking means are to be provided so that the shore supply can only be connected to a dead switchboard. The interlocking means are to be arranged to prevent connection to a live switchboard when operating normally or in the event of a fault.
- (2) The simultaneous connection of a HV-shore supply and a ship source of electrical power to the same dead section of the electrical system is to be prevented.

3. Load transfer via automatic synchronization

- (1) Load is to be automatically synchronized and transferred between the high voltage shore supply and ship source(s) of electrical power following their connection in parallel.
- (2) Any system or function used for paralleling or controlling the shore connection is to have no influence on the ship's electrical system, when there is no shore connection.
- (3) If the defined transfer time limit for transferring of load between HV-shore supply and ship source(s) of electrical power is exceeded, one of the sources is to be disconnected automatically and an alarm is to be provided to advise relevant duty personnel.

Section 3 Testing and Inspection

301. General

1. General (2022)

Electrical equipment and cables applicable to **Pt 6, Ch 1** are to comply with **Table 6.1.1** in **Pt 6, Ch 1, 103.** of the Rules and **Pt 6, Ch 5, 501. 2** of the Guidance.

2. Shop tests

The components for high voltage shore connection system, except junction box and socket box, are to be subjected to shop tests after completion of assembly.

302. Test after installation

- (1) visual inspection
- (2) high voltage test
- (3) insulation resistance measurement
- (4) measurement of the earthing resistance
- (5) function test including correct settings of the protection devices
- (6) function test of the interlocking system
- (7) function test of the control equipment
- (8) phase-sequence test
- (9) function test of the cable management system(where applicable)
- (10) integration tests to demonstrate that the new installation is operated properly with onboard systems such as power management system, alarm and monitoring system. etc. (2022)

303. Survey assigned to maintain classification

Periodical survey items of high voltage shore connection system are to be applied as follows.

1. Special survey (2022)

Special survey for high voltage shore connection system is to be in accordance with **Pt 1, Ch 2, Sec 5-1, 502. 3.**

2. Annual survey (2022)

Annual survey for high voltage shore connection system is to be in accordance with requirements for electrical part in **Pt 1, Ch 2, 203.** ⚓

CHAPTER 9 CARGO VAPOUR EMISSION CONTROL SYSTEMS

Section 1 General

101. Application

1. At the request of the owner, the requirements in this Chapter apply to cargo vapour emission control systems installed on the tankers classed with or intended to be registered under the Society for the purpose of control of vapour emission from cargo tanks. "Tankers" referred in this Chapter are oil tankers and chemical tanks.
2. The requirements in this Chapter are based on the technical requirements of **IMO MSC/Circ. 585** and **USCG CFR 46 Part 39** and the Rules apply to be registered the class notation in accordance with **Pt 1, Ch 1, Sec 2. (2020)**

102. Definitions

Terms used in this Chapter are defined as follows:

1. **Vapour collection system** means an arrangement of piping and hoses used to collect vapour emitted from a tanker's cargo tanks and transport the vapour to a vapour processing unit.
2. **Vapour processing unit** means the components of a vapour control system that recovers, destroys, or disperses vapour collected from a tanker.
3. **Vapour emission control system** means an arrangement of piping and hoses used to control vapour emissions collected from a tanker, and includes the vapour collection system and the vapour processing unit.
4. **Service ship** means a ship, which in a lightering operation transports products between another ship and a facility or vice versa.

103. Class notations

Ships which comply with this Chapter may be assigned with the following notations at the request of the owner.

1. VEC1: Ships in which cargo vapour emission control systems is installed in accordance with **Sec 2**
2. VEC2: Ships in which cargo vapour emission control systems is installed in accordance with **Sec 3**
3. VECL: Ships engaged in the transportation of cargoes between a facility and another ship and vice versa, and in which vapour balancing systems are installed in accordance with **Sec 4**

Section 2 Requirements for VEC1 Notation

201. Vapour piping systems

1. Each tanker is to have vapour collection piping which is permanently installed, with a tanker vapour connection located as close as practical to the loading manifold. In lieu of permanent piping, chemical tankers are permitted to have a permanent vapour connection at each cargo tank for connection to a vapour hose which is to be kept as short as practicable, and in no case longer than 3 m.
2. If a tanker simultaneously collects vapours from cargoes which react in a hazardous manner with other cargoes, it is to keep these incompatible vapours separate throughout the entire vapour collection system.
3. A means is to be provided to eliminate liquid condensate which may collect in the system, such as draining and collecting liquid from each low point in the line.
4. Vapour collection piping is to be electrically bonded to the hull and is to be electrically continuous.
5. When inert gas distribution piping is used for vapour collection piping, means to isolate the inert gas supply from the vapour collection system is to be provided. The inert gas main isolation valve required by **Pt 8, Annex 8-5, 2 (9) (C)** may be used to satisfy this requirement.
6. The vapour collection system is not to interfere with the proper operation of the cargo tank venting system.

202. Vapour line connections

1. An isolation valve capable of manual operation is to be provided at each tanker vapour connection. The operating position of this valve is to be readily determined visually.
2. The end of each vapour collection pipe or vapour collection hose is to be readily identifiable to prevent misconnection. The last 1.0 m of vapour piping inboard of the vapour connection flange is to be painted red/yellow/red with the red bands 0.1 m wide, and the yellow band 0.8 m wide. The yellow band is to be labeled with "VAPOUR" in black letters at least 50 mm high. (Refer to **Fig 9.9.1**.)

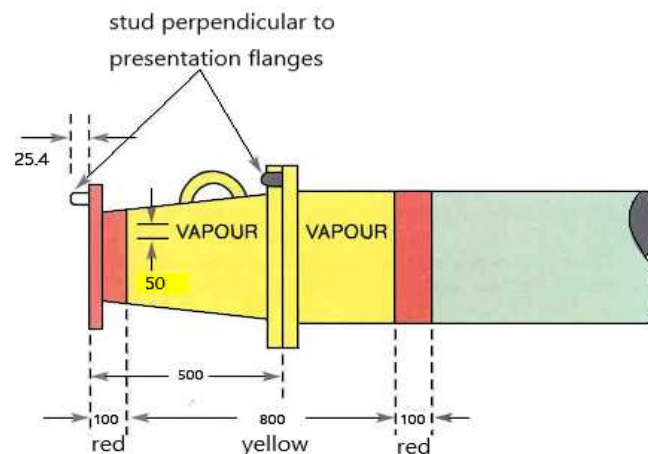


Fig 9.9.1 Identification of vapour manifold

3. In order to prevent the possible misconnection of the vapour manifold to a shoreside terminal liquid loading line, each tanker vapour connection flange is to conform to **OCIMF Recommendations for Oil Tanker Manifolds and Associated Equipment**. This provision is applicable regardless of the size of the ship.
4. Hoses, carried onboard for vapour connection, are to meet the following:
 - (1) be suitable for the service;

- (2) have maximum allowable working pressure of at least 0.034 MPa and design burst pressure of at least five times its maximum allowable working pressure.
- (3) have maximum allowable vacuum of at least 0.014 MPa below atmospheric;
- (4) be electrically continuous and
- (5) have an extra hole of 16 mm in each flange corresponding to a stud fitted at vapour line connections flange.

203. Cargo Gauging Systems

1. Each cargo tank of a tanker that is connected to a vapour collection system is to be equipped with a cargo gauging device which:
 - (1) provides a closed gauging arrangement that does not require opening the tank to the atmosphere during cargo transfer;
 - (2) allows the operator to determine the liquid level in the tank for the full range of liquid levels in the tank;
 - (3) indicates at cargo control station the liquid level in the tank; and
 - (4) if portable, is installed on the tank during the entire transfer operation.

204. Overfill control system (2020)

1. Each cargo tank is to be equipped with an overfill control system. The overfill control system is to:
 - (1) be independent of the cargo gauging system;
 - (2) come into operation when the normal tank loading procedures fail to stop the tank liquid level exceeding the normal full condition. The overfill alarm is to be activated early enough to allow the person in charge of transfer operations to stop the cargo transfer before the tank overflow;
 - (3) give a visual and audible tank overfill alarm to the ship's operator;
 - (4) provide an agreed signal for sequential shutdown of onshore pumps or valves or both and of the ship's valves. The signal as well as the pump and valve shutdown may be dependent on operator's intervention. The use of shipboard automatic closing valves is to be permitted only when specific approval has been obtained from the Society;
 - (5) have alarms fitted in the cargo control station, where provided, but in each case in such a position that they are immediately received by responsible members of the crew;
 - (6) alarm in the event of loss of power to the alarm system or failure of the electrical circuitry to the tank level sensor; and
 - (7) be able to be checked at the tank for proper operation prior to each transfer or contain an electronic self-testing feature which monitors the condition of the alarm circuitry and sensor.
 - (8) The overfill alarms are to be identified with the labels "TANK OVERFILL ALARM" respectively, in black letters at least 50 mm high on a white background.

205. Vapour overpressure and vacuum protection

1. Each cargo tank is to have a controlled pressure venting system which is designed on the basis of the maximum designed loading rate multiplied by a factor of at least 1.25 in order to prevent the pressure in the tank from exceeding the design pressure.
2. Each cargo tank is to have a controlled vacuum venting system which is capable of preventing a vacuum in the cargo tank vapour space, whether generated by withdrawal of cargo or vapour at maximum rates, that exceeds the maximum design vacuum for the tank.
3. Venting systems are to be type approved.
4. Each tanker equipped with a vapour collection system that is common to two or more tanks is to be fitted with a pressure sensing device that senses the pressure in the main vapour collection line for those tanks, and which:
 - (1) has a high pressure alarm that alarms at a pressure of not more than the lowest pressure relief valve setting in the cargo tank venting system; and
 - (2) has a low pressure alarm that alarms at a pressure of not less than atmospheric pressure for an inerted tanker, or the lowest vacuum relief valve setting in the cargo tank venting system for a non-inerted tanker.

206. Operational procedures

1. Cargo transfer rate

- (1) The rate of cargo transfer is not to exceed the maximum allowable transfer rate as determined by the lesser of the following:
 - (A) the venting capacity of the pressure relief valves in the cargo tank venting system divided by a factor of at least 1.25;
 - (B) the vacuum relieving capacity of the vacuum relief valves in the cargo tank venting system; and
 - (C) The rate based on pressure drop calculations for a given pressure at the facility vapour connection, such that the pressure in any cargo tank connected to the vapour collection system does not exceed 80 % of the opening set pressure of any pressure relief valve in the cargo tank venting system.
- (2) In application of (1) (C), when calculating pressure drop, the following is to be used:

$$VGR = 1 + 0.25 \frac{P_v}{0.0862}$$

$$\rho_{va} = (SG_v \cdot V_v + V_a) 10.9 \cdot P_{p/v} \quad (\text{kg/m}^3)$$

$$V_v = \frac{P_v}{P_{p/v}}, \quad V_a = \frac{P_{p/v} - P_v}{P_{p/v}}$$

VGR : vapour growth rate (dimensionless); to be as calculated above or 1.25, whichever is larger

P_v : saturated vapour pressure at 46.1 °C (MPa, absolute)

$P_{p/v}$: cargo tank PV valve pressure setting at 46.1 °C (MPa, absolute)

ρ_{va} : vapour-air mixture density at 46.1 °C (kg/m³)

SG_v : specific gravity of cargo vapour (dimensionless)

V_v : partial volume of vapour at 46.1 °C (dimensionless)

V_a : partial volume of air at 46.1 °C (dimensionless)

- (3) Where the capacities of a pressure/vacuum valve are obtained by testing with air only, the following equations may be used to correct the capacities for cargo oil vapour.

$$Q_A = Q_L \cdot VGR \cdot C \quad (\text{m}^3/\text{h})$$

$$C = \sqrt{\frac{\rho_{va}}{\rho_a}}$$

Q_A : required air equivalent volumetric flow rate (m³/h)

Q_L : cargo transfer rate (m³/h)

C : density correction factor (dimensionless)

ρ_{va} : vapour-air mixture density at 46.1 °C (kg/m³)

ρ_a : air density at 46.1 °C (kg/m³)

2. A cargo tank is not to be filled higher than the level at which the overflow alarm required by **204** is set.
3. A cargo tank is not to be opened to the atmosphere for gauging or sampling while the tanker is connected to a vapour emission control system unless:
 - (1) loading to the tank is stopped;
 - (2) the tank is isolated from any other tank which is in the process of being loaded; and
 - (3) precautions are taken to reduce any pressure in the cargo tank vapour space and prevent an electrostatic spark from occurring.

4. If the tanker is equipped with an inert gas system the isolation valve required by **201. 5** is to remain closed during vapour transfer.
5. Unless equipped with an automatic self-test and circuit monitoring feature, each tank overflow control system alarm required by **204. 1 (7)**, on a cargo tank being loaded, is to be tested at the tank for proper operation prior to the start of cargo transfer.

207. Instruction Manual

1. An instruction manual including principles and procedures of operation of the vapour emission control system is to be prepared and provided on board
2. The instruction manual is also to include:
 - (1) piping diagram of vapour collection piping;
 - (2) the maximum allowable transfer rate;
 - (3) the maximum pressure drop in the vapour collection system for various transfer rates;
 - (4) the relief settings of each pressure and vacuum relief valve;
 - (5) pre-transfer procedures; and
 - (6) procedures to be followed in the event of a fault during vapour collection operations.

Section 3 Requirements for VEC2 Notation

301. General

1. In addition to the requirements of **Sec 2**, the requirements of **302.** and **303.** are to be complied with.

302. High level alarm system (2020)

1. Each cargo tank of a tanker is to be equipped with an high level alarm which:
 - (1) is to be independent of the overfill alarm system;
 - (2) is to be identified with the labels "HIGH LEVEL ALARM" in black letters at least 50 mm high on a white background;
 - (3) is to be set at no less than that corresponding to 95 % of tank capacity. The high level alarm is to come into operation before overfill alarm;
 - (4) is to give a visual and audible tank high level alarm to the ship's operator;
 - (5) is to alarm in the event of loss of power to the alarm system or failure of the electrical circuitry to the tank level sensor; and
 - (6) is to be able to be checked at the tank for proper operation prior to each transfer or contain an electronic self-testing feature which monitors the condition of the alarm circuitry and sensor.

303. Vapour overpressure and vacuum protection

1. The pressure relief setting is not to cause the valve to open at a pressure of less than 7 kPa.
2. The vacuum relief setting is not to open at less than 3.5 kPa below atmospheric pressure.
3. Relief capacities of PV valves are to be tested in accordance with **Para 1.5.1.3** of **API Standard 2000**.
4. The PV valve is to have a mechanical means to check its proper operation and to ensure that it will not remain in the open position.
5. In lieu of requirements of **205. 4**, vapour collection system is to be fitted with a pressure sensing device that senses the pressure in the main vapour collection line, which:
 - (1) has a pressure indicator located at the cargo control station;
 - (2) has a high pressure and a low pressure alarm that:
 - (A) is audible and visible at the cargo control station;
 - (B) alarms at a high pressure of not more than 90 % of the lowest pressure relief valve setting

- in the cargo tank venting system;
- (C) alarms at a low pressure of not less than 1 kPa for an inerted tanker, or the lowest vacuum relief valve setting in the cargo tank venting system for a non-inerted tanker.

Section 4 Requirements for VECL Notation

401. General

1. Requirements in this Section apply to ships engaged in the transportation of cargoes between a facility and another ship and vice versa(hereinafter referred to as "service ship").
2. In addition to the requirements of **Sec 3**, the requirements of **402.** are to be complied with.

402. Design and equipment

1. If the cargo tanks on a ship discharging cargo and a ship receiving cargo are inerted, the service ship is to:
 - (1) have a means to inert the vapour transfer hose prior to transferring cargo vapour;
 - (2) have an oxygen analyser with a sensor or sampling connection fitted within 3 m of the ship vapour connection which:
 - (A) activates an audible and visible alarm at the cargo control station when the oxygen content in the vapour collection system exceeds 8 % by volume;
 - (B) has an oxygen concentration indicator located at the cargo control station;
 - (C) has a connection for injecting a span gas of known concentration for calibration and testing of the oxygen analyser.
2. If the cargo tanks on a ship discharging cargo are not inerted, the vapour collection line on the service ship is to be fitted with an approved detonation flame arrester located within 3 m of the ship vapour connection.
3. An electrical insulating flange or one length of non-conductive hose is to be provided between the ship vapour connection on the ship.

Section 5 Surveys

501. General

1. Kinds of surveys

Cargo vapour emission control systems, which are registered or intended to be registered to the Society, are to be subjected to the following surveys:

- (1) Survey for classification of the cargo vapour emission control systems (hereinafter referred to as "Classification Survey")
- (2) Survey for maintaining classification of the cargo vapour emission control systems (hereinafter referred to as "Survey Assigned to Maintain Classification"), which are:
 - (A) Annual Survey
 - (B) Special Survey
 - (C) Occasional Survey

2. Time of classification survey and intervals of survey assigned to maintain classification

- (1) Classification Survey is to be carried out when the application for classification is made.
- (2) Survey Assigned to Maintain Classification is to be carried out at the periodical survey.

502. Classification Survey

1. Drawings and data

For the cargo vapour emission control systems intended to undergo a Classification Survey during

construction, the following plans and information in triplicate are to be submitted to the Society before the work is commenced.

- (1) Cargo vapour piping diagram
- (2) Wiring diagram and detail construction of cargo tank gauging systems, overfill control systems, pressure control systems and oxygen concentration indicator(if fitted)
- (3) Calculations associated with maximum allowable cargo transfer rate and PV valve capacity
- (4) Calculations for overfill settings.
- (5) Instruction manual for cargo vapour emission control systems in accordance with **207**.

2. Tests and inspections

Cargo vapour emission control systems are to be tested and inspected in accordance with applicable requirements in **Pt 5, Ch 6** and **Pt 7, Ch 6**.

503. Survey Assigned to Maintain Classification

1. Annual survey

- (1) For ships assigned with notation VEC1 and VEC2, the following items are to be surveyed.
 - (A) External examination of all cargo vapour piping systems
 - (B) Confirmation of the proper operation of the vapour manifold isolating valve
 - (C) Confirmation of the condition of the stud fitted at the vapour connection flanges
 - (D) Confirmation that any hoses used for the conveyance of vapour are in accordance with **202.4**
 - (E) Where inert gas distribution piping is used for vapour collection, confirmation of the continuing effectiveness of the inert gas main isolating valve
 - (F) Correct operation of the closed cargo gauging system for each tank which is connected to the vapour collection system.
 - (G) Examination of the cargo tank venting system and flame screens
 - (H) Verification of the satisfactory operation of the followings:
 - (a) High vapour pressure in main vapour collection line
 - (b) Low vapour pressure in main vapour collection line
 - (c) Cargo tank overfill
 - (d) Cargo tank high level (not applicable for notation VEC1)
 - (e) Loss of power to alarm system
 - (f) Automatic shutdown system (where fitted)
 - (I) Examination of the permanent records to verify the operation and maintenance of the system
- (2) For ships assigned with notation VECL, the following items are to be surveyed in addition to above (1).
 - (A) Confirmation that the detonation flame arrester (where fitted) is in satisfactory condition.
 - (B) Confirmation that a means of electrical insulation is provided for the vapour manifold connection.
 - (C) Confirmation of the accuracy of the fixed oxygen analyzer by means of a calibration gas.
 - (D) General examination of any devices (such as compressors or blowers) used to increase the vapour flow rate.

2. Special survey

- (1) For ships assigned with notation VEC1 and VEC2, the following items are to be surveyed in addition to annual survey items required by **503. 1 (1)**.
 - (A) Examination of all valves for cargo vapour emission control systems are to be examined.
 - (B) Examination of the closed gauging system
 - (C) Examination of the independent cargo tank overfill alarms
 - (D) Testing vapour collection system hoses for electrical continuity or non-conductivity
 - (E) Examination of deck seals where inert gas distribution piping is used for vapour collection
- (2) For ships assigned with notation VECL, annual survey items required by **503. 1 (2)** and items required by (1) above are to be surveyed. ⚴

CHAPTER 10 BALLAST WATER MANAGEMENT

Section 1 General

101. Application

1. The requirements in this Chapter apply to ballast water management complying with the **International Convention for the Control and Management of Ship's Ballast Water and Sediments** (hereinafter referred to the Convention), of the ships classed with or intended to be registered under the Society.
2. "Guidelines" are referred to in this Chapter are the Guidelines referred to in the Convention.

102. Definitions

Terms used in this Chapter are defined as follows:

1. **Ballast Water Management** means several processes, either singularly or in combination, to avoid the uptake or discharge of harmful aquatic organism and pathogens within ballast water and sediments through treatment or exchange of ballast water.
2. **Ballast water management plan** means the plan for the handling or treating of ballast water onboard a ship to minimize the transfer of harmful organisms or pathogens in the ship's ballast water and sediment.
3. **Convention** means the International Convention for the Control and Management of Ship's Ballast Water and Sediments.
4. **Ballast water exchange** means a process involving the replacement of water in a ballast tank using the following methods or other exchange methodologies recommended or required by Organization.
 - (1) **Sequential method** means a process by which a ballast tank intended for the carriage of water ballast is first emptied and then refilled with replacement ballast water to achieve at least a 95 % volumetric exchange.
 - (2) **Flow-through method** means a process by which replacement ballast water is pumped into a ballast tank intended for the carriage of water ballast, allowing water to flow through overflow or other arrangements. At least 3 times the tank volume is to be pumped through the tank.
 - (3) **Dilution method** means a process by which replacement ballast water is filled through the top of the ballast tank intended for the carriage of water ballast with simultaneous discharge from the bottom at the same flow rate and maintaining a constant level in the tank throughout the ballast exchange operation. At least 3 times the tank volume is to be pumped through the tank.
5. **Ballast water management system** means any system which processes ballast water such that it meets or exceeds the Ballast Water Performance Standard in Regulation D-2 in the Convention. The BWMS includes ballast water treatment equipment, all associated , and sampling facilities. The categorization of BWMS technologies is given in **Table 9.10.1** Applicability of the requirements for each BWMS technology is in accordance with **Table 9.10.2 (2022)**
6. **Ballast water treatment equipment** means a mechanical, physical, chemical, or biological process, either singularly or in combination, that removes, renders harmless, or avoids the uptake or discharge of harmful aquatic organisms and pathogens within ballast water and sediments. Ballast water treatment equipment may operate at the uptake or discharge of ballast water, during the voyage, or at a combination of these events.
7. **Ballast Water Management Room** is any space containing equipment belonging to the Ballast Water Management System. A space containing remote controls for the BWMS or a space dedicated to the storage of liquid or solid chemicals for BWMS need not be considered as a BWMR for the purposes of this Rules. (2022)
8. **Organization** means the International Maritime Organization (IMO).
9. **Tanker** means a tanker defined by Pt 8, Ch 1, 103. 48.

103. Class notations

Ships which comply with this Chapter may be assigned with the one or a combination of following notations.

1. BWE: Ships in which the ballast water exchange system is installed in accordance with **Sec 2** for ballast water management
2. BWT: Ships in which the ballast water management system is installed in accordance with **Sec 3** for ballast water management

Table 9.10.1 Categorization of BWMS technologies (2022)

BWMS's Technology category ⁽³⁾ → (Refer to Annex 9-3)	1	2	3a	3b	3c	4	5	6	7a	7b	8
	In-line UV or UV + Advanced Oxidation Technology (AOT) or UV + TiO ₂ or UV + Plasma	In-line Flocculation	In-line membrane separation and de-oxygenation (injection of N ₂ from a N ₂ Generator)	In-line de-oxygenation (injection of Inert Gas from Inert Gas Generator)	In-tank de-oxygenation with Inert Gas Generator	In-line full flow electrolysis	In-line side stream electrolysis ⁽²⁾	In-line (stored) chemical injection	In-line side-stream ozone injection without gas/liquid separation tank and without Discharge treatment tank	In-line side-stream ozone injection with gas/liquid separation tank and Discharge water treatment tank	In-tank pasteurization and de-oxygenation with N ₂ generator
Characteristics ↓											
Des-infection lasting											
when ballasting											
After-treatment de-ballasting											
when											
Examples of dangerous gas as defined in Sec 3 301. 2. (2)											
Notes: (1) To be investigated on a case by case basis based on the result of the IMO (GESAMP) MEPC report for Basic and Final approval in accordance with the G9 Guideline. (2) In-line side stream electrolysis may also be applied in-tank in circulation mode (no treatment when ballasting or de-ballasting) (3) Taking into consideration future developments of BWMS technologies, some additional technologies may be considered in this Table 1 by identifying their characteristics in the same manner as for the above BWMS cat.1, 2, 3a, 3b, 3c, 4, 5, 6, 7a, 7b and 8.											

Table 9.10.2 Applicability of the requirements for each BWMS technology

BWMS's Technology category → (Refer to Annex 9-3)	1	2	3a	3b	3c	4	5	6	7a	7b	8
	In-line UV or UV + Advanced Oxidation Technology (AOT) or UV + TiO ₂ or UV + Plasma	In-line Flocculation	In-line membrane separation and de-oxygenation (Injection of N ₂ from a N ₂ Generator)	In-line de-oxygenation (Injection of Inert Gas from Inert Gas Generator)	In-tank de-oxygenation with Inert Gas Generator	In-line full flow electrolysis	In-line side stream electrolysis	In-line (stored) chemical injection	In-line side-stream ozone injection without gas/liquid separation tank and without Discharge treatment tank	In-line side-stream ozone injection with gas/liquid separation tank and Discharge water treatment tank	In-tank pasteurization and de-oxygenation with N ₂ generator
Characteristics ↓											
301. 1 and 2	X	X	X	X	X	X	X	X	X	X	X
302. 1 and 2 (1) (2)	X	X	X	X	X	X	X	X	X	X	X
302. 2 (3) (4) and 3 (6) (7)			X	X	X						X
302. 3 (1) to (5)	X	X	X	X	X	X	X	X	X	X	X
302. 4			X	X	X						X
302. 4 (2)				X						X	
302. 4 (3)	X	X	X	X	X	X	X	X	X	X	X
303. 1 (1) (A)				X	X				X	X	
303. 1 (1) (B)						X	X	X			
303. 1 (2)	X	X	X	X		X	X	X	X	X	
303. 1 (3)	X	X	X	X	X	X	X	X	X	X	X
303. 1 (4) (5)	X	X	X	X		X	X	X	X	X	
304. 1 (1)		X	X			X	X	X	X	X	X
304. 1 (2)			X	X	X				X	X	X
304. 1 (3)									X	X	
304. 1 (4)						X	X	X	X	X	
304. 1 (5)						X	X	X			
304. 1 (6)			X	X	X				X	X	X
304. 2 (1) to (4)		X	X	X	X	X	X	X	X	X	X
304. 2 (5)			X			X	X	X	X	X	X
304. 2 (6)			X						X	X	X
304. 2 (7)			X			X	X	X	X	X	X
304. 3		X				X	X	X	X	X	
304. 4						X	X	X	X	X	

Section 2 Ballast Water Exchange Systems

201. General

1. Application

- (1) Requirements of this Section are to be applied to ships where ballast water exchange at sea is accepted as a ballast water management process.
- (2) Ballast water exchange systems are to comply with Ballast Water Exchange Standard (D-1) of the Convention.
- (3) Ships in which ballast water exchange systems are installed in accordance with this Section will be assigned an BWE notation.
- (4) In addition to requirements in this Chapter, applicable requirements in **Pt 5, Ch 6, Sec 4** are to be complied with.

202. Ballast water exchange systems

1. Valve arrangement

- (1) Every ballast tank and hold intended for the carriage of water ballast is to be provided with isolating valves for filling and emptying purposes.
- (2) The isolating valves specified in above (1) are to be arranged so that they remain closed at all times except when ballasting, deballasting or ballast exchange operations are being carried out.

2. Sea chests and shipside openings intended for ballast water exchange

The relative positions of ballast water intake and discharge openings are to be such as to preclude as far as practicable the possibility of contamination of replacement ballast water by water which is being pumped out.

3. System arrangement

- (1) The design of ballast water systems is to allow for ballast water exchange operations with the minimum number of operational procedures.
- (2) The internal arrangements of ballast tanks as well as ballast water piping inlet and outlet arrangements are to allow for complete ballast water exchange and the clearing of any sediments. (Refer to **Guideline G12, Guidelines on Design and Construction to Facilitate Sediment Control on Ships (IMO Res. MEPC.150(55))**.)
- (3) The design of sea suction line strainers is to be such as to permit cleaning of strainers without interrupting ballast water exchange procedures.

4. Special provisions depending on the method of ballast water exchange

- (1) Sequential method
 - (A) The capacity of each pump is to be capable of providing ballast water exchange of the largest dedicated ballast water tank or group of tanks that are undergoing simultaneous exchange (whichever is the greater volume), as per the approved Ballast Water Management Plan.
 - (B) Ballast water exchange of cargo holds used for the carriage of water ballast will require an extended period of time over that specified in above (A) and is normally to be completed within twenty four hours by one pump.
- (2) Flow-through method
 - (A) The design of water ballast exit arrangements are to be such that the tank or hold is not subject to a pressure greater than that for which it has been designed.
- (3) Dilution method
 - (A) Where the dilution method is accepted, arrangements are to be made to automatically maintain the ballast water level in the tanks at a constant level. These arrangements are to include the provision of a manual emergency stop for any operating ballast pump, in case of valve malfunction or incorrect control actions.
 - (B) High and low water level alarms are to be provided where maintaining a constant level in a tank is essential to the safety of the ship during ballast water exchange.

203. Surveys

1. General

- (1) Kinds of surveys
Ballast water exchange systems, which are registered or intended to be registered to the Society, are to be subjected to the following surveys:
 - (A) Survey for classification of the ballast water exchange systems (hereinafter referred to as "Classification Survey")
 - (B) Survey for maintaining classification of the ballast water exchange systems (hereinafter referred to as "Survey Assigned to Maintain Classification"), which are:
 - (a) Annual Survey
 - (b) Special Survey
 - (c) Occasional Survey
- (2) Time of classification survey and intervals of survey assigned to maintain classification
 - (A) Classification Survey is to be carried out when the application for classification is made.
 - (B) Survey Assigned to Maintain Classification is to be carried out at the periodical survey.

2. Classification Survey

- (1) Drawings and data
For the Ballast water exchange systems intended to undergo a Classification Survey during construction, the following plans and information in triplicate are to be submitted to the Society before the work is commenced.
 - (A) Arrangement of the ballast tanks and pumps
 - (B) Capacity of the ballast tanks and pumps
 - (C) Ballast piping diagram including vents and overflows, valve arrangement and controls, and level gauge in the ballast tanks
 - (D) Calculations demonstrating the adequacy of the vents and overflows to prevent over-pressurization or under-pressurization of the ballast tanks
 - (E) The location of ballast water and sediment sampling openings
 - (F) Ballast water management plan
 - (G) Trim & stability booklet and loading manual
- (2) Tests and inspections
Piping systems and control systems of ballast water exchange systems are to be tested and inspected in accordance with applicable requirements in **Pt 5** and **Pt 6**.

3. Survey Assigned to Maintain Classification

- (1) Annual survey
 - (A) External examination of structure, equipment, controls and piping systems
 - (B) Review of the ballast water exchange records and the ballast water exchange plan
 - (C) Verification of the operation of alarms and safety devices
- (2) Special survey
 - (A) Annual survey items required by above (1)
 - (B) Examination of valves, seals, pumps, control panels, vents, air pipes and monitoring sensors.

Section 3 Ballast Water Management Systems

301. General

1. Application

- (1) Requirements of this Section are to be applied to ships where ballast water management systems are accepted as a ballast water management process.
- (2) Ballast water management systems are to comply with Ballast Water Performance Standard (D-2) of the Convention.
- (3) The ballast water management system is to be type-approved by Flag Administration and the Society as followings. (2021)
 - (A) BWMS to be installed on or after 28th October 2020 is to be approved by Res. MEPC.300(72) (BWMS Code) or Res. MEPC.279(70) (2016 G8)
 - (B) BWMS to be installed before 28th October 2020 is to be approved by Res. MEPC.300(72) (BWMS Code), Res. MEPC.279(70) (2016 G8) or **Res. MEPC.174(58)(G8)**
 - (C) The word "installed" means the contractual date of delivery of the ballast water management system to the ship. In the absence of such a date, the word "installed" means the actual date of delivery of the ballast water management system to the ship. In addition, in the International Ballast Water Management Certificate, the installation date described above in relation to the installation of the ballast water treatment system and the date of commissioning thereafter may be existed.
- (4) Ships in which ballast water management systems are installed in accordance with this Section will be assigned an BWT notation.
- (5) In addition to requirements in this Chapter, applicable requirements in **Pt 5, Ch 6, Sec 4** are to be complied with.

2. Definitions

- (1) **Hazardous area** is defined in IEC 60092-502:1999 and means an area in which an explosive gas atmosphere is or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of electrical apparatus. The classification of hazardous area is to be in accordance with **Pt 6, Ch 1, 101. 4 (1)**. When a gas atmosphere is present, the following hazards may also be present: toxicity, asphyxiation, corrosivity and reactivity. (2022)
- (2) **Dangerous gas** means any gas which may develop an atmosphere being hazardous to the crew and/or the ship due to flammability, explosivity, toxicity, asphyxiation, corrosivity or reactivity and for which due consideration of the hazards is required, e.g. hydrogen(H₂), hydrocarbongas, oxygen(O₂), carbon dioxide(CO₂), carbon monoxide(CO), ozone(O₃), chlorine(Cl₂) and chlorine dioxide(ClO₂), etc. (2022)
- (3) **Dangerous liquid** means any liquid that is identified as hazardous in the Material Safety Data Sheet or other documentation relating to this liquid.
- (4) **Non-hazardous area** means an area which is not a hazardous area as defined in above (3). (2022)
- (5) **Cargo area is** defined as follows. (2022)
 - (A) For tankers, **Pt 7, Sec 1, 103. 6**
 - (B) For chemical tankers, **Pt 7, Sec 6, 106. 6**
 - (C) For gas carriers, **Pt 7, Sec 5, 105. 6**
 - (D) For offshore support vessels, Paragraph 1.3.1 of the IMO Resolution A.673(16) as amended by Resolution MSC.236(82) or Paragraph 1.2.7 of the IMO Resolution A.1122(30), as applicable.

302. Ballast water management systems

1. General

- (1) The Ballast water management systems (BWMS) is to be operated in accordance with the requirements specified in the Type Approval Certificate(TAC) issued by the Flag Administraion. BWMS should be operated within its Treatment Rated Capacity (TRC) as per the TAC. This may require limiting of ship's ballast pump flow rates.
The arrangement of the bypasses or overrides of the BWMS is to be consistent with the approved Operation Maintenance and Safety Manual by the Flag Administration's Type Approval.

In case the maximum capacity of the ballast pump(s) exceeds the maximum treatment rated Capacity (TRC) of the BWMS specified in the TAC issued by the Flag Administration, there should be a limitation on the BWMP giving a maximum allowable flow rate for operating the ballast pump(s) that shall not exceed the maximum TRC of the BWMS. (2022)

- (2) Where the ballast pump has a capacity exceeding the treatment rated capacity of an BWMS, an appropriate flow control arrangement is to be provided for the ballast pumps and operational manual for flow control arrangement is to be specified in the ballast water management plan.
- (3) BWMS should be subject to design review by the Classification Society to verify the compliance of the BWMS's manufacturer package with the Classification Rules. Manufacturers of the BWMS may apply for this design review at the type approval process.

In general, monitoring functions of BWMS belongs to system category I under the application of the **Table 6.2.2** in **Pt 6 Ch 2**. However, in case a by-pass valve is integrated in the valve remote control system, the by-pass valve belongs to the system category II Ballast transfer remote control system.

The BWMS's components which required in **Pt 5** and **Pt 6** are required to be inspected and certified by the Classification Society at the manufactory (Society Certificate (SC) as defined in UR M72) including pressure vessels, piping class I or II, filters, switchboards, etc. (2022)

- (4) In addition to requirements in this Chapter, applicable requirements in **Pt 5, Ch 6, Sec 4** are to be complied with. (2022)

2. Piping systems

- (1) The material and design of BWMS piping systems are to comply with **Pt 5, Ch 6, Sec 1**.
- (2) BWMS is to be arranged such that the ballast water flows to the farthest ballast tank at maximum capacity specified in the ballast water management plan.
- (3) Where a vacuum or overpressure may occur in the ballast piping or in the ballast tanks due to the height difference or injection of inert gas or nitrogen(N₂), a suitable protection device is to be provided, i.e. P/V valves, P/V breakers, P/V breather valves, or pressure safety relief valve or high/low pressure alarms). The pressure and vacuum settings of the protection device should not exceed the design pressure of the ballast piping (BWMS categories 3a and 3b) or ballast tank (BWMS categories 3a, 3b and 3c), as relevant. (2022)
- (4) For BWMS categories 3a, 3b and 3c, the inert gas or nitrogen product enriched air from the inert gas system and from the protection devices installed on the ballast tanks (i.e. P/V valves, P/V breakers or P/V breather valves) are to be discharged to a safe location on the open deck. (2022) **[See Guidance]**

3. Electrical equipment and control systems

- (1) Electrical equipment and control systems are to comply with **Pt 6** unless otherwise specially provided in each Paragraph.
- (2) Arrangements of electrical equipment installed in hazardous are to comply with **Pt 6, Ch 1, Sec 9**.
- (3) Local instrumentation of the BWMS is to be fitted so as to enable to check the followings:
 - (A) Ballast pump operational status;
 - (B) BWMS operational status; and
 - (C) Remote control valve, where fitted, position indication
- (4) The BWMS is to be provided with by-pass or override arrangement to effectively isolate it from any essential ship system to which it is connected. For new installation or retrofit to existing ships, under normal operating conditions of ballasting and de-ballasting given in the Ballast Water Management Plan (BWMP) the adequacy of the generating plant capacity installed on the vessel is to be demonstrated by an electrical load analysis.

For retrofit installation to existing ships, a revised electrical load analysis with preferential trips of non-essential services can be accepted. (2022)
- (5) Electric and electronic components are not to be installed in a hazardous area unless they are of certified safe type for use in the area. Cable penetrations of decks and bulkheads are to be sealed when a pressure difference between the areas is to be maintained. (2022)
- (6) When the concerned ballast tanks are hazardous areas, an extension of hazardous area is to be considered at the outlet of the protection devices: with reference to IEC 60092-502:1999 §4.2.2.9 the areas on open deck, or semi-enclosed spaces on open deck, within 1.5 m of their outlets are to be categorized hazardous zone 1 and with reference to IEC 60092-502:1999 §4.2.3.1, an additional 1.5 m surrounding the 1.5 m hazardous zone 1 is to be categorized hazardous zone 2. Any source of ignition such as anchor windlass or opening into chain locker should be located outside the hazardous areas. (2022)

- (7) Where products covered by IEC 60092-502:1999 are stored on-board or generated during operation of the BWMS, the requirements of this standard shall be followed in order to: (2022)
- Define hazardous areas and acceptable electrical equipment
 - Design ventilation systems.
- 4. Inert Gas Systems (2022)**
- (1) Inert gas systems installed for de-oxygenation BWMS (categories 3a, 3b, 3c and 8) are to be designed in accordance with the following requirements:
- (A) Requirements in **Annex 8-5, Pt 8**:
- (a) **1** (2) (3)
 - (b) **2** (6) (7) (8)(A)-(C)(F) (11)(A)-(E) except (E)(a)(iii) and ©
 - (c) **3** (1)(B) (2) (4)(B) (5)-(7) except (7)(B)(a)
 - (d) **4** (5) (8) (9)
 - (e) For inert gas systems installed for in-tank de-oxygenation BWMS (category 8): **2** (9) (10) except (10)(F)(G)(J)
- (B) In general, when applying requirements in **Annex 8-5, Pt 8** to inert-gas based BWMS, the following modifications are to be considered:
- (a) The terms "cargo tank" and "cargo piping" are to be replaced by "ballast water tank" or "ballast water piping" as relevant.
 - (b) The term "cargo control room" is to be replaced by "BWMS control station" as relevant
 - (c) Requirements for slop tanks on combination carriers are to be disregarded
 - (d) When applying **2** (11) (E) (a) (i) in **Annex 8-5, Pt 8**, the acceptable oxygen content is to be specified by the manufacturer, 5% oxygen content need not necessarily be applied.
- (C) In addition to the requirements in (A) and (B), the following requirements comply with:
- (a) Plans in diagrammatic form are to be submitted for appraisal and should include the following:
 - (i) details and arrangement of the inert gas generating plant including all control and monitoring devices;
 - (ii) arrangement of the piping system for distribution of the inert gas.
 - (b) Subsequent surveys are to be carried out at the intervals required by the Classification Society Rules.
 - (c) Requirements in **Annex 8-5, Pt 8**:
 - (i) **4** (3) (4) (10) (11)
 - (ii) **5** (4) (5) (6) (In applying **5** (6), the terms "cargo tanks" and "cargo piping" are to be understood as "ballast tanks" and "ballast piping" respectively. For de-oxygenation BWMS (categories 3a, 3b, 3c and 8), the requirements in (A) & (B) prevail.)
- (2) When cavitation is the BWMS treatment process (for example by use of pressure vacuum reactor working in combination with a vertical ballast water drop line) or part of the BWMS treatment process (for example by use of "smart pipe" or "special pipe" in BWMS category 7b or by use of "venturi pipe" in BWMS technology 3b) or by use other means, the design and the wall thickness or grade of materials or inside coating or surface treatment of the part of the piping where the cavitation is taking place is to be specifically considered.
- (3) When it is required to have an automatic shutdown of the BWMS for safety reasons, this must be initiated by a safety system independent of the BWMS control system.

303. Additional requirements for tankers (2022)

1. The following requirements are to be applied for tankers.

- (1) Hazardous area classification is to be in accordance with **IEC 60092-502:1999** with due consideration of IACS UI SC274.
- (A) BWMS using ozone generators (categories 7a and 7b) and de-oxygenation BWMS using inert gas generator by treated flue gas from main or auxiliary boilers or gas from an oil or gas-fired gas generator (categories 3b and 3c) are to be located outside the cargo area in accordance with **3** (1) (B) in **Annex 8-5, Pt 8**. **[See Guidance]**
- (B) In-line full flow electrolysis BWMS (category 4), in-line side-stream electrolysis BWMS (category 5) and in-line injection BWMS using chemical which is stored onboard (category 6) can be located inside the hazardous areas with due consideration of the requirement of **302.3** (5) but should not be located inside the cargo pump room unless it is demonstrated by the BWMS manufacturer that the additional hazards that could be expected from dangerous liquids and dangerous gases stored or evolved from the BWMS (for example H₂ generation):

【See Guidance】

- (a) do not lead to an upgrade of the hazardous area categorization of the cargo pump room
 - (b) are not reactive with the cargo vapours expected to be present in the cargo pump room,
 - (c) are not reactive with the fire-extinguishing medium provided inside the cargo pump room
 - (d) are not impacting the performance of the existing fire-fighting systems provided inside the cargo pump room
 - (f) are not introducing additional hazards inside the cargo pump room such as toxicity hazards that would not have been prior addressed by suitable counter measures.
- (2) In general, two independent BWMS should be required i.e. one for ballast tanks located within the cargo area and the other one for ballast tanks located outside cargo area. Specific arrangements where only one single In-line BWMS (categories 1, 2, 3a, 3b, 4, 5, 6, 7a and 7b) could be accepted are given in **table 9.10.3**. **【See Guidance】**
- (3) Isolation between ballast piping serving the ballast tanks inside and outside of the cargo area is to be in accordance with the following requirements:
- (A) Interconnection in between the ballast piping serving the ballast tanks located within the cargo area and the ballast piping serving the ballast tanks located outside the cargo area may be accepted if appropriate isolation arrangement is provided in accordance with **305**. is applied.

【See Guidance】

The means of the appropriate isolation is to be one of the following;

- (a) Two(2) non-return valves with positive means of closing in series with a spool piece (refer **Fig 9.10.2(a)**), (also mentioned “means of dis-connection” in **305**.) **【See Guidance】**
- (b) Two(2) non-return valves with positive means of closing in in series with a liquid seal at least 1.5 m in depth (refer **Fig 9.10.2(b)**) **【See Guidance】**
- (c) Automatic double block and bleed valves and a non-return valve with positive means of closing. (refer **Fig 9.10.2(c)**) **【See Guidance】**

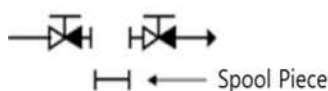


Fig 9.10.2(a)

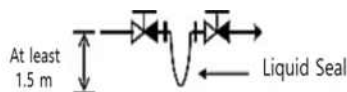


Fig 9.10.2(b)

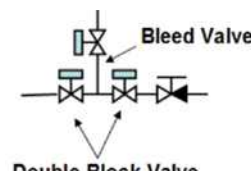


Fig 9.10.2(c)

- (B) The above-mentioned means of appropriate isolation is to be provided on the open deck in the cargo area. **【See Guidance】**
- (4) Sampling lines which are connected to the ballast water piping system serving the tanks in the cargo area and provided for the purpose for any BWMS: ballast water sampling required by the G2 Guideline of the BWM Convention (2004) or BWMS technologies categories 4, 5, 6, 7a and 7b: total residual oxidant (TRO) analysis in closed loop system are not to be led into a non-hazardous enclosed space outside the cargo area.
- (5) In spite of (4), the sampling lines may lead into a non-hazardous enclosed space outside the cargo area provided the following requirements are fulfilled:
- (A) The sampling facility (for BWMS monitoring/control) is to be located within a gas tight enclosure (hereinafter, referred to as a 'cabinet'), and the following (a) through (d) are to be complied.
- (a) In the cabinet, a stop valve is to be installed on each sampling line.
 - (b) Gas detection equipment is to be installed in the cabinet and the valves specified in (a) above are to be automatically closed upon activation of the gas detection equipment.
 - (c) Audible and visual alarm signals are to be activated both locally and at the BWMS control station when the concentration of explosive gases reaches a pre-set value, which should not be higher than 30% of the lower flammable limit (LFL). Upon an activation of the alarm, all electrical power to the cabinet is to be automatically disconnected.
- 【See Guidance】**
- (d) The cabinet is to be vented to a safe location in non-hazardous area on open deck and the vent is to be fitted with a flame arrester.
- (B) The standard internal diameter of sampling pipes is to be the minimum necessary in order to achieve the functional requirements of the sampling system.

- (C) The cabinet is to be installed as close as possible to the bulkhead facing the cargo area, and the sampling lines located outside the cargo area are to be routed on their shortest ways.
- (D) Stop valves are to be located in the non-hazardous enclosed space outside the cargo area, in both the suction and return lines close to the penetrations through the bulkhead facing the cargo area. A warning plate stating "Keep valve closed when not performing measurements" is to be posted near the valves. Furthermore, in order to prevent backflow, a water seal or equivalent arrangement is to be installed on the hazardous area side of the return pipe.
- (E) A stop valve is to be installed on the cargo area for each sampling line (i.e. both the suction and return lines).
- (F) The samples which are extracted from the ballast water piping system serving the tanks within the cargo area are not to be discharged to a tank located outside the cargo area and not to discharge to a piping line supplying the spaces located outside the cargo area. (refer Fig 9.10.3)

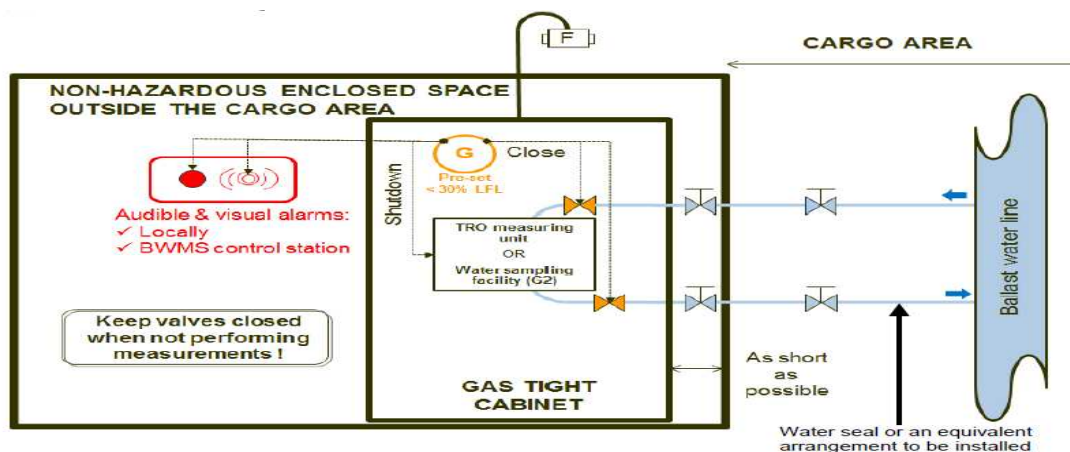


Fig 9.10.3

304. Special requirements for BWMS categories 2, 3a, 3b, 3c, 4, 5, 6, 7a, 7b and 8 generating dangerous gas or dealing with dangerous liquids. (2022)

1. Where the operating principle of the BWMS involves the generation of a dangerous gas, the following requirements are to be satisfied:
 - (1) Gas detection equipment is to be fitted in the spaces where dangerous gas could be present, and an audible and visual alarm is to be activated both locally and at the BWMS control station in the event of leakage.
The gas detectors should be located as close as possible to the BWMS components where the dangerous gas may accumulate.
For flammable gases and explosive atmosphere including but not limited to H_2 , the construction, testing and performance of the gas detection devices is to be in accordance with IEC 60079-29-1:2016, IEC 60079-29-2:2015, IEC 60079-29-3:2014 and/or IEC 60079-29-4:2009, as applicable.
Where other hazards are considered like toxicity, asphyxiation, corrosive and reactivity hazards, a recognized standard acceptable to the Society is to be selected with due consideration of the specific gases to be detected and due consideration of the performance of the detection device with regards to the specific atmosphere where it is used.
 - (2) In spaces where inert gas generator systems are fitted (BWMS categories 3b and 3c) or nitrogen generators are fitted (BWMS categories 3a and 8), at least two oxygen sensors shall be positioned at appropriate locations (as required by Pt 8 Annex 8-5 2 (11) (E) (d)) to alarm when the oxygen level falls below 19%.
 - (A) The alarms shall be both audible and visual and shall be activated:
 - (a) inside the space
 - (b) at the entry into the space

- (c) inside the BWMS control station
- (B) For BWMS categories 7a and 7b, at least two oxygen sensors shall be positioned at appropriate locations in the following spaces:
 - (a) spaces where ozone generators are fitted
 - (b) spaces where ozone destructors are fitted
 - (c) spaces where ozone piping is routed
- (C) to alarm when the oxygen level raises above 23 %. The alarms shall be both audible and visual and shall be activated at the following locations:
 - (a) inside the space
 - (b) at the entry into the space
 - (c) inside the BWMS control station
- (D) Automatic shut-down of the BWMS is to be arranged when the oxygen level raises above 25%. Audible and visual alarms independent from those specified in the preceding paragraph are to be activated prior to this shut-down.
- (3) For BWMS categories 7a and 7b, at least one ozone sensor shall be provided at the vicinity of the discharge outlet to the open deck from the ozone destructors addressed in safe location to alarm when the ozone concentration level raises above 0.1 ppm. The alarms shall be both audible and visual and shall be activated in the BWMS control room. **【See Guidance】**
 - (A) In addition, at least two ozone sensors shall be positioned at appropriate location in the following spaces:
 - (a) spaces where ozone generators are fitted
 - (b) spaces where ozone destructors are fitted
 - (c) spaces where ozone piping is routed
 - (B) to alarm when the ozone concentration level raises above 0.1 ppm. The alarms shall be both audible and visual and shall be activated at the following locations:
 - (a) inside the space
 - (b) at the entry into the space
 - (c) inside the BWMS control station
 - (C) Automatic shut-down of the BWMS is to be arranged when the ozone concentration measured from one of the two sensors inside the space raises above 0.2 ppm.
- (4) Inside double walled spaces or pipe ducts constructed for the purpose of **304. 6** (1) of the Guidance, sensors are to be provided for the detection of H₂ leakages (BWMS categories 4, 5 and 6 when relevant) or O₂ leakages (BWMS categories 7a and 7b) or O₃ leakages (BWMS categories 7a and 7b). The sensors are to activate an alarm at the high level settings and automatic shut-down of the BWMS at the high-high level settings described in above 1 (1) to (3) **【See Guidance】**
- (5) For in-line full flow electrolysis BWMS (category 4), in-line side-stream electrolysis BWMS (category 5) and in-line injection BWMS using chemical which is stored onboard (category 6): the hydrogen de-gas arrangement (when provided) is to be provided with redundant ventilation fans and redundant monitoring of the ventilation system.
In addition the ventilation fan shall be certified explosion proof and have spark arrestor to avoid ignition sources to enter the ventilation systems whereas remaining H₂ gas may be present in dangerous concentrations.
Audible and visual alarms and automatic shut-down of the BWMS are to be arranged for respectively high and high-high levels of H₂ concentration. The open end of the hydrogen by-product enriched gas relieving device is to be led to a safe location on open deck. **【See Guidance】**
- (6) The open end of inert gas or nitrogen gas enriched air (BWMS categories 3a, 3b, 3c and 8) or oxygen-enriched air (BWMS categories 3a, 7a, 7b and 8) are to be led to a safe location on open deck. **【See Guidance】**
- 2. Where the piping is conveying active substances, by-products or neutralizers that are containing dangerous gas or dangerous liquids as defined respectively in **301. 2** (2) and (3), the following requirements are to be satisfied: **【See Guidance】**
 - (1) Irrespective of design pressure and temperature, the piping is to be either of Class I (without special safeguard) or Class II (with special safeguard) as required by **table 5.6.1** in **Pt 5 Ch 6**. The selected materials, the testing of the material, the welding, the non-destructive tests of the welding, the type of connections, the hydrostatic tests and the pressure tests after assembly on-board are to be as required in **Pt 5 Ch 6**. Mechanical joints, where allowed, are to be selected in accordance with **table 5.6.11** in **Pt 5 Ch 6**. **【See Guidance】**

- (2) The length of pipe and the number of connections are to be minimised.
 - (3) Inside double walled space or pipe ducts constructed as the special safeguard for the purpose of **304. 6** (1) of the Guidance are to be equipped with mechanical exhaust ventilation leading to a safe location on open deck. **[See Guidance]**
 - (4) The routing of the piping system is to be kept away from any source of heating, ignition and any other source that could react hazardously with the dangerous gas or liquid conveyed inside. The pipes are to be suitably supported and protected from mechanical damage.
 - (5) Pipes carrying acids are to be arranged so as to avoid any projection on crew in case of a leakage.
 - (6) H₂ by-product enriched air vent pipes (BWMS categories 4, 5 and 6) or O₂ enriched air vent pipes (BWMS categories 3a, 7a, 7b and 8) or O₃ piping (BWMS categories 7a and 7b) shall not be routed through accommodation spaces, services spaces and control stations.
 - (7) O₂ enriched air vent pipes (BWMS categories 3a, 7a, 7b and 8) shall not be routed through hazardous areas unless it is arranged inside double walled pipes or pipe ducts constructed as the special safeguard for the purpose of **304. 6** (1) of the Guidance and provided with suitable gas detection as described in **1** (4) and mechanical exhaust ventilation as described in **2** (3).
 - (8) The routing of H₂ by-product enriched air vent pipes (BWMS categories 4, 5 and 6) or O₂ enriched air vent pipes (BWMS categories 3a, 7a, 7b and 8) is to be as short and as straight as possible. When necessary, horizontal portions may be arranged with a minimum slope in accordance with the manufacturer's recommendation.
- 3.** For BWMS using chemical substances or dangerous gas which are stored on-board for either storage or preparation of the active substances (BWMS categories 2 and 6), storage or preparation of the neutralizers (BWMS categories 4, 5, 6, 7a and 7b) or recycling the wastes produced by the BWMS (BWMS category 2).
- (1) procedures are to be in accordance with the Material Safety Data Sheet and BWM.2/Circ.20 "Guidance to ensure safe handling and storage of chemicals and preparations used to treat ballast water and the development of safety procedures for risks to the ship and crew resulting from the treatment process", and the following measures are to be taken as appropriate:
 - (A) The materials, inside coating used for the chemical storage tanks, piping and fittings are to be resistant to such chemicals substances.
 - (B) Chemical substances (even if they are not defined as dangerous liquid in the sense of **301. 2** (3) and gas storage tanks are to be designed, constructed, tested, inspected, certified and maintained in accordance with:
 - (a) for independent tanks permanently fixed onboard containing dangerous liquids (eg. sulfuric acid H₂SO₄) or dangerous gas (eg. oxygen O₂): the Classification Rules as applicable to pressure vessels
 - (b) for independent tanks permanently fixed onboard not containing dangerous liquid (eg. sodium sulphite, sodium bisulphite or sodium thiosulphate neutralizers) and not containing dangerous gas (eg. nitrogen N₂): the Classification Rules or other industry standard recognized by the Classification Society
 - (c) for portable tanks: the IMDG Code or other industry standard recognized by the Classification Society.
 - (C) When the chemical substances are stored inside integral tanks, the ship's shell plating shall not form any boundary of the tank.
 - (D) Dangerous liquids and dangerous gas storage tank air pipes are to be led to a safe location on open deck. **[See Guidance]**
 - (E) An operation manual containing chemical injection procedures, alarm systems, measures in case of emergency, etc. is to be kept onboard.
 - (F) Dangerous liquid storage tanks and their associated components like pumps and filters, are to be provided with spill trays or secondary containment system of sufficient volume to contain potential leakages from tank openings, gauge glasses, pumps, filters and piping fittings. Further to the safety and/or pollution assessment of the concerned chemical substances, consideration should be provided for segregation of the drains from such spill trays (or secondary containment system) or piping systems from engine room bilge system or from cargo pump room bilge system, as applicable. When necessary, arrangement should be provided within the spill trays (or within the secondary containment system) for the detection of dangerous liquid or dangerous gas as defined respectively in **301. 2** (2) and (3). **[See Guidance]**
- 4.** A risk assessment is to be conducted in a generic manner during the design review mentioned in

302. 1 (3) and submitted to the Classification Society for approval for the BWMS category 4(in all cases), category 5 (in all cases), category 6 (when one of the MSDS indicates that the chemical substance stored on-board is either flammable, toxic, corrosive or reactive), category 7a and 7b (in all cases). **【See Guidance】**

- (1) The recommended risk assessment techniques for BWMS and other guidances are listed below but not limited to:
 - (A) FMEA, FMECA, HAZID, HAZOP, etc.
 - (B) ISO 31010 . Risk Assessment Techniques
 - (C) IACS Recommendation Rec. 146
 - (D) Rules of the Classification Society for risk assessment techniques
- (2) The risk assessment should ensure that the package supplied by the BWMS's manufacturer is intrinsically safe and/or provides mitigation measures to the hazards created by the BWMS which have been identified during the design review mentioned in **302. 1** (3) but that need to be implemented during the installation on-board.

305. Installation of one single BWMS on tankers (2022)

This table does not cover In-tank technologies categories 3c and 8.

Table 9.10.3 In-line BWMS's technologies categorization

BWMS's Technology category →		1	2	3a	3b	4	5	6	7a	7b
		In-line UV or UV + AOT or UV + TiO ₂ or UV + Plasma	In-line Flocculation	In-line membrane separation and de-oxygenation (injection of N ₂ from a N ₂ Generator)	In-line de-oxygenation (injection of Inert Gas from Inert Gas Generator)	In-line full flow electrolysis	In-line side stream electrolysis ⁽³⁾	In-line (stored) chemical injection	In-line side-stream ozone injection without gas/liquid separation tank and without Discharge treatment tank	In-line side-stream ozone injection with gas/liquid separation tank and Discharge water treatment tank
Characteristics ↓										
Des-infection when ballasting	Making use of active substance		X			X	X	X	X	X
	Full flow of ballast water is passing through the BWMS	X	X	X	X	X				X
	Only a small part of ballast water is passing through the BWMS to generate the active substance						X			
After-treatment when de-ballasting	Full flow of ballast water is passing through the BWMS	X								X
	Injection of neutralizer					X	X	X	X	X
	Not required by the Type Approval Certificate issued by the Administration		X	X						
Examples of dangerous gas as defined in Sec 3, 301. 2. (2)			⁽¹⁾	O ₂ N ₂	CO ₂ CO	H ₂ Cl ₂	H ₂ Cl ₂	⁽¹⁾		O ₂ O ₃ N ₂
After-treatment when de-ballasting	BWMS is located in the outside the cargo area	Not Acceptable	Case 1.2 ⁽²⁾	Case 1.3a ⁽²⁾	Case 1.3b	Case 1.4 ⁽²⁾	Case 1.5	Case 1.6	Case 1.7a	Case 1.7b ⁽²⁾
Notes: (1) To be investigated on a case by case basis based on the result of the IMO (GESAMP) MEPC report for Basic and Final approval in accordance with the G9 Guideline. (2) Only « Means of dis-connection » as described in 303. 1 (3) (A) are to be applied. (3) In-line side stream electrolysis may also be applied in-tank in circulation mode (no treatment when ballasting or deballasting)										

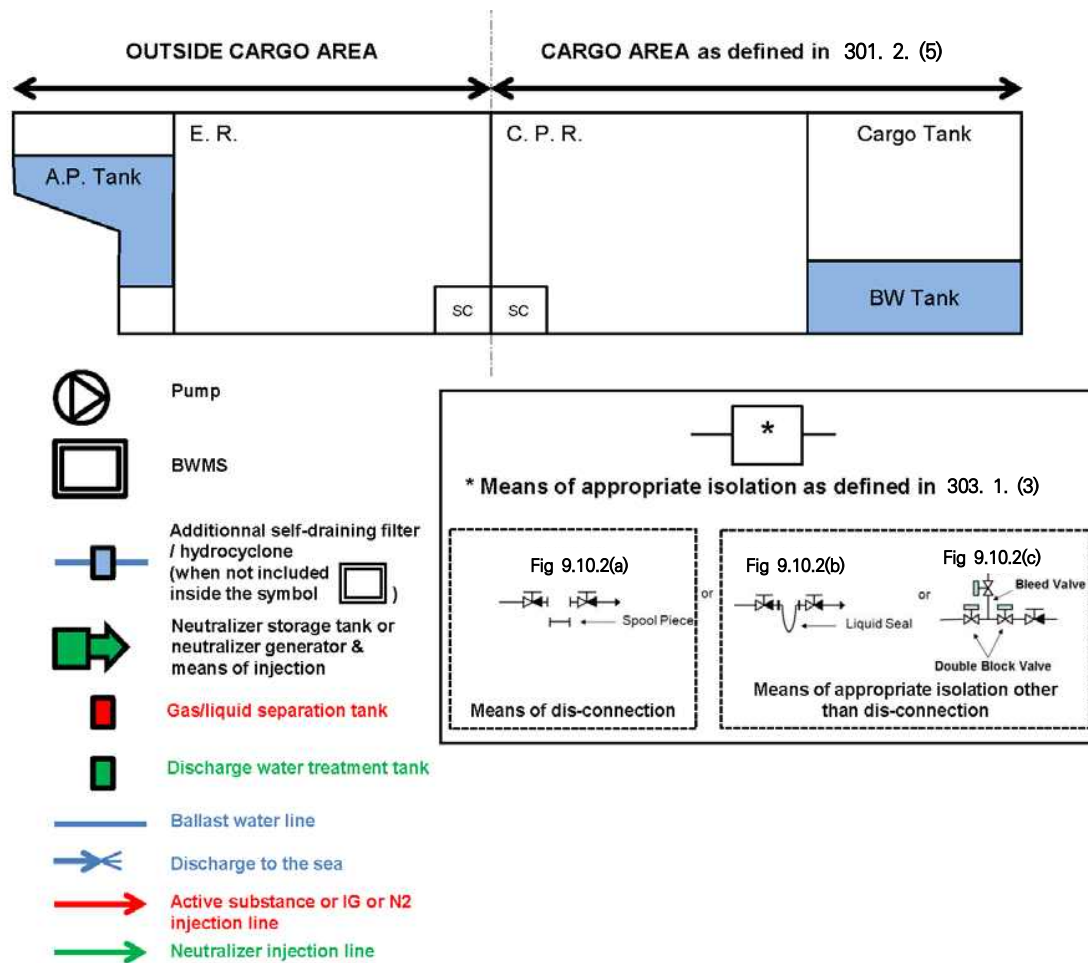


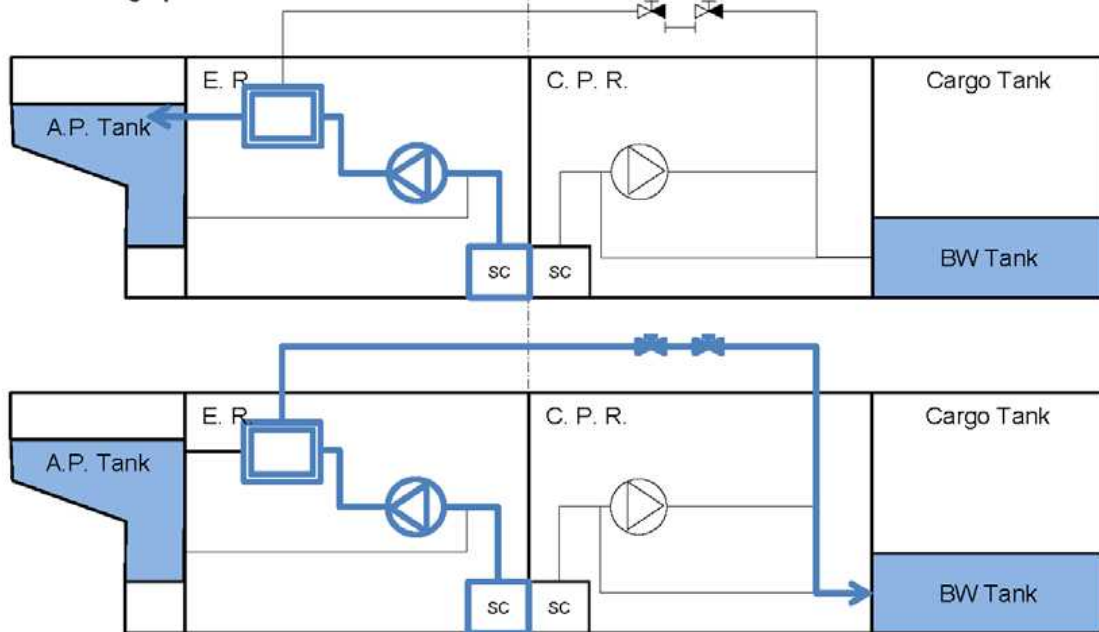
Fig 9.10.4 Example for arrangements

BWMS installed outside the cargo area

Case 1.2 (Technology category 2, Flocculation); and

Case 1.3a (Technology category 3a De-oxygenation with N₂ Generator)

Ballasting operations:



De-Ballasting operations:

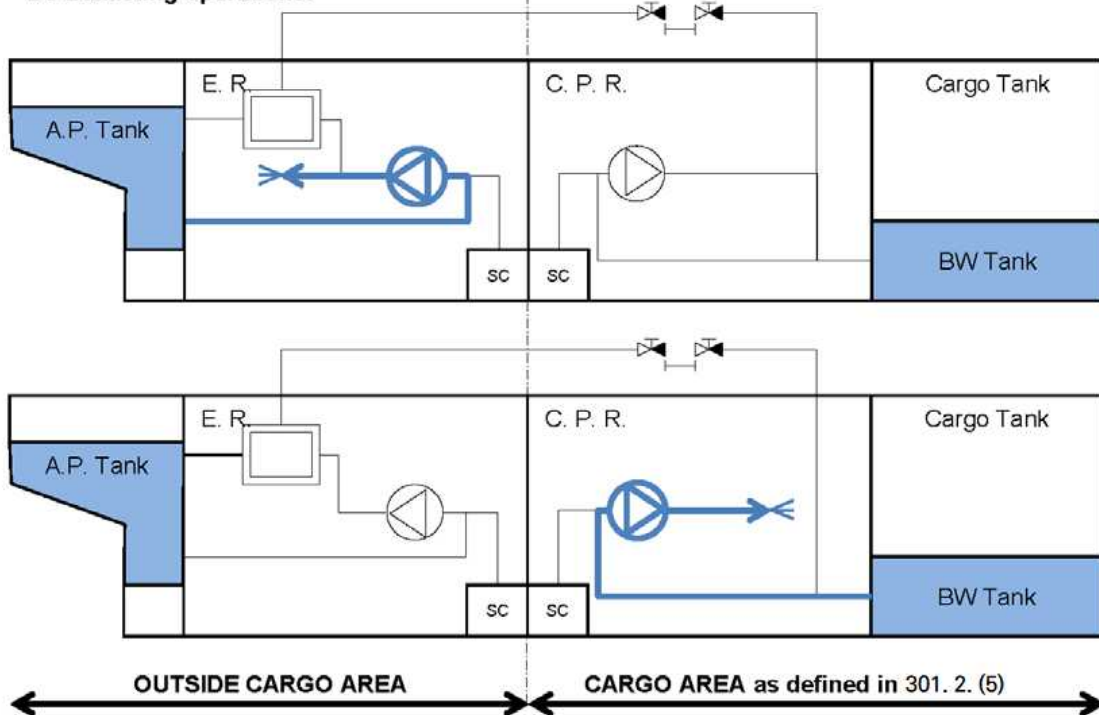


Fig 9.10.5

BWMS installed outside the cargo area

Case 1.3b (Technology category 3b, De-oxygenation with Inert Gas Generator):

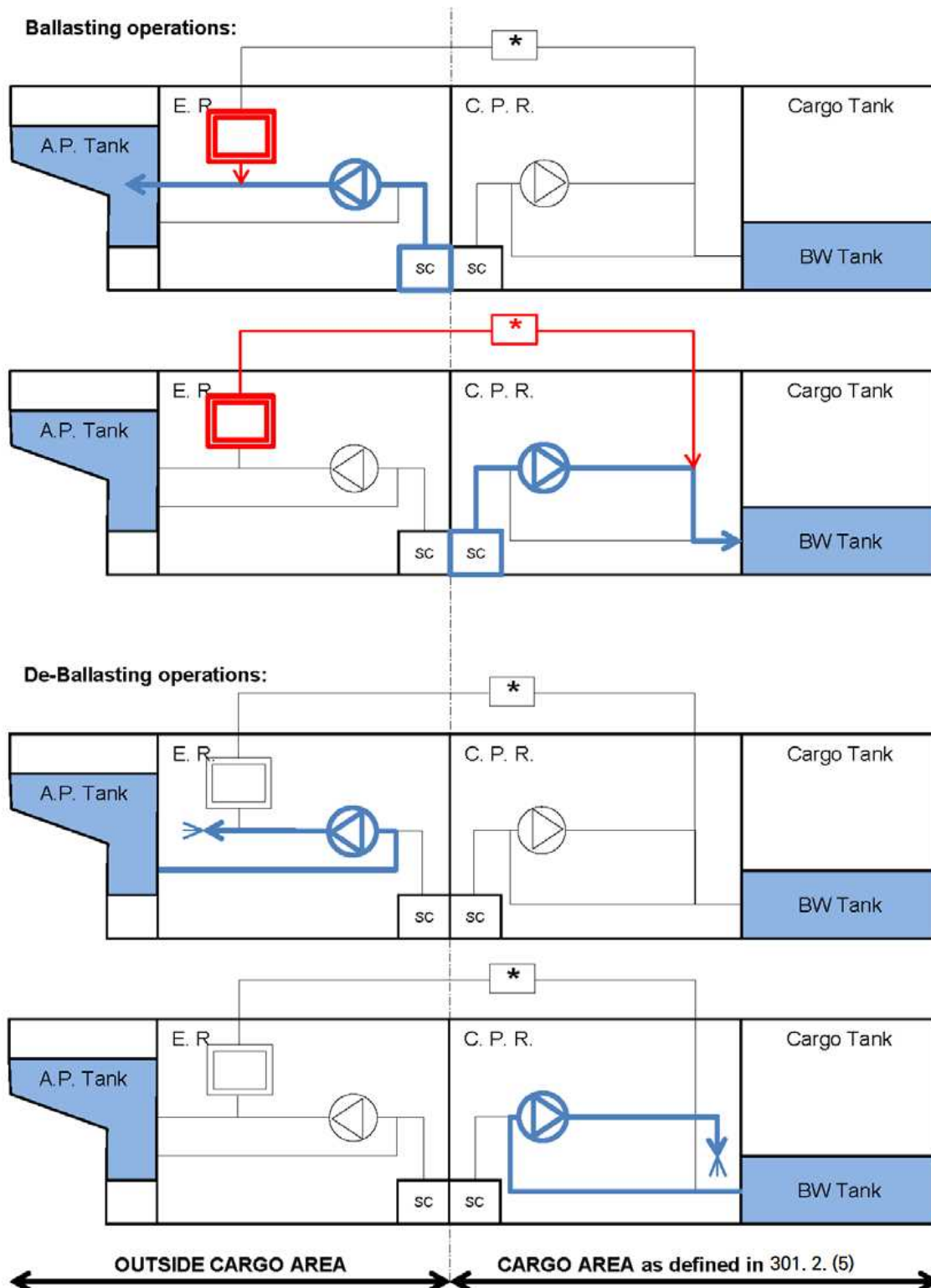


Fig 9.10.6

BWMS installed outside the cargo area

Case 1.4 (Technology category 4, Full-flow electrolysis):

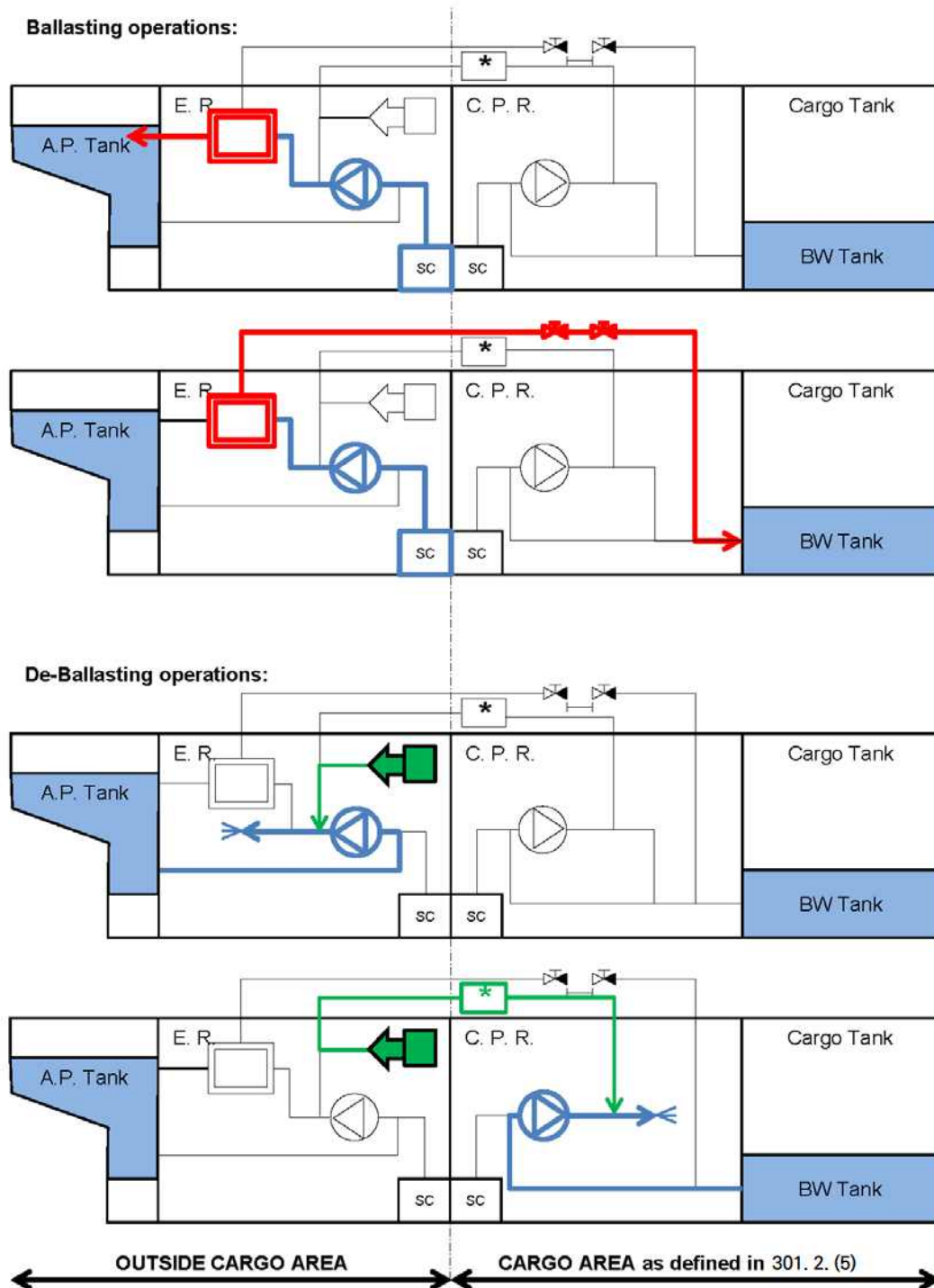


Fig 9.10.7

BWMS installed outside the cargo area

Case 1.5 (Technology category 5, Side-stream electrolysis):

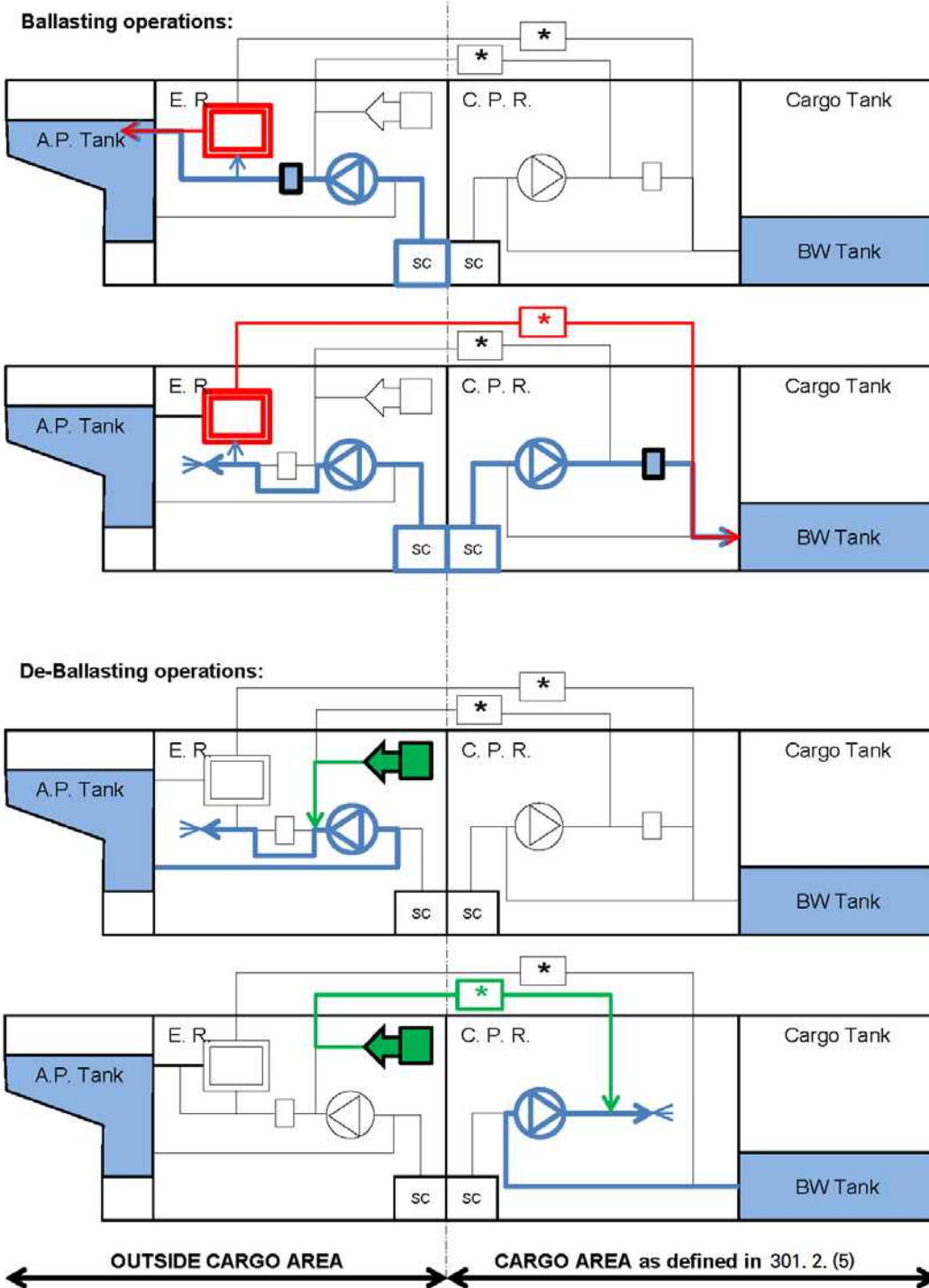


Fig 9.10.8

BWMS installed outside the cargo area

Case 1.6 (Technology category 6, Stored chemical injection)

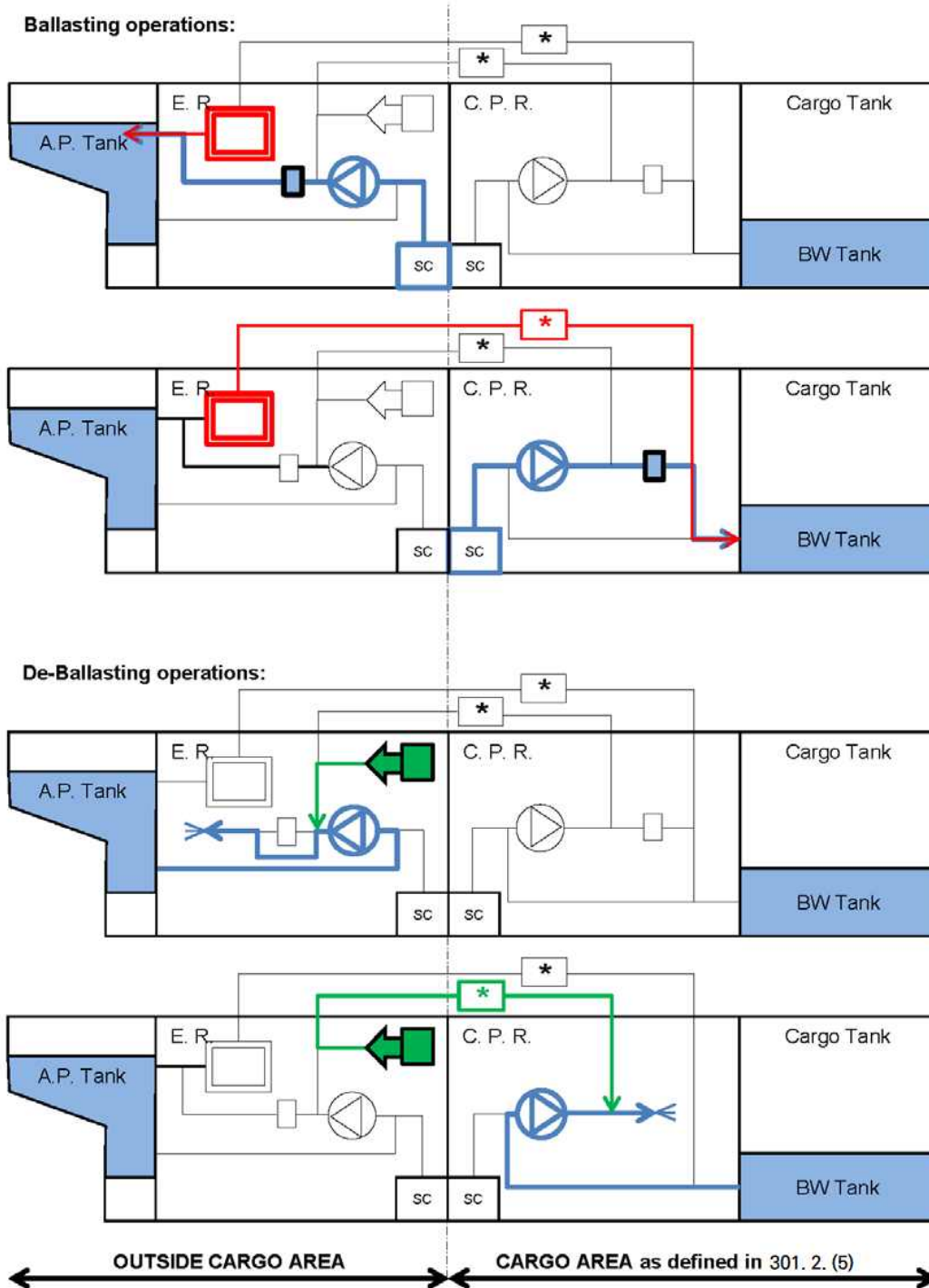


Fig 9.10.9

BWMS installed outside the cargo area

Case 1.7a (Technology category 7a, Side-stream ozone injection without gas/liquid separation tank and without discharge water treatment tank):

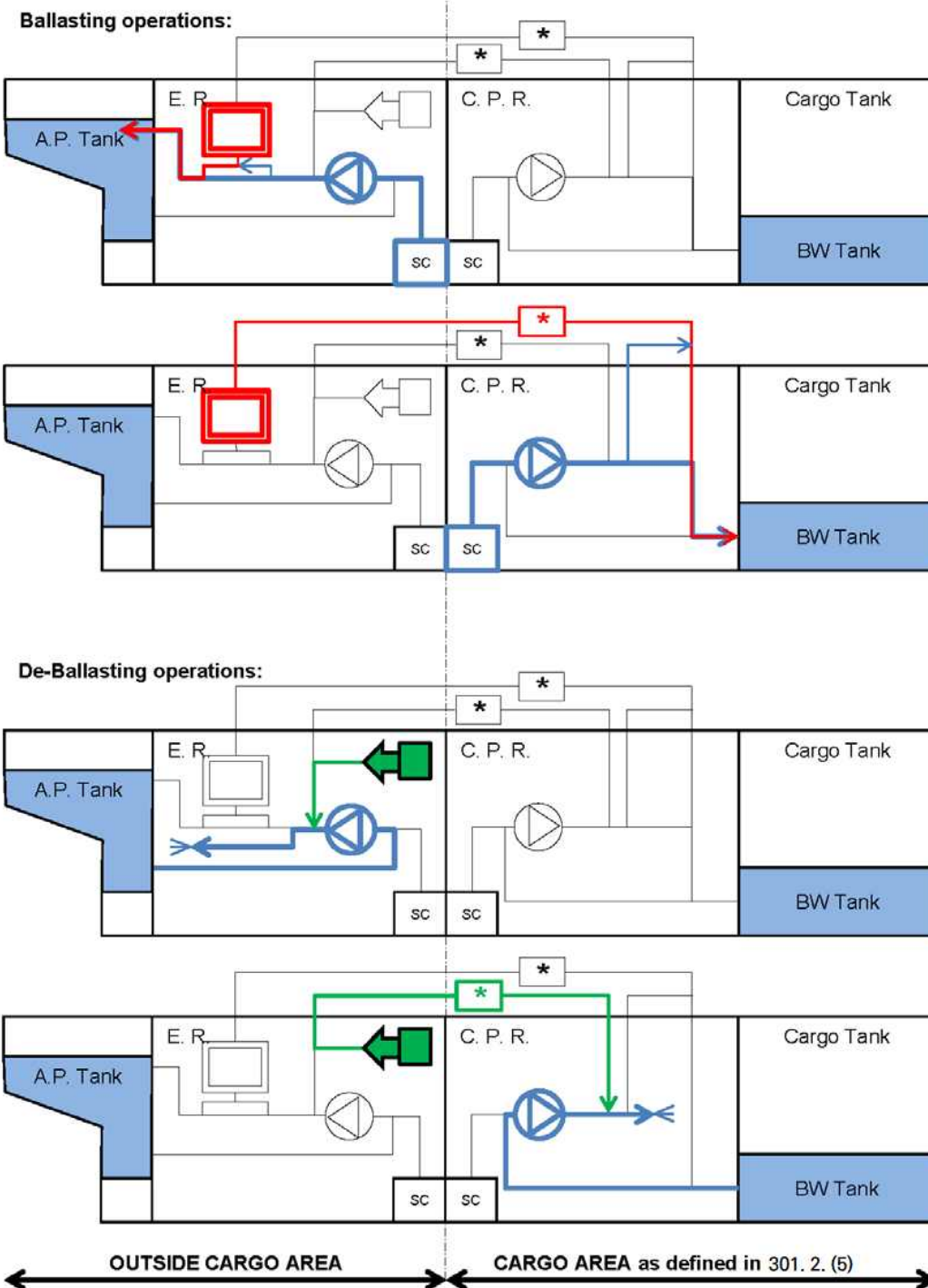


Fig 9.10.10

BWMS installed outside the cargo area

Case 1.7b (Technology category 7b, Side-stream ozone injection with gas/liquid separation tank and discharge water treatment tank):

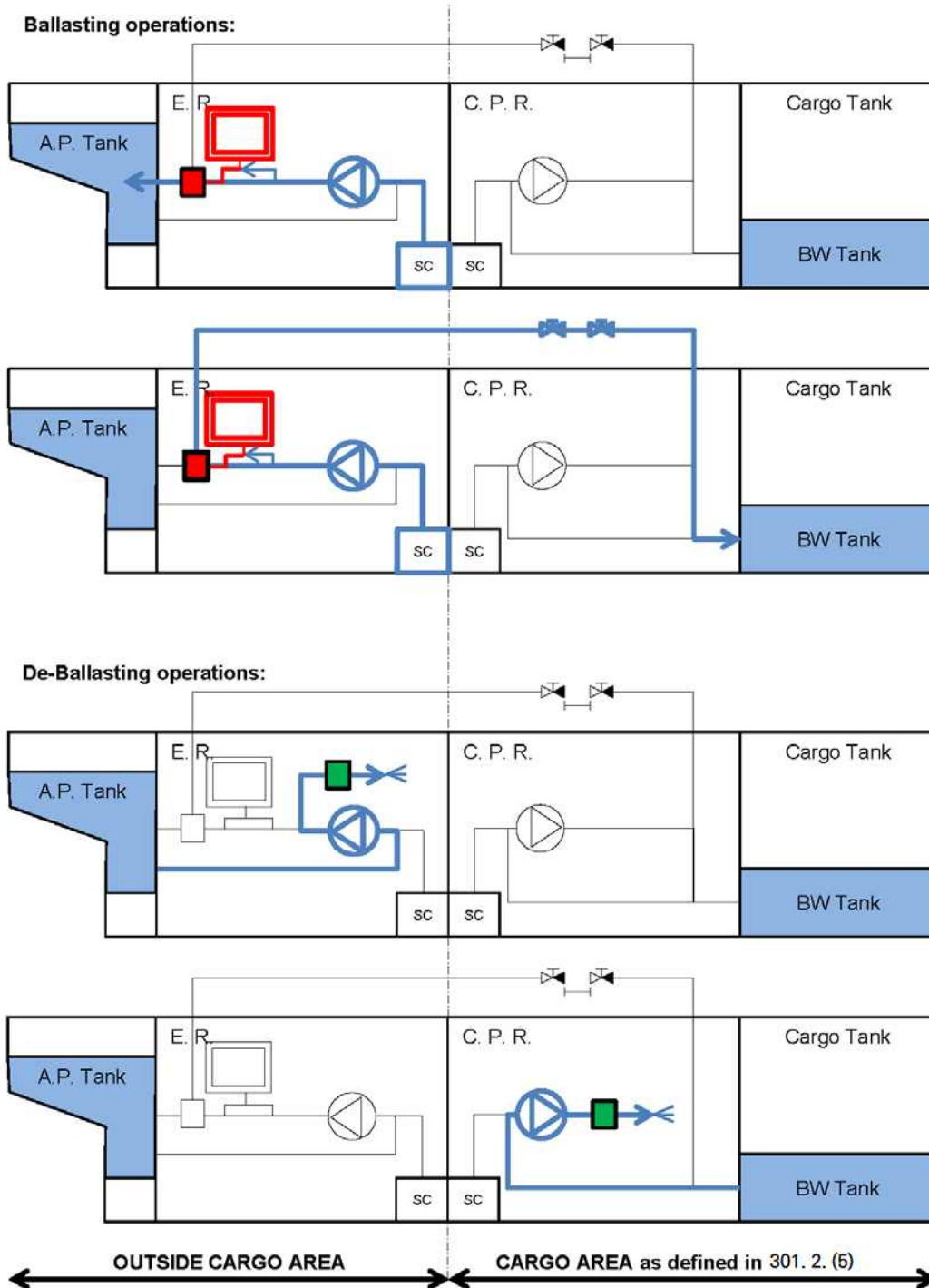


Fig 9.10.11

306. Surveys

1. General (2018)

- (1) Kinds and intervals of surveys are to comply with **203. 1.**
- (2) Tests and inspections on type approved products are to comply with **306. 4.**

2. Classification Survey (2021)

- (1) Drawings and data
For the BWMS intended to newly install or register to this Society, the following plans and information in triplicate are to be submitted to the Society before the work is commenced.
 - (A) General specification of the BWMS
 - (B) Ballast piping diagram
 - (C) The location of ballast water openings
 - (D) Electrical schematic drawing
 - (E) Drawing of tanks containing liquid chemicals including air pipes, sounding and drain systems from drip trays (when fitted)
 - (F) Arrangement of detection system associated with toxic or flammable gases
 - (G) operation and maintenance manual
- (2) Tests and inspections
 - (A) Piping systems and control systems of BWMS are to be tested and inspected in accordance with applicable requirements in **Pt 5** and **Pt 6.**
 - (B) It is to confirmed that the documentation required in IMO Res. MEPC.279(70) or Res. MEPC.300(72), Paragraph 8.2 is on board. In cases where BWMS has been approved in accordance with Res. MEPC 174(58), it is to confirmed that the documentation required in **G8 Guidelines**(IMO Res. MEPC.174(58)), Paragraph 8.1 is on board.
 - (C) Items required in IMO Res. MEPC.279(70) or Res. MEPC.300(72), Paragraph 8.3 are to be verified. In cases where BWMS has been approved in accordance with Res. MEPC 174(58), items required in **G8 Guidelines**(IMO Res. MEPC.174(58)), Paragraph 8.2 are to be verified.
 - (D) After installation of the BWMS, a function test is to be carried out to at the onboard test or sea trial.

3. Survey Assigned to Maintain Classification

- (1) Annual survey
 - (A) External examination of structure, equipment, controls and piping systems
 - (B) Review of the ballast water exchange records and the ballast water exchange plan
 - (C) Verification of the operation of alarms and safety devices
- (1) Special survey
 - (A) Annual survey items required by above (1)
 - (B) Examination of valves, seals, pumps, control panels, vents, air pipes and monitoring sensor.

4. Tests and inspections on type approved products (2018)

- (1) General
The type approved ballast water management system is to be verified that the structure is suitable and completion tests is to be carried out. The detailed test is to be in accordance with **Ch 3, Sec 35** of the **Guidance for approval of manufacturing process and type approval, etc..**
- (2) Completion tests
 - (A) External examination
 - (B) Operation tests and performance tests
 - (C) Insulation resistance tests and high voltage tests (to be applied to electric devices, electronic devices and so on)
 - (D) Pressure tests (to be applied to hydraulic devices, pneumatic devices and so on)
 - (E) Other tests considered necessary by the Society

Section 4 Installation of BWMS on-board ships (2022)

401. General

1. Application

- (1) This Unified Requirement details fire safety measures, in addition to that required by **Pt 8** of the Rules, related to the installation of Ballast Water Management Systems onboard any ship. And this Section is to be read in conjunction with **Sec 3**.
- (2) The requirements of this Section apply for BWMS technologies as listed in **Table 9.10.1**. BWMS with alternative technologies are to be specially considered by the Classification Society.

2. Definitions

- (1) **Airlock** is a space enclosed by gastight steel bulkheads with two gastight doors spaced not more than 2.5 m apart. The doors shall be self-closing without any holding back arrangements. Air locks shall have mechanical ventilation and shall not be used for other purposes. An audible and visual alarm system to give a warning on both sides of the air lock shall be provided to indicate if more than one door is moved from the closed position. The air lock space shall be monitored for dangerous gas as defined in **301. 2 (2)**.
- (2) BWMS storing, introducing or generating chemicals.
In general, BWMS storing, introducing or generating chemicals refer to In-line flocculation (cat.2 as per **Table 9.10.1**), Chemical injection (cat.6 as per **Table 9.10.1**) and BWM technologies using neutralizers injection (cat.4, 5, 6 and 7 as per **Table 9.10.1**).
BWMS that do not store, introduce or generate toxic or flammable chemicals may be specially considered as detailed in **Table 9.10.4** below.

Table 9.10.4 Requirements that may be reduced for BWMS storing, introducing or generating chemicals depending on the chemicals.

Requirement	Conditions to be met before reducing the requirement
402. 3 (4)	The stored chemicals are neither toxic nor flammable
403. 1 (1)	No dangerous gas as defined in 301. 2. (2) will be generated by the BWMS
403. 2 (1)	The BWMS does not use any flammable or toxic chemical substances
406. 1 (1)	No toxic chemical is stored and no toxic gas will be generated by the BWMS
407. 1 407. 3 407. 6	No toxic chemical is used or will be generated by the BWMS
<p>(1) The IMO reports issued during the basic and final approval procedures of the BWMS that make use of active substances (G9 Guidelines) and "safety hazard" as listed in Pt 7, Sec 17, Ch 6 of the Rules (Ch.17 of IMO IBC code) are to be considered for this purpose.</p> <p>(2) Chemicals include additives for BWMS.</p>	

402. Fire categorization

1. General

BWMS shall be classified as follows for the purpose of applying the requirements of **Pt 8** of the Rules

- (1) BWMS containing oil-fired inert gas generators (i.e. BWMS cat.3b and 3c as per **Table 9.10.1**) shall be treated as machinery spaces of category A
- (2) Other BWMS shall be considered as other machinery spaces and shall be categorized, depending on the ship type (10) or (11) according to **Pt 8, Ch 7 102. 3 (2) (A) ⑩** or **⑪** of the Rules (SOLAS II-2/9.2.2.3) or **Pt 8, Ch 7 102. 4** and **103. 3** and **104. 2 (2) (B) ⑦** of the Rules.

2. BWMS located in the cargo area of tankers

Notwithstanding the above 1, where a BWMS is located in the cargo area of a tanker as allowed by **Sec 3**, the BWMR shall be categorized as (8), a cargo pump-room, according to **Pt 8, Ch 7 104. 2 (2) (B) ⑧** for determining the extent of fire protection to be provided.

3. Storage of chemicals

- (1) Spaces where the storage of liquid or solid chemicals for BWMS is intended shall be categorized as store-rooms for the purpose of applying the requirements of **Pt 8** of the Rules.
 - (A) On passenger ships carrying more than 36 passengers:
 - (a) "Other spaces in which flammable liquids are stowed" as defined in **Pt 8, Ch 7, 102. 3. (B) ⑭**, if flammable products are stored
 - (b) "Store-rooms, workshops, pantries, etc." as defined in **Pt 8, Ch 7, 102. 3 (B) ⑬**.
 - (B) On other ships:
 - (a) "Cargo pump-rooms" as defined in **Pt 8, Ch 7, 104. 2. (2) (B) ⑧** if located in the cargo area of a tanker
 - (b) "Service spaces (low risk)" as defined in **Pt 8, Ch 7, 104. 2. (4) ⑤, 103. 3. (2) (B) ⑤ and 104. 2. (2) (B) ⑤** if the surface area is less than 4m² and if no flammable products are stored
 - (c) "Service spaces (high risk)" as defined in **Pt 8, Ch 7, 102. 4. ⑨, 103. 3. (2) (B) ⑨ and 104. 2. (2) (B) ⑨**. It is understood that only chemical injection (cat.6 as per **Table 9.10.1**), in-line flocculation (cat.2 as per **Table 9.10.1**) and technologies using neutralizer injection (cat.4, 5, 6 and 7 as per **Table 9.10.1**) will require chemical or additive storage.
- (2) Where the storage of chemicals is foreseen in the same room as the ballast water management machinery, this room shall be considered both as a store-room and as a machinery space in line with (1).
- (3) When the chemical substances are stored inside integral tanks, the ship's shell plating shall not form any boundary of the tank.
- (4) Tanks containing chemicals shall be segregated from accommodation, service spaces, control stations, machinery spaces not related to the BWMS and from drinking water and stores for human consumption by means of a cofferdam, void space, cargo pump-room, empty tank, oil fuel storage tank, BWMR or other similar space. On-deck stowage of permanently attached deck tanks or installation of independent tanks in otherwise empty hold spaces should be considered as satisfying this provision.

403. BWMR location and boundaries

1. General

- (1) BWMR containing equipment for BWMS of the following types shall be equipped with tested gastight and self-closing doors without any holding back arrangements. But doors leading to the open deck need however not to be self-closing.
 - (A) BWMS storing, introducing or generating chemical substances
 - (B) De-oxygenation based on inert gas generator
 - (C) Electrolysis
 - (D) Ozone injection

2. BWMS using chemical substances

- (1) For BWMS storing, introducing or generating chemicals, the BWMR and chemical substance storage rooms are not to be located in the accommodation area. Any ventilation exhaust or other openings from these rooms shall be located not less than 3m from entrances, air inlets and openings to accommodation spaces. This requirement need not apply in case the BWMS is located in the engine room.

3. Ozone-based BWMS

- (1) Ozone-based BWMS - i.e. cat.7a and 7b - shall be located in dedicated compartment, separated from any other space by gastight boundaries. Access to the BWMR from any other enclosed space shall be through airlock only, except if the only access to that space is from the open deck.

Access to the ozone based BWMR may be provided through the engine room only provided:

- (A) Access from the engine room to the BWMR is through airlock and,

- (B) An alarm repeater is provided in the BWMR, which will repeat any alarm activated in the engine room.
- (2) A sign shall be affixed on the door providing personnel with a warning that ozone may be present and with the necessary instructions to be followed before entering the room

404. Fire fighting

1. Fixed fire-extinguishing system

- (1) Where fitted, fixed fire extinguishing systems shall comply with the relevant provisions of the Fire Safety Systems Code
- (2) Ozone-based BWMS
BWMR containing equipment related to ozone-based BWMS shall be provided with a fixed fire extinguishing system suitable for category A machinery spaces and capable of manual release.
- (3) Where a fixed fire-extinguishing system is provided in the BWMR, it should be compatible with the BWMS and the chemical products that are used, produced or stored in the BWMR. Specific attention shall be paid to potential chemical reactions between the fire extinguishing medium and chemical products used for water treatment.
Especially, water-based fire-extinguishing systems should be avoided in case of sulfuric acid storage.
- (4) Foam fixed fire-extinguishing system
For all kinds of BWMS, in case a foam fire extinguishing system is installed in the BWMR, its efficiency shall not be impaired by chemicals used by the BWMS where relevant.
- (5) Where a fixed fire-extinguishing system is installed in the BWMR, automatic shutdown of the BWMS upon release of the fixed fire extinguishing system shall be arranged. Any need for cool-down necessary for safe shutdown to be considered in the shutdown sequence.
- (6) Where BWMS that includes air or O₂ storage is located in a room covered by a fixed gas fire-extinguishing system, air or O₂ storage shall be taken into account for the gas capacity calculation, unless the discharge pipe from safety valves for air or O₂ storage are led directly to outside the room.

2. Portable fire-fighting equipment

- (1) There shall be at least one portable fire extinguisher that complies with the provisions of the Fire Safety Systems Code and suitable for electrical fires in the BWMR containing UV-type BWMS.

405. Fire prevention

1. Equipment protection

- (1) Overcurrent or overvoltage protection is to be installed to protect UV type BWMS.
- (2) Electrolysis reactors are to be provided with at least with two independent means of monitoring operation. The monitoring system shall initiate audible and visual alarms and automatic shutdown of the BWMS in the event that an anomaly is detected. Requirements for shutdown arrangement are clarified in **302. 4 (3)**.
If a pressure relief valve is also provided, the vent of this valve is to be led to a safe location on the open deck, as clarified in **Sec 3**. The valve should be positioned to optimally remove gas from the electrolysis reactor.

2. Fire detection

- (1) A fixed fire detection and fire alarm system complying with the provisions of the Fire Safety Systems Code shall be installed in spaces containing an inert gas generator or an ozone generator.
- (2) A section of fire detectors which covers a control station, a service space or an accommodation space is not to include a BWMR containing equipment related to ozone based BWMS.

406. Ventilation

1. Ventilation arrangement

- (1) The ventilation systems for BWMR containing BWMS of the following types shall be independent of the ventilation systems serving any other spaces:

- (A) BWMS storing, introducing or generating chemical substances.
 - (B) De-oxygenation, including pasteurization and de-oxygenation (cat.3 and cat.8 as per **Table 9.10.1**)
 - (C) Electrolysis
 - (D) Ozone injection
- (2) The ventilation exhaust for BWMR containing a nitrogen generator shall be located in the lower part of the room in order to efficiently evacuate dangerous gases – as defined in **301. 2 (2)** – heavier than air.
- (3) The ventilation exhaust for BWMR containing electrolysis systems shall be located so as to be able to efficiently evacuate dangerous gases – as defined in **301. 2 (2)** – that could be generated during the electrolysis process. Due regard shall be paid to the expected quantity and density of such gases when designing the ventilation exhaust.
- (4) The following requirements apply to ventilation ducts serving BWMR for ozone-based BWMS:
- (A) The part of the ducts located outside of the BWMR shall be made of steel having a thickness of at least 3 mm for ducts with a free cross-sectional area of less than 0.075 m², at least 4 mm for ducts with a free cross-sectional area of between 0.075 m² and 0.45 m², and at least 5 mm for ducts with a free cross-sectional area of over 0.45 m²; and
 - (B) The ducts shall be suitably supported and stiffened
 - (C) The outside openings of the ducts shall be fitted with protective screens of not more than 13 mm square mesh.
- (5) The ventilation system for BWMR containing ozone-based BWMS or ventilation system for hydrogen de gas arrangement as required by **304. 1 (5)** shall be interlocked with the BWMS such that:
- (A) In case of loss of ventilation (primary and secondary), a visual and audible alarm shall be triggered both inside and outside the BWMR and at a place where a responsible member of the crew is on duty. If the ventilation is not restored after a pre-set time, BWMS shall then be automatically shut down. Any need for cooldown necessary for safe shutdown is to be considered in the shutdown sequence.
 - (B) It shall not be possible to start the BWMS without the ventilation running
- (6) ventilation systems serving BWMR and containing or conveying a dangerous gas, relevant requirements in **304.** are to be satisfied.

2. Ventilation rate

- (1) An adequate power ventilation system shall be provided in enclosed BWMR.
- (2) The ventilation capacity shall be at least 30 air changes per hour where explosive or toxic gases may be generated during operation of the BWMS. The IMO reports issued during the basic and final approval procedures of the BWMS that make use of active substances (G9 Guidelines) and "safety hazard" as listed in **Pt 7, Ch 6, Sec 17.** (Ch.17 of IBC code) are to be used as references for identifying those cases.
- (3) The ventilation capacity may be reduced as follows (More stringent ventilation capacity requirements may arise from other regulations e.g. IBC Code requirements for spaces located in the cargo area):
- (A) Flocculation-type BWMS 6 air changes per hour
 - (B) De-oxygenation, incl. pasteurization and de-oxygenation (cat.3 and cat.8 as per **Table 9.10.1**) 6 air changes per hour
 - (C) Full flow electrolysis 6 air changes per hour
 - (D) Side-stream electrolysis 20 air changes per hour
 - (E) Ozone injection 20 air changes per hour
 - (F) Chemical injection 6 air changes per hour

407. Personal equipment

1. Suitable protection equipment shall be available onboard for the protection of the crew members who are engaged in the servicing, maintenance and repair of BWMS storing, introducing or generating chemicals, as recommended by the product manufacturers. The protection equipment shall consist of large aprons, special gloves with long sleeves, suitable footwear, coveralls of chemical-resistant materials, and tight fitting goggles or face shields or both. The protective clothing and equipment shall cover all skin so that no part of the body is unprotected. This protection equipment is to be provided separately without taking into account equipment required by other mandatory requirements.

2. Work clothes and protective equipment shall be kept in easily accessible places and in special lockers. Such equipment shall not be kept within accommodation spaces, with the exception of new, unused equipment and equipment which has not been used since undergoing a thorough cleaning process. Notwithstanding the above, storage rooms for such equipment within accommodation spaces if adequately segregated from living spaces such as cabins, passageways, dining rooms, bathrooms, etc.
3. When a BWMS storing, introducing or generating chemicals is installed on board, suitably marked decontamination showers and an eyewash shall be available in a convenient location in close proximity to the BWMS and the chemical store room(s).
4. An emergency escape breathing apparatus (EEBD) is to be provided in the BWMR. This emergency escape breathing apparatus may be one of the EEBDs provided in accordance with the requirements of **Pt 8 Ch 10** of the Rules. An EEBD need not be required for BWMS of cat.1 as per **Table 9.10.1**.
5. A personal ozone detector, calibrated as per the manufacturer's specifications, shall be provided for each person engaged in the servicing, maintenance and repair of BWMS utilizing ozone.
6. A two-way portable radiotelephone apparatus dedicated for the BWMS service, maintenance and repair shall be provided, in addition to those required by SOLAS for fire-fighting purposes. This two-way radiotelephone apparatus is to be properly identified in order to avoid mix-up with the apparatus intended for fire-fighting operations. Where the BWMS may release explosive gases, this two-way radiotelephone apparatus shall be of a certified safe type suitable for use in zone 1 hazardous areas, as defined in IEC Publication 60079. Where the BWMS stores, utilizes or introduces chemicals, the apparatus shall undergo deep cleaning or de-contamination after use.

A two-way portable radiotelephone apparatus need not be required for BWMS of cat.1 as per **Table 9.10.1**. ⚓



2022

Guidance Relating to
the Rules for the Classification of Steel Ships

Part 9

Additional Installations

APPLICATION OF THE GUIDANCE RELATING TO THE RULES

This "Guidance Relating to the Rules for the Classification of Steel Ships" (hereafter called as the Guidance Relating to the Rules) is prepared with the intent of giving details as to the treatment of the various provisions for items required the unified interpretations and items not specified in the Rules, and the requirements specified in the Guidance Relating to the Rules are to be applied, in principle, in addition to the various provisions in the Rules.

As to any technical modifications which can be regarded as equivalent to any requirements in the Guidance Relating to the Rules, their flexible application will be properly considered.

APPLICATION OF PART 9 "ADDITIONAL INSTALLATIONS"

1. Unless expressly specified otherwise, the requirements in the Guidance apply to ships for which contracts for construction are signed on or after 1 July 2022.
2. The amendments to the Guidance for 2021 edition and their effective date are as follows;

Effective Date: 1 July 2022

CHAPTER 8 HIGH VOLTAGE SHORE CONNECTION SYSTEMS

Section 1 General

- 101. 1 has been amended.

Effective Date: 1 July 2022 (Date of which contracted for construction for Classification Survey is submitted)

CHAPTER 10 BALLAST WATER MANAGEMENT

Section 3 Ballast Water Management Systems

- Entirely amended.

Annex 9–3 BWMS Technologies categorization (Informative)

- Newly added.

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CHAPTER 1 CARGO REFRIGERATING INSTALLATIONS

Section 1 General

101. General

1. Scope [See Rule]

The refrigerants listed below are not to be used as refrigerants.

- (1) Methyl chloride (CH_3Cl)
- (2) R 12 (CCl_2F_2)
- (3) R 502 (R 22/R 115 (48.8/51.2 wt%) $\text{CHClF}_2/\text{CClF}_2\text{CF}_3$)
- (4) R 13B1 (CF_3Br)
- (5) Other refrigerants as deemed inappropriate by the Society

Section 2 Surveys

201. General [See Rule]

'Continuous Surveys' specified in **201. 2 (2) (D)** of the Rules is conform to the following requirements:

1. When the shipowner or his representative desires to adopt a Continuous Survey system, he is to submit application to the Society for approval on application for that system.
2. The owner of a ship to which continuous survey system is applied is to prepare 'Plan for Undergoing Continuous Surveys on Cargo Refrigerating Installations' or 'Plan for Maintaining Cargo Refrigerating Installations' taking into account items listed in the following (a) to (d) and carry it on board the ship so that it can be presented to the Surveyor whenever he requires it.
 - (1) All items to be covered by continuous surveys are to be included in the plan.
 - (2) Inspection interval of each survey item is not to exceed five years.
 - (3) Inspection of each compressor is to be carried out alternately and with the same interval, as far as possible.
 - (4) Inspection of each pump is to be carried out alternately and with the same interval, as far as possible, by its use.
3. Items to be covered by Continuous Surveys At continuous surveys, open-up inspection and pressure tests are to be carried out on the following machinery and equipment.
 - (1) Compressors
 - (2) Condenser cooling water pumps
 - (3) Primary refrigerant pumps
 - (4) Brine pumps
 - (5) Condensers
 - (6) Evaporators
 - (7) Others to be considered appropriate by the Society

4. Confirmatory Surveys

On the items listed in (a) to (d) of (C) above, confirmatory surveys may be carried out in accordance with the procedures specified in **Pt 1, Annex 1-7, 2 (2) (D)** of the Guidance. For compressors, at least one unit of them is to be subject to open-up inspection during the period of one cycle of continuous surveys.

5. Cancellation of Continuous Survey System

- (1) Where the shipowner or his representative requests the cancellation of applying the continuous survey system, the subsequent surveys are to be in accordance with the following (A) and (B).
 - (A) Where there are machinery and equipment of which their inspection intervals will exceed five years before the next special survey, they are to be inspected within five years from the dates on which the previous surveys were carried out.

- (B) At the next special survey, inspection is to be made on all items to be required at a special survey.
- (2) Where continuous surveys are not carried out in accordance with the Guidance, the application of continuous survey system may be cancelled.

203. Classification Maintenance Surveys

1. The wording 'the interval of opening up' specified in **203. 2** (1) of the Rules means the interval of 25,000 hours of operation. **【See Rule】**
2. The wording 'operation tests' specified in **203. 2** (10) of the Rules means the confirmation of the effectiveness of each unit under operation condition. At this time, leak tests of refrigerant are to be carried out. When necessary, the concentration of brine is to be measured. **【See Rule】**

Section 3 Refrigerating Machinery

302. Construction, etc. of refrigerating machinery **【See Rule】**

'Automatic cut off devices' specified in **302. 1** (3) of the Rules includes flow switches.

303. Cooling appliances in refrigerated chambers **【See Rule】**

Temperature difference between the refrigerated chamber and the refrigerant is, as a rule, to be within 5°C for fruit, and 10°C for frozen meat.

Section 4 Special Requirements for Refrigerating Machinery Using Ammonia as Refrigerant

407. Electrical installations **【See Rule】**

The wording 'certified safe types for use in the flammable atmosphere concerned' in **407. 1** (1) of the Rules means electrical equipment having intrinsically safe, flame-proof or pressurized construction grouped into Apparatus Group IIA and Temperature Class T1 as specified in **IEC 60079**.

Annex 9-1 Spare Parts (for Reference)

101. Spare parts for general tools and equipment

1. One set of motor coupling bolts with nuts and washers of each size used.
2. One expansion valve of each size used.
3. One float regulator assembly of each size used.
4. At least two glass thermometers in the case of thermometers.
5. In the case of thermometers: 5 % of the total number of temperature sensors, but not less than one of each type used. Two sets of standard resistors of each size used.
6. Two sets of relief valves of each size used.

102. Spare parts for refrigerant compressors

1. Where screw type compressors are installed, the following spare parts are to be provided.
 - (1) One set of main bearing of each size used.
 - (2) One set of thrust bearing of each size used.
 - (3) One set of rotor seals of each size used.
2. Where reciprocating compressors are installed, the following spare parts are to be provided.
 - (1) One set of piston and piston rod or connecting rod of each size used.
 - (2) One set of crankshaft main bearing of each size used.
 - (3) One complete assembly of each size of compressor suction and delivery valves.
 - (4) One set of wearing parts of the crankshaft seals where the crankcase is subjected to the refrigerant pressure.
 - (5) One set of crankshaft coupling bolts with nuts and washers of each size used.
 - (6) One set of driving belts of each size used.

103. Spare parts for electrical equipment

Spare parts for the electrical equipment are to comply with the requirements in **Pt 6, Ch 1, Sec 18** of the Rules. ⚓

CHAPTER 2 CARGO HANDLING APPLIANCES

Section 1 General

101. General

1. Application [See Rule]

In application to **101. 1** (1) of the Rules, cargo handling appliances means that come under either of the followings:

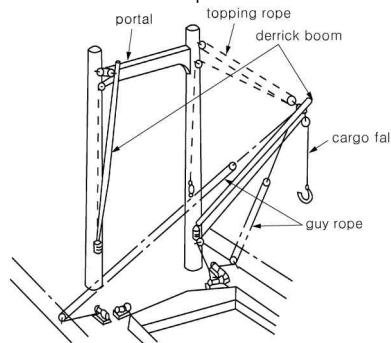
- (1) The cargo handling appliances, except cargo ramps, of safe working load not less than 1 ton which are installed in ships subject to the requirements of *Korean Ship Safety Act*.
- (2) The cargo handling appliances of safe working load not less than 1 ton which are installed in ships(not less than 300 tons gross tonnage) subject to the requirements of *Fishing Vessels Act. (2018)*
- (3) The cargo handling appliances installed in the ships other than those specified in (1) and (2) above, for which the assignment of the safe working load, etc. is requested.

2. Equivalency [See Rule]

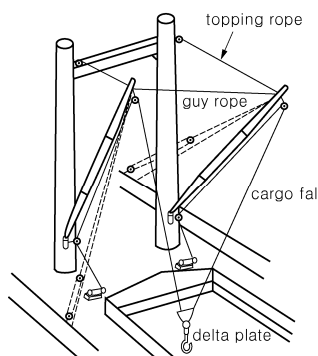
In addition to the requirements of **101. 2** of the Rules, any existing cargo gear, cargo ramps and loose gear designed and manufactured not under the requirements of the Rules may be deemed by the Society to comply with the Rules, provided that they have passed the tests and inspection required by the Society. The expression Tests and inspection required by the Society means the Design Examination specified in **203. 1** of the Rules and the Work Examination specified in **203. 2** of the Rules thereof. However, the Society may dispense with part of the plan investigation and examination for the machinery and gear which passed the plan investigation and examination of the official or third-party organizations considered appropriate by the Society and were certified by them. (2020)

102. Definitions [See Rule]

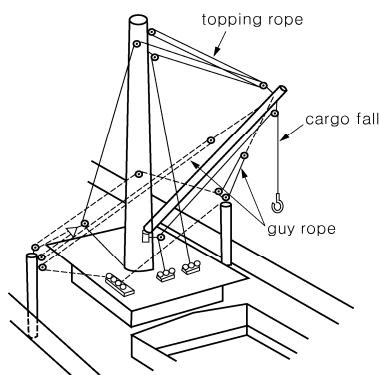
The derricks come under the requirements of the Rules include those illustrated in **Fig 9.2.1**.



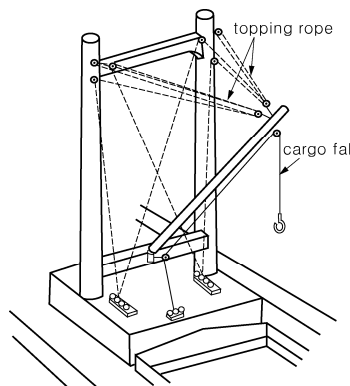
(1) Swinging derrick system



(2) Union-purchase derrick system



(3) One topping derrick crane system



(4) Tow topping derrick crane system

Fig 9.2.1 Derrick Systems

2. In **102. 11** of the Rules, the "other restrictive conditions deemed by the Society" means the restrictive conditions for safe working according to characteristic of applicable cargo handling appliances. **[See Rule]**

103. Arrangement, Construction, Materials and Welding

1. General Construction **[See Rule]**

- (1) The cargo gear which are to comply with the additional requirements considered appropriate by the Society in applying the Rules as specified in **103. 2** (1) of the Rules include the following (A) through (D):
 - (A) Cargo gear installed on mobile offshore units
 - (B) Cargo gear installed on workboats
 - (C) Hoisting and stowing equipment for submersibles and diving
 - (D) Other equipment to which the Society deems necessary to pay special attention
- (2) "The Guidance relating to the Rules" specified in **103. 2** (2) of the Rules include the following requirements (A) through (D):
 - (A) Where steel materials of various strengths are used in the structural members, due considerations are to be given to the stress caused in the material of lower strength adjoining that of higher strength.
 - (B) For the members in which high tensile steels are used, special attention is to be paid to the structural details so that significant stress concentration may not take place.
 - (C) Where high tensile steels are extensively used in the structural members, careful considerations are required. In such cases, a thorough study with regard to ensuring buckling strength and the results of the study are to be submitted to the Society.
 - (D) Dimensions of the members are to comply with the following requirements (a) through (e):
 - (a) The minimum thickness of post specified in **303. 3** of the Rules may be obtained from the following formula:

$$5.0K+1.0 \quad (\text{mm})$$

where:

$$K = \sigma_{yM} / \sigma_{yH}$$

σ_{yM} : Specified value of yield stress of mild steel

σ_{yH} : Specified value of yield stress of high tensile steel

- (b) The minimum outside diameter of post at the base specified in **305. 2** of the Rules may be as obtained from the following formula:

$$5hK \quad (\text{cm})$$

where :

h : As specified in **305. 2** of the Rules

K : As specified in (a) above

- (c) The value of the coefficient C_2 specified in **Table 9.2.8** and **305. 3** (1) (A) of the Rules may be substituted by the value of C_2 multiplied by the coefficient K specified in (a) above.
- (d) The minimum thickness of the structural members specified in **403. 6** of the Rules may be substituted by the value obtained from the following formula:

$$5.0K+1.0 \quad (\text{mm})$$

where:

K : As specified in (a) above

- (e) The minimum thickness of the structural members specified in **803. 4** of the Rules may be substituted by the value obtained from the following formula:

Weather part : $5.0K+1.0$ (mm)

Enclosed part : $5.0K$ (mm)

where:

K : As specified in (a) above

2. Materials [See Rule]

- (1) "Cases considered appropriate by the Society" mentioned in **103. 4** (1) of the Rules are the following cases (A) to (C):
- (A) Where B of more than 25 mm in thickness are used in the following members (a) to (c) of the structural members of cranes:
- (a) Flange for mounting slewing ring (bearing) of jib crane
 - (b) Housing base of jib crane
 - (c) Members constituting movable parts of gantry crane, etc. with increased plate thickness to ensure stiffness. However, requirements specified in **Table 9.2.1** of the Rules may be applied according to the magnitude of working stresses
- (B) Where steel pipes conforming to the following requirements (a) through (d) are used to manufacture the structural members such as derrick booms, derrick posts, crane jibs, crane posts and other similar members:
- (a) The steel pipes are to be of 20 mm or less in thickness.
 - (b) The steel pipes are to be of Grade 1 or 2 of steel pipes for pressure piping specified in **Pt 2** of the Rules, or the equivalent thereto.
 - (c) Steel pipes to be welded are to be of 0.23 % or less in carbon contents.
- (C) Where rolled steel material and steel pipes, not exceeding 12.5 mm thick, complying with the standards recognized to be appropriate by the Society are used in the structural members of cargo gears which are not employed in cargo handling services excluding those used for cargo hoses. The materials of the structural members welded directly to the hull structure, however, are to comply with the requirements in **103. 4** (1) of the Rules or (2) (a) to (c) above.
- (2) Classification of the steel materials used in the structural members, travelling girders, tracks, etc. of cargo gear regularly used in especially cold zones or refrigerated hold chambers are to comply with **Table 9.2.1** according to design temperatures.
- (3) Forged or cast steel parts used in the following structural members (A) through (F) may be of the materials conforming to standards considered appropriate by the Society.
- (A) Topping bracket of derrick system
 - (B) Gooseneck bracket and gooseneck pin of derrick system
 - (C) Derrick heel lugs and head fitting of derrick boom
 - (D) Heel bracket of jib crane
 - (E) Heel fitting of crane jib
 - (F) Bracket and pin for movable parts of gantry crane, cargo lift and cargo ramps
- (4) In **103. 4** (4) of the Rules, the "considered appropriate by the Society" means the case as considered by International Standard(ISO), National Standard(KS) or equivalent standards.
- (5) In **103. 4** (6) of the Rules, the "any standards recognized by the Society to be of equivalent qualities" means the International Standard(ISO), National Standard(KS) or equivalent standards.

Table 9.2.1 Classification of Steel Materials Exposed to Low Temperature (2019)

Design temperature T (°C)	Material thickness t (mm)				
	$t \leq 10$	$10 < t \leq 20$	$20 < t \leq 25$	$25 < t \leq 40$	$40 < t$
$-10 \leq T$	A/AH		B/AH	D/DH	E/EH
$-20 \leq T < -10$	B/AH	D/DH	E/EH		
$-30 \leq T < -20$	E/EH			$RL235A$	$RL235B$
$-40 \leq T < -30$	$RL235A$		$RL235B$		*
$-50 \leq T < -40$	$RL235B$		*		
(NOTES)					
1. Steel grades for the construction capable of relieving thermal stress will be specially considered by the Society.					
2. The Society may require materials having higher notch toughness according to the material thickness and construction if the design temperature is below -50°C or working stress of the material exposed to low temperatures exceeds 60% of the yield point.					
3. Steel grades for the members corresponding to classification asterisked * will be specially considered by the Society.					
4. Symbols used in this Table are same as those in Table 9.2.1 of the Rules.					

3. Welding [See Rule]

In application to 103. 5 of the Rules, the followings are to be applied.

- (1) Welding of derrick posts is to comply with the following requirements (A) through (H):
 - (A) Welding of post is to be both side welding as far as practicable.
 - (B) Welding of post to deck is to be of double grooved at the foot of post. If inside work of the post is difficult due to small diameter or any other reasons, penetration welding with the backing metal for single groove may be permitted.
 - (C) As for the welding of side plates to upper and lower plates constituting portal, the fillet size, at the portal ends and at the portions where topping brackets, eyes, etc. are fitted are to be of $F1$ weld specified in Pt 3, Table 3.1.6 of the Rules.
 - (D) Welding for portal and post are to be both side welding as far as practicable. If the angle(α) shown in Fig 9.2.2 is small, the ends of portal are to intersect orthogonally with the post surface by providing knuckle to carry out fillet welding as completely as practicable.

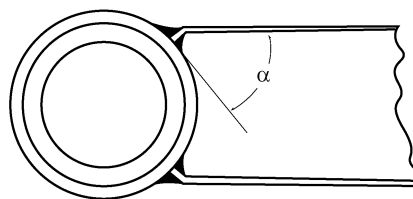


Fig 9.2.2 Welding for Portal and Post

- (E) Topping brackets and gooseneck brackets are to be fitted by penetrating the post or mounting the base. If the plate thickness of the post or the mounting base exceeds 12.5 mm, the welding is to be penetration welding with grooves.
- (F) The joint of derrick boom for circumferential is to be both side welding and back welding after removing defects of face run by back chipping. However, penetration welding with backing metal may be permitted limiting to such an unavoidable case as partial replacement for repair. In this case, the welded joint concerned is to be verified by suitable non-destructive inspection carried out along the whole length of weld line that it is free from injurious defects.
- (G) The backing metal used for the joint derrick boom for longitudinal joint is to be jointless along the whole length with smooth surface.

- (H) The requirements in (B), (E) and (F) above may be modified for the derricks not used in cargo handling service in consideration of the safe working load and the type of construction.
- (2) Welding for cranes is to comply with the following requirements (A) to (E):
 - (A) The requirements in (1) (F) and (G) above are to be applied to the butt welding and longitudinal seam welding of jib by constructing the words "derrick boom" as "jib".
 - (B) Where welding from both sides (including fillet weld) is difficult for the welded joints other than butt welding and longitudinal seam welding of the jib, penetration bead welding or welding with backing strip is to be carried out.
 - (C) As for the welding of crane post, the requirements in (1) (A) and (B) above are to be applied.
 - (D) The following parts are, as a rule, to be fixed by full penetration type welding.
 - (a) Fixing part of crane post and post flange for slewing ring
 - (b) Fixing part of bracket for sheave to jib top
 - (c) Fixing part of bracket for sheave to crane house
 - (d) Fixing part of base bracket of jib
 - (e) Fixing part of crane house well and turning table
 - (E) The fillet weld applied to the primary structural members is, as a rule, to be *F1* weld specified in **Pt 3, Table 3.1.6** of the Rules, or equivalent thereto.
- (3) Welding for cargo lifts and cargo ramps is to comply with the following requirements (A) to (C):
 - (A) The fillet weld applied to the primary structural members is to comply with the requirements in (2) (E) above.
 - (B) Welding for non-slip bar, etc. fitted directly to the primary structural members is to be carried out in such a way that it may not give any injurious effect on the members.
 - (C) The method of welding for stoppers, their braces and similar fittings used in stowing the machinery are to be selected or carried out in such a way that they do not give any adverse effect on the structural members or hull structures.
- (4) Welding for the structural members of cargo gear used regularly in especially cold zones or refrigerated hold chambers is to be carried out in such a way that it may not give any adverse effect on prevention of occurrence of low temperature brittle fracture in consideration of the structure, working stress, etc.
- (5) When cast steel or forged steel parts are connected to steel plates by butt welding or lap welding, the details of welded joints are to comply with the requirements specified in **Pt 2, Ch 2, Sec 3** of the Rules.
- (6) Non-destructive inspection for welded joints of structural members of cargo gear and cargo ramps is to comply with the following requirements (A) to (C):
 - (A) The following places (a) to (c) are to be subjected to radiographic test or ultrasonic test:
 - (a) Places specified in (1) (F) above
 - (b) For structural members of cranes, places specially considered by the Society according to their structure and method of construction as well as the places specified in (2) (A) above
 - (c) Places being suspicious in integrity of welded joints
 - (B) When the Society deems necessary, the following places corresponding to (a) to (d) are to be subjected to the magnetic particle test or dye penetrant test:
 - (a) Welded joint of rolled steel plate to cast or forged steel
 - (b) Trace of removing hanging pieces, jigs, etc. welded temporarily to the structural members
 - (c) Weld of cargo fitting
 - (d) Fillet welds of structural members being suspicious in integrity
 - (C) Method of non-destructive test specified in (A) and (B) above and judging criteria of defects are to be in accordance with the discretion of the Society according to the construction of the places concerned.

Section 2 Surveys

201. General

1. Application [See Rule]

In application to **201. 1** of the Rules, the followings are to be applied.

- (1) Posts for derricks and cranes and supports for cargo lifts/ramps fixed directly to the hull structure are to be subjected to the tests and examinations specified in **Pt 1** of the Rules for the Survey and Construction of Steel Ships in addition to this chapter.
- (2) Where cargo lifts and cargo ramps constitute part of the hull structure, they are to be subjected to the tests and examinations in compliance with the requirements in **Pt 1** of the Rules, according to the type and arrangement of hull structure.
- (3) In applying the requirement in **201. 1** (4) of the Rules, the Load Tests specified in **202.** of the Rules may be omitted provided that the cargo gear is to comply with the condition in either of the following (A) or (B).
 - (A) For heavy derrick systems: they are not frequently used and the Load Tests will be carried out before use.
 - (B) For union-purchase derrick systems: they passed the Load Tests as a swinging derrick system and eye plates of preventer stays are in good order.
- (4) In **201. 1** (3) of the Rules, the term "where deemed necessary" means the case as specified in **Pt 1, Ch 1, 801. 1** of the Guidance.

2. Preparation and Attendance for Tests and Surveys [See Rule]

In application to **201. 2** (3) of the Rules, "The Surveyor considers that the safety for execution of the tests and examinations is not ensured" means that the safety measure of prevention for down-fall is not taken at high position survey, etc.

202. Surveys of Cargo Handling Appliances [See Rule]

In **201. 2** (4) (D) of the Rules, the "other cases when considered necessary by the Society" means the case where the occasional survey was recommended or carried out occasional survey by owner's request.

203. Registration Surveys

1. Drawings and Other Documents to be Submitted [See Rule]

In application to **203. 1** of the Rules, the followings are to be applied.

- (1) Notwithstanding the requirements in **203. 1** of the Rules, where whole cargo handling appliances or any components thereof are manufactured on the basis of the drawings and documents already approved at the same works, submission of the drawings and documents other than the following documents (A) and (B) may be dispensed with.
 - (A) Application for omission of submission of drawings
 - (B) General arrangement of cargo handling appliances
- (2) Submission of drawings of hydraulic motors, hydraulic pumps, steam cylinders, pneumatic motors or internal combustion engines for driving various winches and travelling machines used in cargo handling appliances are to be in accordance with the following requirements (A) to (C) according to the output:
 - (A) Where the output is less than 375 kW:
Submission of drawings may be dispensed with. However, name of manufacturer, type and principal particulars are to be described in the approval drawings of winches or travelling machines employed.
 - (B) Where the output is 375 kW or more:
Principal particulars, drawings of structural details and strength calculation sheet are to be submitted in one set for reference.
 - (C) Others:
Where the machinery is installed in ships under the classification of the Society for the first time, the requirements in (B) above are to be applied even when the output is less than 375 kW.

- (3) General arrangement plan and structural drawings of derricks are to include at least the following items (A) and (B):
- (A) General arrangement plan
 - (a) Masts, posts, guy posts, shrouds, stays(including attached rigging screws), derrick booms, and arrangement of cargo fittings fitted to hull structure, etc.
 - (b) Breadth of ship and outreach
 - (c) Positions and name of cargo blocks and arrangement of running ropes(for lifting and slewing)
 - (d) Positions, types and capacities of winches
 - (e) Self-weight of lifting beams, grabs, lifting magnets, spreaders, etc.
 - (B) Structural drawings
 - (a) Construction, dimensions and materials of masts, posts, guy posts and derrick booms
 - (b) Dimensions and materials of shrouds and stays
 - (c) Dimensions and materials of gooseneck brackets, topping brackets, eye plates at upper and lower ends of preventer stays and other cargo fittings

2. Examinations for Workmanship [See Rule]

In application to **203. 2** of the Rules, the followings are to be applied.

- (1) Tests and examinations for driving machines, etc. for cargo gear and cargo ramps are to be in accordance with the following requirements (A) to (D):
- (A) Hydraulic motors and regulating valves attached thereto:
 - (a) Where the output is less than 375 kW, shop tests may be replaced with the tests conducted by the manufacturer. In this case the Society may require submission of the test results, if it deems necessary.
 - (b) Where the output is 375 kW or more, for tests except performance verification tests and open-up examinations, if manufacturers carry out internal tests and submit test reports, the presence of the Surveyor may be omitted. The hydraulic(water or oil) test is to be carried out at a pressure of 1.5 times the design pressure. (2017)
 - (c) Notwithstanding the requirements (a) and (b) where the driving machines are installed on the class ship of the Society for the first time, the hydraulic test, performance verification test, and open-up examination are all to be carried out in the presence of the Surveyor.
 - (B) Hydraulic pumps:

Hydraulic pumps are to be dealt with in similar ways to (A) (a) to (c) above depending on the outputs of the driving motors.
 - (C) Steam cylinders, pneumatic motors and internal combustion engines:

These are to be dealt with in similar ways to (A) (a) to (c) above depending on each output. The hydraulic tests for the steam cylinders are to be carried out at a pressure of 1.5 times the design steam pressure and those for the valves directly connected to the cylinder are to be carried out at a pressure of 2 times the design steam pressure.
 - (D) Driving motors for winches or hydraulic pumps and their control equipment:

These are to comply with the requirements specified in **Pt 6** of the Rules and to pass the tests and examinations specified in **Pt 6** of the Rules thereof.
- (2) Winches which are used for the cargo gear and cargo ramps(except those specified in (3) below) are to be subjected to the tests and examinations mentioned in the following (A) and (B) at the shop tests after completion of assembly including installation of driving machines, etc. In this case, one winch selected from those of the same type manufactured at the same time and to be installed on the same ship is to be tested in the presence of the Surveyor, and, if the results are satisfactory, tests and examinations for other winches may be substituted by confirmation of the test results issued by the manufacturer.
- (A) Electro-hydraulic winches
 - (a) Visual examinations and checking of the construction:

It is to be ascertained that no practically injurious defects exist in materials and workmanship and each movable part moves smoothly.
 - (b) No-load test:

The winch is to be operated with no load at the maximum speed for 30 minutes(15 minutes for each normal and reverse rotation) and be ascertained that the performance and each structural part is in good order.

- (c) Load tests:
The winch is to hoist and lower the rated load for a period of 30 minutes continuously. (Pause of 20 seconds may be inserted between each hoisting and lowering operation, and effective lift is desirable to be 10 m or more.) During this operation, the temperature rise of the bearings, the hoisting speeds, the lowering speeds and the input power are to be measured and ascertained that they are in good order.
 - (d) Braking tests:
During hoisting and lowering the rated load for the winch, return the control handle to the neutral position and check the slip of the load to be 1.5 m or less. Manual releasing test of the brake is also to be carried out and ascertained to be in good order.
 - (e) Speed control tests
 - (f) Emergency assurance tests:
The emergency assurance devices provided in the winches is to be ascertained of the performance by cutting off power supply during lowering the rated load.
 - (g) Overload tests:
The winch is to hoist and lower a load weighing 125 % of the rated load several times. The winch is to be stopped at least three times during lowering the load and ascertained to be in good order.
 - (h) Adjustment of the over-pressure preventive device:
The adjusted pressure is to be checked as necessary.
 - (i) Open-up examinations
The Society may require an open-up examination of the part where abnormality is found.
 - (j) Other tests deemed necessary by the Surveyor.
 - (B) The shop test for steam winches, electric winches and winches driven by internal combustion engines are also to be carried out in accordance with the requirement specified in (A) above for electro-hydraulic winches(except (A) (h) above).
 - (3) Winches that are used for cranes, special derricks, cargo lifts or cargo ramps and are integrated in their moving bodies are, as a rule, to be handled in accordance with the requirements in (2) above. However, in case where deemed impracticable by taking into account the construction or arrangement of the winch, part or whole of the tests and examinations specified in (2) above may be permitted to be carried out at the time of the Load Tests specified in **205.** of the Rules.
3. In application to **203. 3. (1) (B)** of the **Rules**, the term 'When considered necessary by the Surveyor' means the cases as specified in **Pt.1 Ch.1, 801. 2** of the **Guidance.** (2020)

204. Annual Surveys

1. In application to **204. 1** of the Rules, at Annual Surveys, the structural members and loose gear in which corrosion, abrasion or other defects specified in the followings are found are, as a rule, to be repaired or renewed: **【See Rule】**
- (A) Structural members(plate members and cargo fittings other than pin construction):
Structural members in which amount of wear and tear reaches 10 % of the original dimensions. However, this may not be applied where steel plates having enough margin to the thickness required by the Rules is used.
 - (B) Cargo fittings of pin construction:
Structural members where clearance between pin or similar fitting and its mating hole increases up to 10 % of the original diameter of the pin. However, for gooseneck pin the limit of clearance between the cross bolt and the bracket hole is to be 5 % of the original diameter of the cross bolt.
 - (C) Loose gear(except wire ropes)
For loose gear except wire ropes, those corresponding to any of the followings:
 - (a) Those in which injurious deformation occurred
 - (b) Those in which injurious deformation occurred
 - (c) Those in which amount of abrasion or corrosion reaches 10 % or more of the original dimensions
 - (d) Blocks whose sheaves do not rotate smoothly
 - (D) Wire ropes
Wire ropes corresponding to any of the followings:
 - (a) Those in which 5 % or more of total number of independent wires(except filler wires)

- were broken within a length of 10 times the diameter of wire rope
- (b) Those in which reduction in diameter of the wire rope reaches 7 % or more of the diameter
 - (c) Those in which kink or other injurious deformation occurred
 - (d) Those in which significant corrosion occurred at the surface of independent wires or inside the wire rope
 - (e) Those deemed necessary by the Surveyor
2. In **204. 1 (1), 2, 3, 4 (1) and 5 (1)** of the Rules, the "where considered necessary by the Surveyor" means the case as specified in **Pt 1, Ch 1, 801. 1** of the Guidance. **[See Rule]**

205. Load Tests **[See Rule]**

1. Load Tests (2021)

In application to **205.** of the Rules, the followings are to be applied.

- (1) Load Tests for cranes which are newly constructed, as a rule, are to be carried out after having been assembled at the shops, as well as after having been installed on board the ships. If the results of the shop tests are satisfactory for one crane selected from those of the same type manufactured at the same time and to be installed on the same ship, those for other cranes may be substituted by confirmation of the test results issued by the manufacturer. If it is considered by the Surveyor that the Load Tests are impractical at the manufacturer's shop, the Load Tests at the shop may be dispensed with subject to carrying out the Load Tests on board.
- (2) For cargo gear exclusively using grabs, lifting beams, magnets, spreaders and other similar loose gear (hereinafter referred to as "cargo holding gear"), the test load and safe working load may be dealt with in either case of the following (A) or (B) in accordance with the application:
 - (A) Where the mass of loose gears is included in the safe working load:

$$\begin{aligned}\text{Test load} &= \alpha \times \{(\text{maximum cargo mass}) + (\text{mass of cargo holding gear})\} \\ \text{Safe working load} &= (\text{maximum cargo mass}) + (\text{mass of cargo holding gear})\end{aligned}$$

where:

α : a factor obtained from the test load specified in **Table 9.2.2** of the Rules divided by the safe working load. However, for the safe working load not less than 20 t but less than 50 t, the test load is to be the safe working load plus 5 t.

- (B) Where the mass of loose gears is not included in the safe working load and the maximum cargo mass only is assigned as the safe working load, the cargo gear whose safe working load is assigned by this procedure is to satisfy the following conditions:
 - (a) The load tests are to be carried out employing the loose gears used in the cargo gear concerned or other loose gears having same construction and mass.
 - (b) The loose gears used on board the ship is to be the same gears as used in the load test or those having same construction and mass.

$$\begin{aligned}\text{Test load} &= \alpha \times (\text{maximum cargo mass}) \\ \text{Safe working load} &= \text{maximum cargo mass}\end{aligned}$$

where:

α : As specified in (A) above

- (3) Load Tests for cargo gear which are used for solely conventional cargo handling by cargo hook are, as a rule, to be handled in accordance with the manners specified in (2) (B) above.
- (4) Details of Load Tests and operation tests for cargo gear and cargo ramps are to comply with the following requirements in (A) to (E), in addition to those specified in the Rules.
 - (A) Derricks
 - Where assignment of additional safe working load specified in **902. 2 (A)** of the Rules is made, the Load Test for the additional safe working load may be dispensed with. In this

case the relationship between the safe working load, etc. and additional safe working load, etc. is to satisfy the following formula:

$$B = W \frac{\cos \alpha}{\cos \beta}$$

where:

- W : Safe working load (t)
- α : Allowable minimum angle (*degree*)
- B : Additional safe working load (t)
- β : Additional allowable angle (*degree*)

(B) Jib cranes

- (a) Where assignment of additional safe working load specified in **902. 2** (B) of the Rules is made, the Load Test for the additional safe working load must not be dispensed with.
- (b) For cranes with constant safe working load regardless of slewing radius, slewing tests are to be carried out at the maximum radius with test load based on the safe working load suspended on it and luffing operation to the minimum radius or the smallest possible radius is to be carried out and slewing test at that radius is also to be carried out as far as practicable.
- (c) For cranes whose safe working load changes depending on the slewing radius, slewing tests are to be carried out at both the maximum and minimum slewing radius after hoisting the test loads corresponding to each radius.
- (d) For cranes capable of doing all three of hoisting, slewing and luffing operations or any two out of these three operations simultaneously, these combined operations prescribed in the design specifications are to be verified that they are in satisfactory condition with the test loads corresponding to the limited radius suspended on it.

(C) Gantry cranes and other track-mounted cranes

- (a) The crane is to run on the track within the traveling limits with the safe working load suspended on it. In this case, the hull structure supporting the traveling track is also to be confirmed that it is free from defects.
 - (b) Where traveling trolley is employed, it is to run the whole traveling range through with the safe working load suspended on it.
 - (c) Where spouson girder of stowing type for traveling trolley is employed, stretching and stowing operations of the girder are to be ascertained that they are in good order.
- (D) In case of hydraulic cranes where limitations of pressure make it impossible to lift a test load 25 percent in excess of the safe working load, it will be sufficient to lift the greatest possible load, but in general this should not be less than 10 percent in excess of the safe working load.
- (E) "The method considered appropriate by the Society" in **205. 1** (4) (B) of the Rules means the following requirements at least.
- (a) Accuracy of the load weighing machine is to be within the range of ± 2.5 %.
 - (b) Load applying position is to be selected in such a way that the stress generated in the structural members be the most severe within the approved operating range.
 - (c) The load is to be sustained for a period of 5 minutes or more being sufficient to ensure the load indicator remains constant.

Section 3 Derrick Systems

302. Design Loads

1. Load Considerations [See Rule]

In application to **302. 1** of the Rules, where strength of derrick systems is to be calculated directly, external forces exerting on top of boom are to include tension in topping lifts, tension in guy ropes, tension in cargo falls(which is caused by the weight of cargo), tension in cargo relief, half of self-weight of boom, and additional loads including self-weight of cargo blocks, hooks, ropes, etc. However, the additional loads may be as given in **Table 9.2.2**.

2. Loads due to Ship Inclination [See Rule]

In application to **302. 3** of the Rules, the followings are to be applied.

- (1) Where an angle of heel less than that specified in the Rules is used for the design of structural members, data concerning ship inclination in service condition in at least the following conditions (A) through (C) are to be submitted to the Society. Longitudinal strength of hull and stability in these conditions are to be separately examined.
 - (A) Ship light condition
 - (B) On going condition in service of cargo loading
 - (C) Immediately before fully loaded condition
- (2) In ships conducting ballast adjustment to keep angle of heel within that specified in **302. 3** of the Rules in working condition, data concerning the following (A) through (C) are to be submitted to the Society. All these data are to be entered in the Instruction Manual to Cargo Handling Machinery and Gear referred to in **905. 2** of the Rules.
 - (A) Specifications of equipment for ballast adjustment
 - (B) Method and procedure of ballast adjustment
 - (C) Trouble-shooting of equipment for ballast adjustment

Table 9.2.2 Additional Loads

Safe working load W (t)	Additional Loads (t)
$W \leq 2$	$0.283 W$
$2 < W \leq 15$	$0.4 \sqrt{W}$
$15 < W \leq 50$	$0.1 W$
$50 < W$	As considered appropriate by the Society

303. Construction of Derrick Posts [See Rule]

In **303. 4** (1) of the Rules, the "any other method approved as appropriate by the Society" means other method to be supported with strength verified by direct strength calculation method.

306. Simplified Calculation Methods for Derrick Booms

1. In **306. 2**, **Table 9.2.10**, **9.2.11** and **306. 3**, **Table 9.2.14** of the Rules, the "value as considered appropriate by the Society" means the accepted value in accordance with **Pt 1, Ch 1, 104.** or **105.** of the Guidance. [See Rule]
2. In application to **306. 2** (2) of the Rules, the "any other standards recognized by the Society to be equivalent" means the International Standard(ISO), National Standard(KS) or equivalent standards. [See Rule]

Section 4 Cranes

402. Design Loads

1. In **402. 1** (K), **9** (2) (I) and (5) (E) of the Rules, the "other loads considered necessary by the Society" means the loads act on structure part of crane by snow, ice and changing temperature, etc. **[See Rule]**
2. In application to **402. 5**, **Table 9.2.16** of the Rules, the "value as considered appropriate by the Society" are specified in **Ch 3 Sec 1 103. 1 of the Rules for the Towing Survey of Barges and Tugboats**. **[See Rule]**

3. Load due to Ship Inclination **[See Rule]**

In application to **402. 7** of the Rules, in calculating loads due to ship inclination to be taken into consideration in the design of cranes, requirements in **302. 3** (1) and (2) specified for derrick systems may be also applied to cranes.

4. Load Combinations **[See Rule]**

In application to **402. 9** of the Rules, wind loading need not be taken into account for cargo gear mentioned in the following (A) and (B):

- (A) Cargo gear used in cargo hold, engine room, and other enclosed spaces in ship
- (B) Cargo gear installed on weather deck and used only for loading and unloading articles other than cargo. The Society may, however, require to take the wind loading into account considering the construction system, method of operation, and safe working load of the machinery and gear.

403. Strength and Construction

1. General **[See Rule]**

In application to **403. 1** of the Rules, the followings are to be applied and in **403. 1** (3) of the Rules, the "when considered necessary by the Society" means the case as specific cranes except cranes specified in **Table 9.2.15**.

- (1) As for slewing ring of the crane, drawings and data given in the following (A) through (E) are to be submitted to the Society. However, for those having operational experiences aboard ships under the classification of the Society, the requirements may be reduced to only those specified in (B).
 - (A) Those giving structural details and materials of slewing ring
 - (B) Allowable values of vertical load, radial load, and upsetting moment exerting on the slewing ring
 - (C) Installation criteria of slewing ring
 - (D) Strength calculation sheet
 - (E) Data on operating experience and quality control during period of manufacture.
- (2) In construction of jib crane house, such portions subjected to concentrated load as fixing parts of brackets for sheaves and wire rope stoppers are to be effectively reinforced.

2. Fixed Posts **[See Rule]**

In application to **403. 8** of the Rules, the followings are to be applied.

- (1) Where the fixing flange of slewing ring of jib crane at the upper part of post is reinforced by brackets, the brackets are at least to be fitted at every two fixing bolts for the slewing ring.
- (2) The method of reinforcement specified in (1) above is to be applied also to gantry cranes and other special cranes having slewing ring.

404. Special Requirements for Track-mounted Cranes

1. Stability **[See Rule]**

In application to **404. 1** of the Rules, Tracks for track-mounted cranes are to comply with the following requirements (A) through (C):

- (A) The tracks are to have proper cross section, to be properly laid considering expansion and construction due to hull deformation and thermal effect, to be rigid and horizontal, and to have sufficient strength and monolithic travel surface.

- (B) Where intended to serve as anchor to stop the crane under strong wind condition, the tracks are to be properly designed for the purpose intended.
- (C) Tracks for electric cranes are to be properly earthed.

Section 5 Cargo Fittings

502. Cargo Fittings

1. In **502. 1 (3), 2 (2) and 3** of the Rules, the "any other standards recognized by the Society" means the International Standard(ISO), National Standard(KS) or equivalent standards. **[See Rule]**
2. In **502. Table 9.2.21, 9.2.22 and Table 9.2.25** of the Rules, the "value as considered appropriate by the Society" means the accepted value in accordance with **Pt 1, Ch 1, 104. or 105.** of the Guidance. **[See Rule]**

Section 6 Loose Gear

602. Cargo Blocks

1. Cargo Blocks for Wire Ropes **[See Rule]**

In application to **602. 1** of the Rules, diameters of equalizer sheaves and sheaves of overload sensing devices at the bottom of groove are to be not less than 10 times and 5 times the diameters of wire ropes to be used, respectively.

603. Ropes

1. Wire Ropes **[See Rule]**

- (1) In application to **603. 1** of the Rules, terminal connections of ropes are to comply with the following (A) through (F), as a standard:
 - (A) A loop splice should have at least three tucks with a whole strand of rope, followed by two tucks with half the wires cut out of each strand.
 - (B) All tucks other than the first should be against the lay of the rope. If another form of splice is used, it should be as efficient as that described in (A) above.
 - (C) A splice in which all the tucks are with the lay of the rope should not be used in the construction of a sling or in any part of a cargo handling appliance where the rope is apt to twist about its axis.
 - (D) If a loop is made or a thimble secured to a wire rope by means of a compressed metal ferrule, the ferrule should be made to a manufacturer's standard conforming to the following (a) through (e):
 - (a) The material used for the manufacture of the ferrule should be suitable, particularly to withstand plastic deformation without any sign of cracking.
 - (b) The correct size(both in diameter and length) of ferrule should be used for the diameter of the rope.
 - (c) The end of the rope that looped back should pass completely through the ferrule.
 - (d) The correct dies should be used for the size of the ferrule.
 - (e) The correct closing or compression pressure should be applied to the dies.
 - (E) Where zinc or other alloy is cast in socket to hold the end of rope, work is to be done in accordance with the manufacturer's criteria conforming to the following requirements (a) through (d):
 - (a) Rope length necessary to make alloy casting is to be ensured.
 - (b) Oil and dirt adhering to independent wires are to be completely removed and proper clean surfaces are to be ensured by treatment before casting work.
 - (c) Casting temperature suitable to the characteristics of the alloy is to be properly maintained.
 - (d) Socket is to be preheated before casting of alloy.
 - (F) The terminal fitting of any wire rope should be capable of withstanding the following loads (a) or (b).

- (a) Not less than 95 % of the minimum breaking load of the rope in the case of a rope of a diameter of 50 mm or less
 - (b) Not less than 90 % of the minimum breaking load of the rope in the case of a rope of a diameter above 50 mm
- (2) In **603. 1** (B), **2** (A) of the Rules, the "the standards as deemed appropriate by the Society" and "the recognized standards" means the International Standard(ISO), National Standard(KS) or equivalent standards.

605. Equivalent Requirements

1. General [See Rule]

In application to **605. 1** of the Rules, the followings are to be applied.

- (1) Construction and materials of cargo blocks and hooks are to comply with the following requirements in (A) through (C).
 - (A) Steel blocks are to comply with other standards considered appropriate by the Society.
 - (B) Wooden blocks are to comply with other standards considered appropriate by the Society.
 - (C) Hooks are to comply with other standards considered appropriate by the Society.
- (2) Sheaves, main parts of which are fabricated by welding steel plates, are to be verified prior to application that they have sufficient structural strength by the tests and inspections specified in the following (A) through (F):
 - (A) Welding procedure test(The test items are in accordance with the requirements specified in **Pt 2, Ch 2, Sec 4** of the Rules. They are, however, increased or decreased according to the type of joint.)
 - (B) Structural strength test(Local and/or total strength)
 - (C) Fatigue test(Test is to be carried out by rotating the sheave at least 10^6 turns under the most severe load condition of the block.)
 - (D) Load Test
 - (E) Verifying test for special process of manufacture such as quenching
 - (F) Verification test for process of manufacture conforming to manufacturing standard(No occurrence of defects such as distortion is to be verified.)

Section 7 Machinery, Electrical Installations and Control Engineering Systems

701. General

1. Application [See Rule]

In application to **701. 1** of the Rules, "They may be suitably modified" specified in the requirement of winches used for cargo ramps means that the requirements specified in **702. 2** (1) (A), (B), (E), (F), **704. 2** (3) and **704. 3** (1) of the Rules are not applied.

702. Machinery

1. Hoisting Machinery [See Rule]

In application to **702. 2** of the Rules, the followings are to be applied.

- (1) Winches are to be so designed that the safety factor of the structural parts based on the ultimate tensile strength of the material is not less than the value given as follows according to the safe working load of cargo gear incorporating the winches concerned:
 - 5 : for safe working load is 10 t or less
 - 4 : for safe working load exceeds 10 t
- (2) Winches which may have to continue stalling condition for a given period with load applied to winch drums are to be provided with devices capable of preventing positively rotation of the drum by means of such mechanism as ratchet in addition to the braking devices specified in **702. 2** (1) (D) of the Rules. In general, winches having mechanism shown in the following (A) and (B) correspond to these winches:
 - (A) Topping drum(or guy drum) of a winch, which drives its cargo hoist drum and topping

- drum(or guy drum) by a same driving unit through clutch
- (B) Drum of a topping winch or guy winch, which is used as the end stopper of wire rope holding the boom at its working position
- (3) "The rope at its end is to be secured to the drum" specified in **702. 2 (2)** of the Rules means a force to sustain a load being double the drum load on condition that the wire rope is wound on the drum by four full turns.

703. Power Supply

1. General [See Rule]

In application to **703. 1** of the Rules, among cables used in power circuit of 600 V or less for electric equipment for movable cargo gear, rubber flexible cords used in portions requiring flexibility and bending strength are to be those conforming to other standards considered appropriate by the Society.

704. Control Engineering Systems

1. Safety System [See Rule]

In application to **704. 3** of the Rules, the followings are to be applied.

- (1) It recommended that derrick systems are to be provided with limit switches to prevent over winding up, slewing and over luffing.
- (2) Cranes are to be provided with safety devices specified in the following (A) through (D):
- (A) Overload preventive device and overload alarm. Cranes not serving cargo handling may dispense with these devices.
- (B) Limit switches to prevent over winding up, over slewing over luffing
- (C) Where trolley or crab travels on horizontal jib or luffing jib and safe working load varies depending on the load and radial position of trolley or crab, radial load indicator clearly visible to the operator indicating the following items (a) and (b):
- (a) Safe working load of crane corresponding to the radial position of hook or other hoisting gear fitted to the hoist rope
- (b) Limit value for luffing motion of jib or longitudinal motion of trolley/crab. This, however, does not apply to the case where rated load diagram is posted in the operator cab.
- (D) For cranes having travelling equipment on the body or hoisting device, overrun preventive device on the travelling tracks. In addition, it is recommended that overspeed preventive device be provided.
- (3) Cargo lifts are to be provided with the safety devices given in the following (A) through (C) as far as practicable:
- (A) Overload alarm
- (B) Automatic cutout device for power supply to the driving equipment when hoisting rope or chain slacks
- (C) Interlock device capable of functioning the following (a) and (b) where locking bars are used in stowing device of the lift
- (a) Power is not to be supplied to the lift unless all locking bars are pulled out.
- (b) For hydraulic lifts, locking bars can not be pulled out until oil pressure reaches a pressure sufficient to sustain the lift.
- (4) The emergency stopping device specified in **704. 2 (4)** of the Rules is to operate independently of other control devices.
- (5) Cargo ramps are to be provided with the safety devices specified in the following (A) and (B):
- (A) An alarm device generating alarm before inclination of the ship reaches the value determined in accordance with the requirements in **802. 1 (1)**
- (B) For ramps slewing or travelling with cargo loaded, safety devices determined by the requirements in (1) to (3) above depending on the operating system

Section 8 Cargo Lifts and Cargo Ramps

802. Design Loads

1. Other Loads [See Rule]

In **802. 1** (G), **402. 6** (2) (E), (4) (F), (5) (E) of the Rules, the "other loads considered necessary by the Society" means the loads act on structure part of crane by snow, ice and changing temperature, etc.

2. Loads due to Ship Inclination [See Rule]

In application to **802. 4** of the Rules, the followings are to be applied.

- (1) The load due to ship inclination is, as a rule, to comply with the requirements in **402. 7** of the Rules. The Society, however, may permit to apply value of ship inclination offered, if the data on ship inclination in service conditions are submitted to and deemed appropriate by the Society.
- (2) Cargo ramps are not, as a rule, to be designed to be capable of operating at a slope of exceeding 1/10.

803. Strength and Construction

1. Deflection Criteria [See Rule]

In application to **803. 5** of the Rules, concerning deflections of the cargo lifts and cargo ramps, the Society may permit application of values larger than those specified in **803. 5** of the Rules if it considers no obstruction exists in strength and operation of the equipment judging from the operating experience, results of model tests, etc.

Annex 9–2 Personnel lifting (2017)

101. General

1. Application

- (1) Cranes registered under the Rules for Cargo Handling Appliances (hereinafter referred to as the Rules) in cases where they are used to personnel lifting are to comply with the requirements in this section in addition to the requirements of the Rules.
- (2) The means of embarkation and disembarkation required by SOLAS convention are not to be substituted by such cranes.

102. Surveys

1. Registration Surveys

- (1) Drawings and Other Documents to be Submitted
 - (A) Approval drawing
 - (a) Equipment added for personnel lifting
 - (B) Reference document
 - (a) Operation manual for personnel lifting
 - (C) The operation manual specified in (B) (a) is to contain the following (a) to (c).
 - (a) Restrictions on personnel lifting operations, which contain at least the following:
 - (i) Wind velocity, wave height, and visibility
 - (ii) The maximum angle and slewing radius of cranes (horizontal and vertical distance to the object of lifting)
 - (iii) Safe working loads and hoisting, lowering, and swinging speeds
 - (iv) Embarkation areas of equipment used to lift personnel such as baskets
 - (b) Items regarding persons engaged in personnel lifting operations, which contain at least the following:
 - (i) Roles of the operational master
 - (ii) Qualification of the crane operator
 - (iii) Arrangement of signalmen in cases where the object of lifting cannot be visible from the crane control position
 - (iv) Means to ensure the safety of persons in the basket and engaged in the operation
 - (v) Communications between the operational master and persons involved
 - (vi) Means to address the emergency situations such as rescue means in the case of crane malfunctions
 - (vii) Inspection and testing items prior to personnel lifting operations
 - (c) Items to be checked prior to use of the basket, which contain at least the following:
 - (i) Specifications of the basket such as its own weight, SWL and capacity
 - (ii) Maintenance records
 - (iii) Certifications issued by an official body or a third-party body
- (2) Examinations at Registration Surveys
 - (A) Personnel lifts are to be examined and ascertained to be in good order by the following tests and surveys:
 - (a) Operation tests of the equipment added for personnel lifting
 - (b) Other tests considered necessary by the Society
 - (B) Appliances specified in **106.** on board the ship and markings specified in **107.** are to be examined.

2. Annual Thorough Surveys

At annual thorough surveys, personnel lifts are to be examined and ascertained to be in good order by the following tests and surveys, in addition to the requirements in **Ch 2, 204. 2** of the Rules.

- (A) Operation tests specified in **Par 1 (2) (A) (a)**
- (B) Examinations specified in **Par 1 (2) (B)**

103. Cranes

1. Safe Working Load

The safe working load of the cranes for use for personnel transfers is to be less than 50 % of the safe working load specified in **Ch 2, 102.** of the Rules. The total weight of the basket (sum of its own weight and capacity load) is not to be more than this load.

2. Operational limitation

Except for emergency operations, the operational limitations for lifting of personnel shall be as follows:

- (A) Mean wind velocity: 10 m/s
- (B) Significant wave height: 2 m
- (C) Visibility: daylight or equivalent

104. Loose gear

1. General

The safety factor of any loose gear is to be 10 and more on the basis of the breaking strength against the safe working load specified in **103.**

2. Wire Ropes

In addition to the requirements specified in **Ch 2, 603. 1** of the Rules, wire ropes are to be of an anti-rotation type.

105. Machinery, electrical installations and control engineering systems

1. General

The machinery, electrical installations and control engineering systems used in the personnel lifting are to be arranged to prevent accidental falls of the basket and are to be able to lower the basket in the case of a power supply malfunction.

2. Brakes

- (1) Hoisting and luffing winches shall be equipped with two mechanically and functionally independent brakes.
- (2) Means shall be provided for separate testing of each brake.
- (3) Mechanical brakes shall fulfil the requirements for brakes as given in **Ch 2, 702. 2** of the Rules based on SWL for the actual load cases. SWL will be replaced by rated capacity for personnel handling provided the brake is used in personnel handling mode only.
- (4) Where cylinders are used for luffing, folding or telescopic, they shall be provided with a hydraulic shutoff valve. Alternatively each motion shall have two independent cylinders where each cylinder is capable of holding the rated capacity for lifting of persons.

3. Mode selection for lifting of persons

The control station is to be equipped with a manual switch for selection between cargo and personnel lifting modes. When the mode for personnel lift is selected, the following functions shall be maintained:

- (A) All brakes shall automatically be activated when the controls are in neutral position and in cases where the emergency stop has been activated.
- (B) Where fitted, automatic overload protection system (AOPS) and manual overload protection system (MOPS) shall be overridden.
- (C) Where fitted, motion compensators; i.e. cable tensioning systems and heave compensator systems shall be overridden.
- (D) Where fitted, emergency release systems shall be overridden.
- (E) A warning light continuously illuminating is provided. (2018)

106. Other appliances

1. Communication devices

Appropriate communication devices are to be provided to the operational master, the crane operator, the signalmen, and persons in the basket.

2. Wind gauge

Wind gauge is to be provided to ensure that the operational master can be informed of the wind velocity.

3. Basket

Where the basket is to be approved, it is to comply with **EN 14502-1** or equivalent standard.

107. Certification, marking and documentation

1. Marking of Safe Working Load, etc.

(1) Marking for Cranes

- (A) At the location specified in **Ch 2, 903. 1** of the Rules, the safe working load, the maximum slewing radius, and other restrictive conditions of personnel transfers are to be marked.
- (B) At the locations of the crane control position and embarkation area, a notice indicating the safe working load, the maximum slewing radius, maximum wind velocity, maximum wave height, minimum visibility, and other restrictive conditions for personnel transfers is to be provided. ⚓

CHAPTER 3 AUTOMATIC AND REMOTE CONTROL SYSTEMS

Section 2 Surveys of Automatic and Remote Control Systems

201. General

1. Preparation for surveys and others (2020) [See Rule]

In application to **201. 3** (1) of the Rules, the term "a standard deemed appropriate by the Society" means the acceptance in accordance with **Pt 1, Ch 1, 104.** of the Rules.

202. Classification surveys

1. Drawings and data [See Rule]

The following drawings and data are to be submitted as those for the specific automation equipment specified in **202. 1** (3) (D) of the Rules.

- (1) Remote-controlled ballasting/deballasting arrangements
 - (A) Schematic diagrams for ballasting/deballasting piping systems(with arrangements of ballast tanks, valves, pumps and sea chests, and including the exclusive heel adjusting pipe lines)
 - (B) Arrangements of instruments on remote monitoring and alarm panels for ballasting/deballasting and remote control panels for pumps and valves
 - (C) Schematic diagrams of tank liquid level remote monitoring systems
 - (D) Schematic diagrams of valve operating and remote control systems for valves
- (2) Automatic steering systems

The drawings for approval concerning the automatic steering systems are to include, at least, the following items:

 - (A) Constitution of systems for steering
 - (B) Block diagrams of alarms and indicators
 - (C) Arrangements of instruments on steering stand, alarm panels, etc.
 - (D) Explanatory notes on the functions of the systems
- (3) Remote-controlled handling systems for liquid cargo in bulk
 - (A) Schematic diagrams of liquid cargo piping systems(with arrangements of cargo tanks, valves, and pumps, and tank capacities)
 - (B) Arrangement plans of equipment in the cargo-handling centralized cargo control room (station)
 - (C) Arrangements of instruments on remote monitoring and alarm panels, and remote control panels for pumps, valves, etc., installed in the cargo-handling centralized cargo control room (station)
 - (D) Schematic diagrams of tank liquid level remote monitoring systems
 - (E) Schematic diagrams of valve operating and remote control systems
- (4) Power-driven opening/closing arrangements
 - (A) Arrangement plans of the systems, including their control positions
 - (B) Schematic diagrams of power source
 - (C) schematic diagrams of control source(only in case where separately provided from the power source)
 - (D) Detailed drawings for indicators or alarms, etc. to ensure the safety in opening/closing operations, if provided.
- (5) Automatic recording devices for operating condition of main engine
 - (A) Service instructions for automatic recording devices of operating condition(with notations on constitution of systems, intervals of regular recordings, and details of recording functions including those for regular recording, alarm recording and arbitrary recording)
- (6) Remote-controlled mooring arrangements
 - (A) Arrangement plans of mooring systems(with location of remote control stands and arrangements of mooring lines)
 - (B) Schematic diagrams of power source for mooring systems
- (7) Air-conditioning arrangements for control stations
 - (A) Service instructions for air-conditioning arrangements for control stations
 - (B) Layout of the alarm panel

- (C) Electrical diagrams of air-conditioning arrangements
- (8) Remote-controlled fuel oil filling arrangements
 - (A) Schematic diagrams of fuel oil filling piping system(with arrangements of tanks, valves, and pumps, and tank capacities)
 - (B) Schematic diagrams of remote monitoring and alarm systems of the liquid level in tanks
 - (C) Schematic diagrams of valve operating and remote control systems
 - (D) Arrangement of instruments on remote monitoring and alarm panels and remote valve control panels
- (9) Centralized monitoring devices for refrigerating containers
 - (A) Arrangements of instruments on monitoring panels
 - (B) Electrical diagrams of monitoring panels
 - (C) Lists of monitoring and alarming items
- (10) Cargo hose handling winches
 - (A) General arrangements and layout drawings of cargo hose handling winches
 - (B) Schematic diagrams of power source
 - (C) Schematic diagrams of control source(only in case where separately provided from the power source)
- (11) Automatic washing arrangements
 - (A) General arrangements and layout drawings of washing arrangements
 - (B) Schematic diagrams of washing water piping systems
 - (C) Schematic diagrams of power source for washing arrangements and control systems
- (12) Remote-controlled mooring arrangements at ship-sides
 - (A) Layout of mooring arrangements(including layout of remote control stand and mooring rope)
 - (B) Schematic diagrams of power source for mooring arrangements
- (13) Power-operated pilot ladder winding appliances
 - (A) General arrangements and Layout drawings of winding appliances
 - (B) Schematic diagrams of power source
 - (C) Schematic diagrams of control source(only in case where the control source is provided separately from the power source)
- (14) Centralized monitoring systems for machinery
 - (A) Arrangements of instruments on monitoring panels
 - (B) Lists of monitoring and alarming items
- (15) Centralized control systems for machinery
 - (A) Arrangements of instruments on control panels
 - (B) Lists of monitoring, alarm and control items
- (16) Bridge wing control devices for main engine remote control and remote steering systems
 - (A) General arrangements and layout drawings of bridge wing control devices for main engine remote control and remote steering systems
 - (B) Schematic diagrams of power source
 - (C) System diagram of control source(only in case of source independent of main power source)
- (17) High level alarm for cargo hold bilge
 - (A) Diagram and general arrangement of alarm system
 - (B) Layout of the alarm panel
- (18) Independent remote-controlled mooring arrangements
 - (A) Layout of mooring arrangements(including layout of remote control stand and mooring rope)
 - (B) Schematic diagrams of power source for mooring arrangements
 - (C) Schematic diagrams of remote control systems for mooring arrangements
- (19) Emergency towing rope winches
 - (A) General arrangements and layout drawings of emergency towing rope winches
 - (B) Schematic diagrams of power source
 - (C) Schematic diagrams of control source(only in case where separately provided from the power source)

203. Shop tests

1. Type approval [See Rule]

- (1) In application to **203. 1** of the Rules, "automatic equipments" to be type-approved are, in principle, as follows:
 - (A) Alarm and monitoring systems

- (B) Control systems for, main engine, generators, boilers and essential auxiliary machinery, etc.
 - (C) Computer-based systems
 - (D) Fire detection systems
 - (E) Gas detection systems
 - (F) Electronic governor systems
 - (G) Speed and shaft horsepower sensing equipment
 - (H) Controller
 - (I) Flow, level, limit, pressure, temperature switches
 - (J) Oil mist detectors
 - (K) UPS
 - (L) Electrical and electronic indicators
 - (M) Electric power converters for electric propulsion unit
 - (N) Optical sensors and optical application device applied to the above (A) ~ (M)
 - (O) Those considered necessary by the Society
- (2) "Test methods approved by the Society" specified in **203. 1** of the Rules means the requirements specified in **Ch 3, Sec 23** of the **Guidance for Approval of Manufacturing Process and Type Approval, Etc.**

2. Shop tests of automatic systems (2020) [See Rule]

In application to **203. 2 (1) (E)** of the Rules, the term "Other tests considered necessary by the Society" means the acceptance in accordance with **Pt 1, Ch 1, 104.** of the Rules.

204. On-board tests [See Rule]

- (1) In **204.** of the Rules, the confirmations of the machinery and equipment's operation in case of failures of control systems as deemed necessary by the Society, in general, are to include followings:
- (A) The confirmation that the rotational speed of propeller and direction of thrust are maintained as before failure, in case of failure of remote control devices for main propulsion machinery or controllable pitch propellers specified in **305. 2** of the Rules.
 - (B) The confirmation that the boilers burning systems cease burning in case of failure of automatic and remote control system of boilers specified in **306.** of the Rules.
 - (C) The confirmation that the burning systems cease burning in case of failure of automatic and remote control system of thermal oil installations specified in **308.** of the Rules.
- (2) Following conditions, at least, are to be included as assumed failure conditions of control system
- (A) Power failure of control systems
 - (B) Malfunction of computer for control use

205. Sea trials for the centralized monitoring and control systems for main propulsion and essential auxiliary machinery

1. Main propulsion machinery and controllable pitch propellers [See Rule]

As for the test procedures specified in **205. 1** of the Rules to test the main engine or controllable pitch propellers by bridge control devices, those according to **206.** are to be considered as the standard practice.

206. Sea trials for the operating systems for periodically unattended machinery spaces (2017) [See Rule]

- (1) As for the test procedures specified in **206. 2** of the Rules to test the main engine or controllable pitch propellers by bridge control devices, those shown in **Fig 9.3.1** (for diesel ships) or **Fig 9.3.2** (for steam turbine ships) of the Guidances are to be considered as the standard practice.
- (2) In case of 2-engine 1-shaft propulsion systems, the following tests are to be carried out additionally.
- (A) While two engines are running at the maximum speed, one engine is to be stopped and the other engine is to be tested under the running condition and the other is to be equally tested.
 - (B) While one engine is running at the maximum output, the other engine is to be put into parallel running.
 - (C) While two engines are running at the maximum speed (at the 85 % output or more), one

engine is to be declutched. Tests are to be carried out on each of the two engines.

(3) Other tests considered necessary by the Society are to be carried out.

(4) In **206. 6** of the Rules, 4 hours of unattended machinery operation is to be regarded as the standard practice.

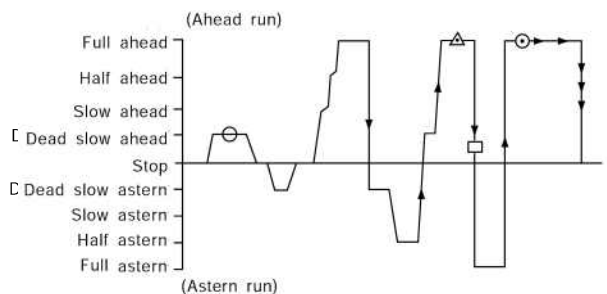


Fig 9.3.1 Trial Procedures for Diesel Ships (2021)

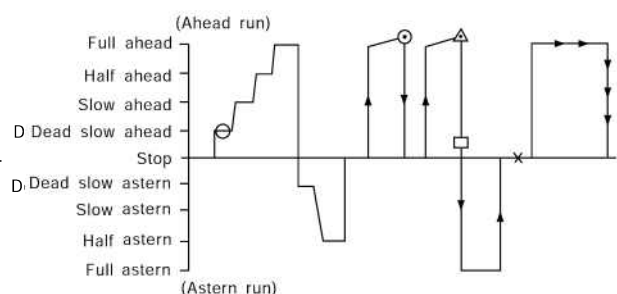


Fig 9.3.2 Trial Procedures for Steam Turbines Ships (2021)

[Remarks]

1. ⊕ signifies putting over the rudder to hard port or hard starboard while proceeding at dead slow ahead.
2. ➡ signifies to operate as quick as practicable. However, where crash astern is performed and admitted by the Surveyor in a separate way (by shipyard's practice standard, etc), it (□) may be dispensed.
3. ➡➡ signifies to cut off the power supply (electric, pneumatic or hydraulic) for the remote control systems and to confirm that the preset speed and direction of the propeller thrust for main propulsion machinery or controllable pitch propellers will be maintained and any abnormal condition will not take place, and the Society needs to confirm if the change-over from this condition to ECR is possible.
4. ➡➡➡ signifies to stop the main propulsion machinery by the emergency stop button.
5. ⊙ signifies to raise the output of main propulsion machinery to that of the normal service condition.
6. △ signifies to raise the ship's speed to that of the normal service condition.
7. × signifies to stop the rotating of the main shaft.

208. Classification maintenance surveys

1. Annual surveys [See Rule]

In application to **208. 1 (3)** of the Rules, the term "Where considered necessary by the Surveyor" means that it is determined that not exhibit the required performance.

Section 3 Centralized Monitoring and Control Systems for Main Propulsion and Essential Auxiliary Machinery

302. System design

1. Control systems (2020) [See Rule]

In application to **302. 4** (7) of the Rules, the term "other measures considered appropriate by the Society" means the acceptance in accordance with **Pt 1, Ch 1, 104.** of the Rules.

2. Computer-based systems [See Rule]

In application to **302. 7** of the Rules, examples of computer-based systems are shown in **Pt 6, Ch 2, Table 6.2.2** of the Rules. Where independent effective backup or other means of averting danger is provided, the system category III may be downgraded to category II.

303. Prevention of flooding and fire safety measures

1. Prevention of flooding [See Rule]

In application to **303. 1** (4) of the Rules, "a bilge injection system" is to be in accordance with the following.

- (1) "a bilge injection system" means the emergency bilge suction specified in **Pt 5, Ch 6, 403. 6** of the Rules.
- (2) The requirements in **303. 1** (4) of the Rules are not applicable to valves serving an emergency bilge system provided (A) to (C). Here, a normally closed non-return valve with positive means of closing is considered to satisfy both (A) and (B) below :
 - (A) The emergency bilge suction valve is to be normally maintained in a closed position,
 - (B) A non-return device is to be installed in the emergency bilge piping, and
 - (C) The emergency bilge suction piping is to be located inboard of a shipside valve that is fitted with the control arrangements required by **303. 1** (4) of the Rules.

2. Fire Safety Measures [See Rule]

- (1) For the prevention of fires, the requirements specified below are to be complied with, in addition to those specified in **303. 2** of the Rules.
 - (A) Joints for Class I piping used in fuel oil pipelines and lubricating oil pipe lines are to be of welded joints as far as practicable.
 - (B) Flexible pipes used in fuel oil pipelines and lubricating oil pipe lines are to be of the approved type and to be protected by adequate means, considering their use, pressure and arrangement.
 - (C) In case where either electric or steam heater is installed in fuel oil systems or lubricating oil systems, at least high temperature alarm or low flow alarm is to be provided in addition to the temperature controller, except when the maximum temperature of the heated oil can not be reached to the flash point.

305. Automatic and remote control of main engines or controllable pitch propellers [See Rule]

1. General

In case where the local control handle fitted to main propulsion machinery is moved to the main control station, the requirements in **305.** of the Rules may not apply except the case that the main control station is provided outside the space where main propulsion machinery is installed.

2. Remote control devices for main engines or controllable pitch propellers

- (1) For the remote control system of main propulsion steam turbine, means for automatic opening of astern intermediate valves at the operation into astern manoeuvring are to be provided.
- (2) Effective countermeasures are to be provided against a failure of remote control system such that loss of power supply (electric, pneumatic or hydraulic power).
- (3) Main engine starting by remote control system for main propulsion machinery and starting air low pressure alarm are in accordance with the followings:
 - (A) In case where the low pressure alarm activate after satisfying the number of starting specified in **Pt 5, Ch 6, 1001. 1** of the Rules, startings after this are to be controlled at the main control station.
 - (B) In case where the low pressure alarm activate before satisfying the number of starting

specified in **Pt 5, Ch 6, 1001. 1** of the Rules, the next startings is to be capable at the remote control station and the number of starting is to be satisfied in the requirements.

3. Bridge Control Devices

It is recommended that the operating handle (or button) of the bridge control devices is linked with the engine room telegraph.

4. Safety Measures

- (1) For the remote control devices for the main propulsion machinery, inter-locking devices are to be provided so as not to allow main propulsion machinery to start on the following conditions:
 - (A) When the turning gear is engaged.
 - (B) When the lubricating oil pressure is low.

306. Automatic and remote control of boilers

1. General (2020) [See Rule]

In application to **306. 1 (3)** of the Rules, the term "deemed appropriate by the Society" means the acceptance in accordance with **Pt 1, Ch 1, 104.** of the Rules.

2. Automatic combustion control systems

- (1) In application to **306. 2 (2) (F)** of the Rules, the term "as deemed appropriate by the Society" means the acceptance in accordance with **Pt 1, Ch 1, 104.** of the Rules. (2020) [See Rule]
- (2) In application to **306. 2 (4)** of the Rules, the term "deemed appropriate by the Society" means the acceptance in accordance with **Pt 1, Ch 1, 104.** of the Rules. (2020) [See Rule]

Section 5 Specific Automatic Equipment

502. Class 1 specific automation equipment

1. In application to **502.** of the Rules, the wording "equipment considered acceptably by the Society may be omitted in consideration of the purpose of the ship, the method of cargo handling and so on" means those shown below : [See Rule]
 - (1) Items which may be omitted according to the purpose of the ship
 - (A) In case of oil tankers, ships carrying liquefied gases in bulk and ships carrying dangerous chemicals in bulk; Power-operated opening/closing appliances specified in **502. 4** of the Rules
 - (B) In case of ships other than above (A); Remote-controlled handling systems for liquid cargo in bulk specified in **502. 3** of the Rules
 - (2) Items which may be omitted according to the method of cargo handling
In case of ships where no ballasting/deballasting is necessary during cargo handling (Roll-on/Roll-off ships, etc.);
Remote-controlled ballasting/deballasting arrangements specified in **502. 1** of the Rules
 - (3) Other items which may be omitted based on the acceptance of the Society
In case less than 3 mooring ropes are required in each of fore and aft of the vessel according to the equipment number in **Pt 4, Ch 8, table 4.8.1** of the Rules, the remote-controlled mooring arrangements may control only that number of ropes, if it can be operated without failure.

2. Remote-controlled ballasting/deballasting arrangements [See Rule]

The wording "control devices necessary for ballasting/deballasting" specified in **502. 1 (1) (B)** of the Rules means the control valves fitted on the piping system to enable the ballasting/deballasting.

3. Automatic steering system (2020) [See Rule]

In application to **502. 2 (11)** of the Rules, the term "Any other items considered necessary by the Society" means the acceptance in accordance with **Pt 1, Ch 1, 104.** of the Rules.

4. Remote-controlled Handling System for Liquid Cargo in Bulk [See Rule]

The wording "control devices necessary for cargo loading and unloading of cargos" specified in **502.**

3 (3) (B) of the Rules means the control valves fitted on the piping system to enable the cargo loading and unloading.

5. Power-driven operated opening/closing appliances [See Rule]

In application to **502. 4** of the Rules, power operated opening/closing appliances are in accordance with the followings:

- (1) An indicator showing opening/closing condition is to be provided at the operating position, in case where no visual verification is available.
- (2) An audible alarm or a yellow rotating warning light is to be provided to ensure the safety at the time of opening/closing operation, in case where no visual verification is available at the operating position.

6. Automatic recording devices for main engine [See Rule]

In application to **502. 5** of the Rules, automatic recording devices are in accordance with the followings:

- (1) The automatic recording devices are to have a function of taking records once four hours (corresponding to one watch).
- (2) The running conditions of main propulsion machinery are to include, at least, the following items:
 - (A) Lubricating oil pressure at main bearing inlet
 - (B) Cooling water temperature at each cylinder outlet.
 - (C) Steam pressure of main boiler
 - (D) Exhaust gas temperature at each cylinder outlet
 - (E) Revolutions per minute of main propulsion machinery or propeller shaft

7. Remote-controlled mooring arrangements [See Rule]

The wording "to be capable of effectively controlling" specified in **502. 6** (1) of the Rules means that speed controls (including starting/stopping controls) in both paying out and heaving in the mooring line are available.

503. Class 2 specific automation equipment

1. In application to **503.** of the Rules, the wording equipment considered acceptable by the Society may be omitted in consideration of the purpose of the ship, the method of cargo handling, etc. means those as shown below: **[See Rule]**

- (1) Items which may be omitted according to the purpose of the ship
 - (A) Oil tankers, ships carrying liquefied gases in bulk and ships carrying dangerous chemicals in bulk;
 - (a) Power-driven opening/closing appliances specified in **502. 4** of the Rules
 - (b) Centralized monitoring devices for refrigerating containers specified in **503. 2** of the Rules
 - (B) Container carriers;
 - (a) Remote-controlled handling systems for liquid cargo in bulk specified in **502. 3** of the Rules
 - (b) Emergency towing rope winches specified in **503. 7** of the Rules
 - (c) Cargo hose handling winches specified in **503. 3** of the Rules
 - (C) Ships other than (A) and (B) above;
 - (a) Those specified in (B) above
 - (b) Centralized monitoring devices for refrigerating containers specified in **503. 2** of the Rules
- (2) Items which may be omitted according to the method of cargo handling
Ships where no ballasting/deballasting is necessary during cargo handling;
Remote-controlled ballasting/deballasting arrangements specified in **502. 1** of the Rules
- (3) Other items which may be omitted based on the acceptance of the Society
In case less than 3 mooring ropes are required in each of fore and aft of the vessel according to the equipment number in **Pt 4, Ch 8, table 4.8.1** of the Rules, the remote-controlled mooring arrangements at ship-side may control only that number of ropes, if it can be operated without failure.

2. Remote-controlled fuel oil filling arrangements [See Rule]

In application to **503. 1** of the Rules, the wording "cases considered acceptable by the Society in

consideration of layout of tanks and valve, etc. for fuel oil filling arrangement" means that all valves required operating for fuel oil filling are located in one place and that maximum 4 fuel oil storage tanks are provided.

3. Cargo hose handling winches [See Rule]

In application to **503. 3** of the Rules, the wording "winch is to be easily operated" means those operable by one person.

4. Automatic deck washing arrangements [See Rule]

In application to **503. 4** (2) of the Rules, the wording "to have enough strength against its working pressure" means to be tested by 1.5 times the design pressure for hydraulic test.

504. Class 3 specific automation equipment

1. In application to **504.** of the Rules, "equipment considered acceptably by the Society may be omitted in consideration of the purpose of the ship, the method of cargo handling, and so on" means those specified below: **[See Rule]**

- (1) Items which may be omitted according to the purpose of the ship
- (A) Oil tankers, ships carrying liquefied gases in bulk and ships carrying dangerous chemicals in bulk;
 - (a) Power-driven opening/closing device specified in **502. 4** of the Rules
 - (b) Centralized monitoring devices for refrigerating containers specified in **503. 2** of the Rules
 - (c) Automatic deck washing arrangements specified in **503. 4** of the Rules
 - (B) Container carriers;
 - (a) Remote-controlled handling systems for liquid cargo in bulk specified in **502. 3** of the Rules
 - (b) Emergency towing rope winches specified in **503. 7** of the Rules
 - (c) Cargo hose handling winches specified in **503. 3** of the Rules
 - (d) Automatic deck washing arrangements specified in **503. 4** of the Rules
 - (C) In case of ore carriers or coal carriers in bulk;
 - (a) Remote-controlled handling systems for liquid cargo in bulk specified in **502. 3** of the Rules
 - (b) Centralized monitoring devices for refrigerating containers specified in **503. 2** of the Rules
 - (c) Emergency towing rope winches specified in **503. 7** of the Rules
 - (d) Cargo hose handling winches specified in **503. 3** of the Rules
 - (D) Ship other than (A) to (C) above;
 - (a) Those specified in (C) above
 - (b) Automatic deck washing arrangements specified in **503. 4** of the Rules
- (2) Items which may be omitted according to the method of cargo handling
- Ships where no ballasting/deballasting is necessary during cargo handling;
Remote-controlled ballasting/deballasting arrangements specified in **502. 1** of the Rules
- (3) Other items which may be omitted based on the acceptance of the Society
- In case less than 3 mooring ropes are required in each of fore and aft of the vessel according to the equipment number in **Pt 4, Ch 8, table 4.8.1** of the Rules, the remote-controlled mooring arrangements at ship-side may control only that number of ropes, if it can be operated without failure.

2. **Centralized monitoring systems for machinery** The centralized monitoring systems for machinery specified in **504. 1** of the Rules is to have the following functions. However, for those provided on the navigation bridge by other requirements of the Rules, these functions may be dispensed with. **[See Rule]**

- (1) Monitoring of alarms for the abnormal conditions on the items given in **Table 9.3.1** through **Table 9.3.5** of the Guidance.
- (2) Indications of the items given in **Table 9.3.1** through **Table 9.3.5** of the Guidance. But when two or more items to be indicated are delivered from a same pump or heat exchanger, indication for only one item may be accepted.

Table 9.3.1 Indications and Alarm Items for Diesel Engine

Item		For main propulsion machinery	For generator engine
Temperature	Cylinder cooling water	Each cylinder outlet	–
	Piston cooling water (oil)	Each cylinder outlet	–
	Lubricating oil (main)	Inlet	–
	Fuel oil	Inlet	–
	Exhaust gas	Each cylinder outlet	Each inlet of turbocharger or each cylinder outlet
	Scavenging air	Air cooler outlet	–
Pressure	Cylinder cooling water	Inlet	–
	Piston cooling water (oil)	Inlet	–
	Fuel oil valve cooling water (oil)	Inlet	–
	Lubricating oil (main)	Inlet	–
	Fuel oil	Inlet	–
	Cooling seawater	Pump outlet	–

Table 9.3.2 Indications and Alarm Items for Steam Turbine

Item		For main Propulsion machinery	For generator engine
Temperature	Lubricating oil	Inlet and each bearing outlet	–
Pressure	Lubricating oil	Inlet	–
	Exhaust steam	Condenser	–

Table 9.3.3 Indications and Alarm Items for Shafting

Item		For main Propulsion machinery	For generator engine
Temperature	Reduction gear lubricating oil	Inlet	–
Pressure	Reduction gear lubricating oil	Inlet	–

Table 9.3.4 Indications and Alarm Items for Boiler and Thermal Oil Installations

Item		Main boiler	Essential auxiliary boiler	Thermal oil installations
Temperature	Fuel oil	Inlet	–	–
	Exhaust gas	Outlet	–	–
	Superheated steam, thermal oil	Outlet	–	Outlet
Pressure	Fuel oil	Inlet	–	–
	Steam	Outlet	Outlet	–

Table 9.3.5 Indications and Alarm Items for Other Machinery

Item	Points of indication
Items deemed necessary by the Society according to the construction and purpose of the machinery installations concerned.	Points required by the Society

3. Centralized control systems for machinery [See Rule]

- (1) "to be capable of effectively controlling" specified in **504. 2** of the Rules means to be capable of controlling as follows.
- (A) For control of main propulsion diesel engines
 - (a) Starting/stopping of the auxiliary blowers (However, in case where the auxiliary blowers are provided with automatic starting/stopping system, they may be omitted)
 - (b) Starting/stopping of the fuel oil supply pumps
 - (c) Starting/stopping fuel oil booster pumps
 - (d) Starting/stopping of the main lubricating oil pump
 - (e) Starting/stopping of the crosshead lubricating oil pumps
 - (f) Starting/stopping of the piston cooling water (oil) pumps
 - (g) Starting/stopping of the cylinder cooling water pumps
 - (h) Starting/stopping of the cooling sea water pumps
 - (B) For control of main propulsion steam turbine
 - (a) Main boiler control (But, except starting at the cold condition of the main boiler)
 - (i) Starting/stopping of the feed water pumps
 - (ii) Starting/stopping of the fuel oil pumps
 - (iii) Starting/stopping of the blowers
 - (iv) Oil burning assembly control
 - (b) Pump control for steam turbine
 - (i) Starting/stopping of the lubricating oil pumps
 - (ii) Starting/stopping of the cooling water pumps
 - (iii) Starting/stopping of the control hydraulic oil pumps
 - (c) Starting/stopping of the soot blower for economizer
 - (C) For control of diesel engines driving generators
 - (a) Starting/stopping of the diesel engines
 - (b) Control of the fuel oil change-over devices
 - (c) Starting/stopping of the cooling sea water pumps
 - (d) Selection of the automatic starting engine in **503. 3 (1) (B)** of the Rules
 - (D) For control of steam turbines driving generators
 - (a) Starting/stopping of the water circulating pumps
 - (b) Change-over of the steam supply between exhaust gas economizers and boilers in case where the steam turbine generators are usually driven by the steam from exhaust gas economizers and are used at anchoring.
 - (E) For control of essential auxiliary boilers
 - (a) Starting/stopping of the soot blowers for exhaust gas economizers in case where the steam turbine generators are driven by the steam from exhaust gas economizers
 - (b) Starting/stopping of the boiler water circulating pumps
 - (F) For control of other machinery which are necessary
 - (a) Operating of automatic synchronous making devices and automatic load sharing devices
 - (b) Operating of automatic load shifting devices and load tripping devices

4. Independent remote-controlled mooring arrangements [See Rule]

In application to **504. 5** of the Rules, independent remote-controlled mooring arrangements are in accordance with the followings:

- (1) "To be capable of controlling each drum of mooring winches independently" of the Rules means those of an arrangement having one winch to which an exclusive drum is belonging or an arrangement capable of remote-controlling the clutches and brakes.
- (2) In case where minimum 5 drums are provided at the bow or stern of a ship, it may be acceptable to control 5 drums independently at the bow or stern. ⚓

CHAPTER 4 DYNAMIC POSITIONING SYSTEMS(DP SYSTEMS) (2020)

Section 2 Requirements of DP Systems

201. General

1. In application to **201. 6** of the Rules, for vessels that carry out DP operations where the DP operator's view of the working area is not considered necessary, the view from the backup DP control station may not be similar to the view from the main DP control station. For such vessels(e.g. drilling units) it may be accepted that the view from the backup DP control station is provided by closed circuit television (CCTV) system. (2020) **【See Rule】**

203. Additional requirements for DP systems

1. DPS(2)

- (1) In application to **203. 2 (3)** of the Rules, essential services are those defined in **Pt 6, Ch 1. 101. 4 (13)** of the Rules together with thruster auxiliaries, computers, generator and thruster control equipment, position reference systems, environmental sensors and electrically driven thrusters. **【See Rule】**
- (2) In application to **203. 2 (6) (F)** of the Rules, when considering single failures of switchboards, the possibility of short-circuit of the bus-bars has to be considered. **【See Rule】** ⚓

CHAPTER 5 NAVIGATION BRIDGE SYSTEMS

Section 2 Surveys of Navigation Bridge Systems

202. Classification Survey

1. Drawings and data (2020) [See Rule]

In application to **202. 1** (1) (E) of the Rules, the term "Other drawings and data deemed necessary by the Society" means the acceptance in accordance with **Pt 1, Ch 1, 104.** of the Rules.

2. Shop tests (2020) [See Rule]

In application to **202. 2** (J) of the Rules, the term "Other equipment deemed necessary by the Society" means the acceptance in accordance with **Pt 1, Ch 1, 104.** of the Rules.

203. Survey Assigned to Maintain Classification

1. Annual survey (2020) [See Rule]

In application to **203. 2** (1) (B) (f) of the Rules, the term "Other equipment deemed necessary by the Society" means the acceptance in accordance with **Pt 1, Ch 1, 104.** of the Rules.

Section 5 Accident Prevention Systems

502. Accident Prevention Systems

1. In application to **502. 2** (5) of the Rules, bridge navigational watch alarm system(BNWas) is to comply with the following requirements. [See Rule]

- (1) At the end of this setting period, the alarm system should initiate a visual indication on the bridge.
- (2) If not reset, the BNWas should additionally sound a first stage audible alarm on the bridge 15 seconds after the visual indication is initiated.
- (3) If not reset, the BNWas should additionally sound a second stage remote audible alarm in the back-up officer's and/or master's location 15 seconds after the first stage audible alarm is initiated.
- (4) If not reset, the BNWas should additionally sound a third stage remote audible alarm at the locations of further crew members capable of taking corrective actions 90 seconds after the second stage remote audible alarm is initiated.
- (5) In vessels other than passenger vessels, the second or third stage remote audible alarms may sound in all the above locations at the same time. If the second stage audible alarm is sounded in this way, the third stage alarm may be omitted.
- (6) In larger vessels, the delay between the second and third stage alarms may be set to a longer value on installation, up to a maximum of 3 minutes, to allow sufficient time for the back-up officer and/or master to reach the bridge.

2. In application to **502. 3** of the Rules, "alarm and warning that requires the navigator response" means alarm and warning described in **Appendix 5, Table 1** of **IMO Res.MSC.252(83).** (2017)

[See Rule]

3. In application to **502. 3** (2) of the Rules, bridge navigational watch alarm system(BNWas) of **502. 2** of the Rules may be used for the purpose. (2017) [See Rule]

Section 6 Bridge Work Assist Systems

602. Bridge Work Assist Systems

1. General [See Rule]

In application to **602. 1** (2) of the Rules, the term "Electronic charts deemed appropriate by the Society" means Electronic navigation chart(ENC). In cases where ships navigate in areas in which ENC are not issued, other electronic charts may be used under the same conditions related to the use of paper charts.

2. Bridge information system [See Rule]

- (1) In application to **602. 2** (D) of the Rules, "alarms and warnings which requires the navigator response" means alarm and warning described in **Appendix 5, Table 1** of **IMO Res.MSC.252(83)**. (2020) [See Rule]
- (2) In application to **602. 2** (E) of the Rules, the term "Other functions deemed necessary by the Society" means the acceptance in accordance with **Pt 1, Ch 1, 104.** of the Rules. (2020) [See Rule]

3. Electronic chart display and information system (ECDIS) [See Rule]

In application to **602. 3** (F) of the Rules, the term "Other functions deemed necessary by the Society" means functions described in **IMO Resolution A.817(19)**.

4. Auto tracking system (2020) [See Rule]

In application to **602. 4** (G) of the Rules, the term "Other functions deemed necessary by the Society" means the acceptance in accordance with **Pt 1, Ch 1, 104.** of the Rules. ⚓

CHAPTER 7 DIVING SYSTEMS (2020)

Section 1 Classification

101. General

1. In applying **101. 1** (1) of the Rules, the main equipment which form diving systems are as follows.
[See Rule]

Equipment	Saturation Diving (SAT)	Bounce Diving (BOU)	Surface Diving (SUR)
Diving bell (closed)	○	Choose either diving bell or wet bell	X
Wet bell	X		Choose either wet bell or diving stage
Diving stage	X	X	
Umbilical cable	○	○	○
diving control system	○	○	○
Launch and recovery system	○	○	○
Deck decompression chamber	○	○	○
Life support control system	○		
Life support system			
- breathing gas storage, mixture and distribution	○	○	○
- CO2 scrubber	○	○	○
- Breathing gas reclaim system	○(if fitted)	X	X
- Environmental Control Unit	○	○(if fitted)	○(if fitted)
- Divers hot water unit	○	○(if fitted)	○(if fitted)
- Sanitary installations	○	X	X
Hyperbaric evacuation system	○		
Launch and recovery system of hyperbaric evacuation system	○		

Section 2 Surveys [See Rule]

201. General

1. Application

The requirements apply to periodical surveys for the equipment in **Ch 7, 101. 1.**

2. Followings are to be examined during periodical surveys.

- (1) diving operations log
- (2) valve shut-off checklists
- (3) operational procedures
- (4) emergency procedures
- (5) dive log, duly signed off
- (6) data sheet for diving system
- (7) layout drawing for diving system
- (8) PMS records

3. Survey planning document

- (1) Survey planning document shall be part of the documentation on board for the lifetime of the Diving System. The Survey Planning Document shall be written by the owners representatives in accordance with the principles laid out in this section, but shall be suited to their particular diving system. For transferable diving systems, the Survey Planning Document shall specify scopes for surveys when the system is installed and for surveys when the system is in storage (laidup).
- (2) The Survey Planning Document shall be written in English, or translated into English, and approved by the Society prior to the survey taking place. Checklists shall be included as attachments. It shall have the following information printed on the front page:
 - (A) "DSV survey planning document"
 - (B) name of support vessel or installation given in the classification register
 - (C) Id. number given in the classification register
 - (D) IMO number (for statutory surveys)
 - (E) name of company
 - (F) revision number and date.
- (3) Checklists shall be made available for the surveyor to fill out and endorse at each survey. The checklists shall include the following information at the top of each page:
 - (A) name of support vessel or installation given in the classification register
 - (B) Id. number given in the classification register
 - (C) name of company
 - (D) scope of survey (annual, intermediate, renewal or otherwise)
 - (E) in columns: survey item, condition, action, comment
 - (F) place, date, surveyor, signature, and stamp.

202. Survey items

1. Diving bell

- (1) Testing of the gas cylinders
- (2) Testing of the piping system
- (3) Testing of the ballast release system, if any
- (4) Testing of the emergency systems
- (5) Testing of the location and communication systems
- (6) Testing of the diving bell heating system
- (7) Testing of the electrical installations
- (8) Visual examination of the batteries packs and their watertight seals, if any
- (9) Visual examination of the connectors of the piping lines
- (10) Visual examination of the BIBS, if any
- (11) Visual examination of the anodes, if any
- (12) Visual examination of the structure framework
- (13) Visual examination of the seals on mating faces

2. Wet bell/Diving stage

- (1) Testing of the gas cylinders
- (2) Testing of the piping system
- (3) Testing of the ballast release system, if any
- (4) Testing of the emergency systems
- (5) Testing of the electrical installations
- (6) Visual examination of the batteries packs and their watertight seals, if any
- (7) Visual examination of the connectors of the piping lines
- (8) Visual examination of the BIBS, if any
- (9) Visual examination of the anodes, if any
- (10) Visual examination of the structure framework

3. Deck decompression chamber

- (1) Testing of the PVHO in accordance with **4**
- (2) Testing of the piping system
- (3) Testing of the sanitary systems
- (4) Testing of the fire safety systems
- (5) Testing of the gas regeneration system (CO₂ removal)
- (6) Testing of the environmental control unit
- (7) Testing of the breathing gas reclaim system, if any
- (8) Testing of the instrumentation
- (9) Testing of the communication system
- (10) Testing of the electrical installations

4. PVHO

- (1) Visual examination of the signs of corrosion on the shell of the PVHO and particularly the bottom part inside and outside
- (2) Visual examination of the shell penetrators
- (3) Visual examination of the supporting structure
- (4) Visual examination of the markings
- (5) Visual examination of the insulation, if any
- (6) Visual examination of the doors, hatches and their locking mechanisms
- (7) Visual examination of the medical lock
- (8) Visual examination of the associated piping and fittings
- (9) Visual examination of the connecting flanges between chambers
- (10) Visual examination of the seals on mating faces which are to be cleaned, undamaged and covered lightly in silicone grease.
- (11) Gas leak test at maximum working pressure
- (12) Hydraulic pressure test at 1.5 times the Maximum Allowable Working Pressure. On a case-by-case basis and when deemed acceptable by the Society, alternative to in-service hydraulic testing may be granted (e.g. pressure testing with acoustic emission monitoring).
- (13) Testing of the viewports in accordance with ASME PVHO

5. Electrical installations

- (1) Confirmation that no modifications have been performed on electrical installations and that they are found in satisfactory condition.

6. Launch and recovery system

- (1) Wire lubrication
- (2) If fitted, heave compensation system is to be function tested.

7. Hyperbaric evacuation system

- (1) For hyperbaric evacuation, reference is made to contingency plan defined in IMO Res.692(17).

203. Periodical Survey

Equipment	Survey item	Annual Survey	Intermediate Survey	Special Survey
Gas analyzers	<ul style="list-style-type: none"> ◦ Inspection and functional test of pump, Validity of tube (if disposal type tube fitted, had pump is to be included.) ◦ Visual inspection and functional test ◦ Calibration test to agreed specifications 	<input type="radio"/> <input type="radio"/>		
Diving bells (main framework, lowering device)	<ul style="list-style-type: none"> ◦ Visual inspection for damage and corrosion of main framework and lowering device) ◦ Load test at 1.5 times safety working load 1.5. Non-destructive test of the lifting point or pad eye before and after the load test 	<input type="radio"/> <input type="radio"/>		
Built-in breathing system (BIBS)	<ul style="list-style-type: none"> ◦ Visual inspection and functional test (if fitted, communication equipment is to be included) ◦ Inspection and test in accordance with the manufacturer's criteria (in case of underwater unit) 	<input type="radio"/> <input type="radio"/>		
Communication and Video	<ul style="list-style-type: none"> ◦ Inspection and functional test ◦ Test of battery (where practicable) 	<input type="radio"/> <input type="radio"/>		
Compressors, boosters and filters	<ul style="list-style-type: none"> ◦ Visual inspection and functional test (safety devices are to be included except PRV) ◦ Test of flow rate and delivery pressure ◦ Gas purity test (where practicable) 	<input type="radio"/> <input type="radio"/> <input type="radio"/>		
Pressure vessels	◦ Visual inspection (external)	<input type="radio"/>		
	<ul style="list-style-type: none"> ◦ Visual inspection for details of outside and inside ◦ Gas leak test at maximum working pressure ◦ Pressure test at 1.5 times maximum allowable working pressure. (if necessary, non-destructive test is to be carried out) 		<input type="radio"/> <input type="radio"/>	
	◦ Pressure test at 1.5 times maximum allowable working pressure			<input type="radio"/>
	The frequency and pressure of pressure tests may be in accordance with the flag administration's domestic laws.			
Electrical equipment	<ul style="list-style-type: none"> ◦ Visual inspection ◦ Functional test of equipment (including protectors) ◦ Electrical continuity and insulation resistance test 	<input type="radio"/> <input type="radio"/>		
Emergency locating device of diving bell	<ul style="list-style-type: none"> ◦ Inspection of symptoms of damage or deterioration ◦ Functional test including battery condition check 	<input type="radio"/> <input type="radio"/>		
Environmental control unit	◦ Visual inspection and functional test	<input type="radio"/>		
Fixed fire-fighting system	<ul style="list-style-type: none"> ◦ Visual inspection of nozzles, valves, piping and fittings ◦ Functional test or simulation test using air or gas ◦ Functional test of automatic detection /automatic operation system (if fitted) 	<input type="radio"/> <input type="radio"/> <input type="radio"/>		
Portable fire-fighting system	◦ Visual inspection(external) and test that the indicating device is within the acceptable range	<input type="radio"/>		

Divers breathing gas reclaim system and gas blender	<ul style="list-style-type: none"> ◦ Visual inspection and functional test (safety devices are to be included except PRV) ◦ Disinfection Check of gas bag 	○ ○		
Depth gauge	<ul style="list-style-type: none"> ◦ $\pm 0.25\%$ accuracy of full scale reading ◦ Visual inspection and functional test 	○ ○		
Divers' heating units	<ul style="list-style-type: none"> ◦ Visual inspection and functional test ◦ Insulation resistance test when electricity is supplied 	○ ○		
	◦ Overpressure test			○
Launch and recovery system	<ul style="list-style-type: none"> ◦ Visual inspection of symptoms of damage or deterioration ◦ Static load test at 1.5 times safety working load(SWL) for each brake system ◦ Functional test of heave compensation systems (if fitted) ◦ Functional test of secondary recovery system ◦ Dynamic load test at 1.25 times safety working load(SWL) (to be performed NDT after test if necessary) 	○ ○ ○ ○ ○		
hydraulic power system	<ul style="list-style-type: none"> ◦ Visual inspection and functional test for essential components of the tensioning device ◦ Functional test and check flow rate of intercooler/heater(if fitted) ◦ Hydraulic fluid and oil analysis (replace hydraulic fluid and oil, if necessary) 	○ ○ ○		
Piping and fittings	<ul style="list-style-type: none"> ◦ Visual inspection ◦ Internal cleanliness verification 	○ ○		
	◦ Gas leak test at maximum working pressure		○	
Oxygen piping	◦ Visual inspection	○		
	◦ Gas leak test at maximum working pressure		○	
Pressure relief valve	◦ Visual inspection	○		
	◦ Functional test at setting pressure and gas leak test at maximum working pressure		○	
	◦ Bursting disk is to be replaced every ten(10) years.			
PVHO	◦ Visual inspection	○		
	<ul style="list-style-type: none"> ◦ Visual inspection for details of outside and inside ◦ Gas leak test at maximum working pressure 		○ ○	
	◦ Internal pressure test			○
Viewport	◦ Visual inspection	○		
	◦ Gas leak test including viewport		○	
	◦ Pressure test			○
	◦ Viewport is to be replaced every ten(10) years.			
Sanitary equipment	◦ Visual inspection and functional test	○		
Umbilical cable	◦ Visual inspection and functional test	○		
	◦ Gas leak test at maximum working pressure		○	

Wire rope	<ul style="list-style-type: none"> ◦ Visual inspection ◦ Cut the wire rope of appropriate length and perform the destruction test of the wire rope <ul style="list-style-type: none"> –If it is lower than MBL value at the time of initial production, the result falls 10% below the base value adopted following the test carried out when the rope was first put into service, it is to be discarded. ◦ Static load test at 1.5 times maximum safety load after end termination details 	<input type="radio"/> <input type="radio"/> <input type="radio"/>		
Diving bell ballast	<ul style="list-style-type: none"> ◦ Visual inspection for all framework ◦ Static load test at 1.5 times ballast weight ◦ Non-destructive test for main components ◦ Functional test for ballast release system ◦ Positive buoyancy test of diving bell 	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>		
	◦ Ballast release test			<input type="radio"/>
Hyperbaric Rescue Unit and launch system	<ul style="list-style-type: none"> ◦ Visual inspection ◦ Functional test including emergency launch system 	<input type="radio"/> <input type="radio"/>		
	◦ Replace the wire for launch system (except stainless steel wire)			<input type="radio"/>
Hyperbaric Rescue Unit	<ul style="list-style-type: none"> ◦ Visual inspection and functional test ◦ Visual inspection of towing line 	<input type="radio"/> <input type="radio"/>		
Umbilical cable winch	◦ Functional test	<input type="radio"/>		
	◦ Pressure test at 1.25 times maximum allowable pressure of the swivel			<input type="radio"/>
Diving bell	◦ Visual Inspection and functional test	<input type="radio"/>		
	◦ Weighing in air and in water			<input type="radio"/>
	◦ Testing of the PVHO			
Commissioning	◦ Commissioning at rated maximum depth			<input type="radio"/>

Section 3 Testing

301. General

1. In application to **301. 1** (4) of the Rules, "in accordance with separately provided" means **Guidance for Approval of Manufacturing Process and Type Approval, Etc.** and recognized standard which deemed appropriate by the Society. **[See Rule]**

302. Tests at the manufacturers works

1. In application to **302. 1** of the Rules, the penetrators are to be tested as specified below. **[See Rule]**
 - (1) Test process of compression chamber wall penetrations and underwater plug connections is as follow:
 - (A) Hydraulic pressure test, in which the test pressure must equal twice the design pressure. The test is to be conducted in accordance with the test pressure/time curve shown in **Fig 9.7.1** the changes in pressure being applied as quickly as possible

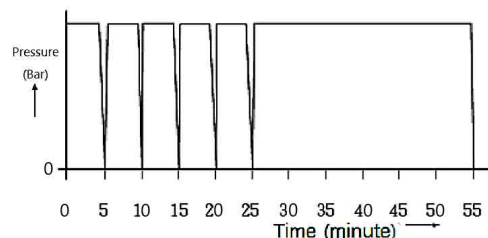


Fig 9.7.1 Test pressure/time curve

- (B) Gas tightness test with shorn, open cable ends.

This test may be performed alternatively under air or helium pressure. If compressed air is used, the test pressure must be equal twice the design pressure; if helium is used, 1.5 times. In all pressure and tightness tests on compression chamber wall penetrations, the pressure must in each case be applied from the pressure side of the wall penetration.
 - (C) High voltage test at an AC voltage of 1000 V plus twice the rated voltage.

This test is performed at the rated frequency and is to be tried out for 1 minute in each case between all the conductors mutually and between the conductors and the casing. The test is performed in the disconnected state. The connection side of the compression chamber wall penetration may be fully wired for the high voltage test. The sealing of the connector shells and the like is permitted where this is stipulated by the manufacturer in the relevant data sheet. The test voltage for plug connections rated at more than 500 V is to be agreed with the Society.
 - (D) Measurement of insulation resistance

The minimum value of the insulation resistance between the conductors mutually and between the conductors and the casing shall be 5 M Ω . The insulation resistance is to be measured with an instrument using 500 V DC. With wet plug connections, the minimum insulation resistance is also to be measured after the connection has been made once in salt water.
 - (E) Visual check against manufacturer's documentation.
- (2) All electrical penetrations in compression chamber walls and all plug connections are to be sub-possible. Subjected to individual inspection by the manufacturer. A Works Test Certificate is to be issued by the manufacturer in respect of this inspection.
 - (3) The necessary test conditions applicable to plug connections in medium voltage systems are to be agreed with the Society in each case.

310. On-board test and Commissioning

1. In application to **310. 3** (1) of the Rules, "in accordance with the discretion of this Society" are those defined in **101. 2** of the Rules. **[See Rule]**

Section 5 PVHO

503. Piping system

1. In application to **503. 1** (2) of the Rules, where non-return valve is installed, non-return valve is to be installed inside the PVHO and shut-off valve is to be external. **【See Rule】**

Section 6 Deck Decompression Chambers and divers transfer system

603. Closed Diving Bell

1. In application to **603. 1** (10) of the Rules, means independent from surface supplies are to be provided to maintain the diver's body temperature and reduce CO₂ for a minimum period of 24 hours in an emergency. This will normally be by means of survival bags and emergency individual scrubbers. **【See Rule】**

605. Rescue chambers (transportable)

1. In application to **605. 4** (2) of the Rules, setting values of safety valves are as follows. **【See Rule】**

	Minimum pressure	Maximum pressure
Response pressure	Maximum Allowable Working Pressure (MAWP)	Maximum Allowable Working Pressure (MAWP) * 1.1
Maximum opening pressure (Maximum Supply)	–	Maximum Allowable Working Pressure (MAWP) * 1.1
Closing pressure	≥ Working Pressure (generally MAWP/1.1)	–

Section 7 Life Support System

703. Breathing gas storage

1. In application to **703. 2** of the Rules, the quantities of breathing gas and pure oxygen to carry on-board is to be assessed for each diving campaign and justified by a risk analysis. Minimum requirements are provided by IMCA D050. **【See Rule】**

Section 10 Launch and Recovery System **【See Rule】**

1002. General design requirements

The dynamic load of launch and recovery system of diving bell are as follows.

1. General

The estimated dynamic loads during the operation of cursors and diving bells, which are connected to stationary support vessel at designed sea condition and propelling support vessel heading in the main direction of incoming waves, are given in clause **3** and **4**.

The specified methods for calculation of hydrodynamic forces are limited to the cases in which the vertical motions of the suspended bell may be taken equal to the corresponding motions of the support vessel. The conditions permitting such assumptions are specified in Clause **3**, 3.1, (2). Other methods deemed appropriate by the Society.

2. Definitions

(1) Parameters applied for calculation of the forces.

m : mass of bell in air corresponding to its working weight including trapped water (kg).

ρ : mass density of seawater

V : volume of displaced water (m^3).

A : cross sectional area of bell with appendices projected on a horizontal plane (m^2).

C_m : coefficient for added mass (water). (For typical diving bells with appendages such as gas containers, bumper structure etc. the coefficient may be taken as $C_m = 1.0$). Above water $C_m = 0$.

C_d : drag coefficient. (For typical diving bells with appendages the coefficient may be taken as $C_d = 1.5$).

a : maximum expected vertical acceleration of the bell (m/s^2).

a_r : maximum expected vertical relative acceleration between bell and water particles (m/s^2).

v : maximum expected vertical velocity of the bell (m/s).

v_r : maximum expected vertical relative velocity between bell and water particles (m/s).

f_w : reduction factor for the wave action on the bell, depending on the submerged depth z of the bell, given by:

$$f_w = e^{\left(-0.32 \frac{z}{h_s}\right)}$$

z : submerged depth of the bell (m) when larger than h_s .

h_s : significant wave height (m).

significant wave height : When selecting the third of the number of waves with the highest wave height, the significant wave height is calculated as the mean of the selection.

$e = 2.72$

f_a and f_v : reduction factors due to wave action under the heading "Motions of ship shaped support vessels".

k : stiffness of the handling system (N/m).

C_B : block coefficient of vessel.

R_P : horizontal distance from centre of mass (i.e. bell) to the axis of rotation, which may be taken at 0.45 L from the after perpendicular of the vessel (m).

A_w : cross sectional area of moon pool.

s_r : maximum expected relative amplitude (+/-) of motion between sea surface and support vessel in way of moon pool (m).

g : acceleration of gravity

d : draught of vessel at bottom of opening for moon- pool for $d > h_s$ (m)

(2) Parameters applied for correction of units in empirical formulae:

$h1 = 1 \text{ m}^{-1}$

$L1 = 1 \text{ m}^{-1}$

$u1 = 1 \text{ m/s}$

$u2 = 1 \text{ m}$

3. Loads on Negative(–) Buoyant Bell

(1) Loads on bell clear of support vessel

(A) In a free flow field the maximum vertical hydrodynamic load F_n acting on a negative buoyant bell in the design sea-state may be taken as the smaller of the values obtained from the two following formulae:

$$F_n = \pm \sqrt{F_{aW}^2 + F_v^2} \quad (\text{N})$$

$$F_n = \pm \sqrt{F_a^2 + F_w^2 + F_v^2} \quad (\text{N})$$

F_{aW} : force due to the combined acceleration of bell and water particles, given by:

$$F_{aW} = (m - \rho V)a + \rho V(1 + C_m)f_a a_r \quad (\text{N})$$

F_v : force due to the relative velocity between bell and water particles, given by:

$$F_v = 0.5\rho AC_d(f_v v_r)^2 \quad (\text{N})$$

F_a : force due to acceleration of bell, given by:

$$F_a = (m + C_m \rho V)a \quad (\text{N})$$

F_w : force due to acceleration of water particles in the deepest wave, given by:

$$F_w = 0.4(1 + C_m)f_w \rho Vg \quad (\text{N})$$

The parameters and principles applied for calculation of the forces are given in (B) of the Rules.

(B) Motions of ship shaped support vessels

The vertical motions of the bell may be taken equal to those of the support vessel when the natural oscillating period of the handling system is less than 3 seconds, as given by:

$$2\pi \sqrt{\frac{m + \rho VC_m}{k}} < 3$$

For calculation of the forces from the formulae given in 3.1 (1) of the Rules, the launching or retrieval velocities are to be added to v and v_r .

The estimation method for a and a_r as well as V and V_r given in the following may be used for vessels with length between perpendiculars L (m) in the range:

$$50 < L < 150$$

operating in sea-states with significant wave heights h_s (m) of magnitude: $2 < h_s < 8$

The heave acceleration a_z of the support vessel is given by the smaller of:

$$a_z = \frac{(5h_1 h_s - 0.02h_1 h_s L_1 L + 1) \times g}{100} \quad (\text{m/s}^2)$$

or a_z as obtained from the Rules. The pitch acceleration a_p of the support vessel is given

by:

$$a_p = \frac{3.5}{C_B} \times \frac{R_p}{L} \times a_z \quad (\text{m/s}^2)$$

The combined vertical acceleration from heave, pitch and roll is given by:

$$a = \sqrt{(ra_z)^2 + a_p^2} \quad (\text{m/s}^2)$$

- r : coefficient of roll
: 1.0 at centreline of vessel
: 1.2 at sides of vessel

The relative acceleration a_r between vessel and water particles at surface is given by:

$$a_r = (0.15q\sqrt{h_1 \times h_s}) \times g \quad (\text{m/s}^2)$$

- q : coefficient for position of bell.
: 1.3 at stern.
: 1.1 at sides amidship.
: 1.0 at vessel's centreline amidship.

The vertical velocity of the vessel may be taken as:

$$v = \left(14 - 4.5 \frac{R_p}{L}\right) \frac{a \times u_1}{g} \quad (\text{m/s}^2)$$

The relative vertical velocity between vessel and water particles at surface is given by:

$$v_r = (0.04 \times L_1 \times L + 6) \frac{a_r \times u_1}{g} \quad (\text{m/s}^2)$$

f_a = reduction factor for vertical relative acceleration of bell due to wave action, given by:

$$f_a = \frac{a + (a_r - a)f_w}{a_r}$$

f_v = reduction factor for vertical relative velocity of bell, given by:

$$f_v = \frac{v + (v_r - v)f_w}{v_r}$$

(2) Hydrodynamic Loads on bell in moon pool

(A) In the flow field of a moon pool (narrow well) the maximum vertical hydrodynamic load F_m acting on a negative buoyant bell may be taken as derived from Clause (1), when C_m and C_d are substituted by $f_m \cdot C_m$ and $f_d \cdot C_d$ respectively, where:

$$f_m = 1 + 1.9(A/A_w)2.25$$

$$f_d = \frac{1 - 0.5A/A_w}{(1 - A/A_w)^2}$$

The factors f_m and f_d obtained from the above apply to moon pools of constant cross section and for the ratio $A/A_w < 0.8$. The relative accelerations a_r and velocities v_r refer to the flow field above the bell.

When A/A_w approaches 1, the hydrodynamic load on the bell approaches the dynamic part of the bottom pressure, and may be taken as:

$$F_m = \pm A s_r \rho \geq \left(-0.32 \frac{d}{h_s} \right) \quad (\text{N})$$

For a moon pool at the centreline of the support vessel s_r may be taken as:

$$s_r = (0.064L + 1.6u_2) \frac{a_r}{g}$$

(3) Impulse Loads

(A) Impulse loads F_i caused by sudden velocity changes in the handling system by start, stop and snatch loads in hoisting ropes may be taken as :

$$F_i = v_i \sqrt{k(m + \rho V C_m)} \quad (\text{N})$$

v_i : impulse velocity (m/s) obtained from Clause 3, 3.3, (2) or Clause 3, 3.3, (3)

(B) Impulse velocity

The impulse velocity v_i during start and stop may be taken as the maximum normal transportation velocity.

(C) Slack

Slack hoisting rope may be expected when

$$|F_n| = (m - \rho V)g$$

When F_n obtained from 3.1 is mainly wave induced and a snatch load is of short duration relative to the wave period i.e. when the natural oscillating period of the handling system is less than 3 seconds as given in 3.1, (2), then the impact velocity v_i may be taken as:

$$v_i = v_1 + v_2 C_i$$

v_i = free fall velocity (m/s) in calm water

$$v_1 = \sqrt{\frac{2(m - \rho V)g}{\rho A C_d}}$$

$v_2 = v_r f_v$ as obtained from 3.1, (2) for tight hoisting ropes

C_i = probability coefficient obtained from the table below

$\frac{v_1}{v_2}$	C_i
$\frac{v_1}{v_2} \leq 0.2$	1
$0.2 < \frac{v_1}{v_2} < 0.7$	$\cos\left(\pi \frac{v_1}{v_2} - 0.2\pi\right)$
$\frac{v_1}{v_2} \geq 0.7$	0

4. Loads on a Positive(+) Buoyant Bell

(1) Impulse loads

(A) Impulse loads F_i caused by sudden velocity changes in the handling system by start, stop and snatch loads in hoisting ropes may be taken as follows:

$$F_i = v_i \sqrt{k(m + \rho V_e 0.6 C_m)} \quad (M)$$

V_e = volume of displaced water of the floating bell

v_i = impulse velocity obtained from Clause (B)

(B) Impulse velocity is taken to be as follows:

$$V_i = V_r + V_{hoist}$$

V_r : from 3 (1) (B) (m/s)

V_{hoist} : normal transportation speed.

5. Design loads

(1) Maximum load

(A) The maximum load P in the vertical direction may be taken as follows:

In water : $P = (m - \rho V)g + F$

F : where F is the larger of F_n and F_i obtained from 3.1, 3.2 and 3.3.

In air : $P = mg + \sqrt{(ma)^2 + F_i^2}$

(B) The design load in the vertical direction may be obtained from the following table.

$\frac{P}{mg}$	Design load
$\frac{P}{mg} \leq 2$	P
$2 < \frac{P}{mg} < 3$	$\left(1.5 - 0.25 \frac{P}{mg}\right)P$
$\frac{P}{mg} \geq 3$	$0.75 P$

Section 11 Hyperbaric Rescue Unit

1103. General design requirements

1. In application to 1103. 2 (2) of the Rules, marking follows as figure below. **[See Rule]** ⚓

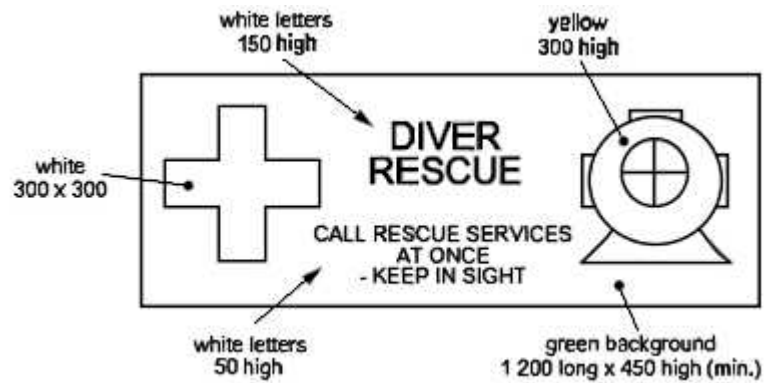


fig. 9.7.2

CHAPTER 8 HIGH VOLTAGE SHORE CONNECTION SYSTEMS

Section 1 General

101. General [See Rule]

1. **Class notation** In application to **101. 4** of the Rules, ships permanently installed high voltage shore connection systems in accordance with the requirements of **Ch 8** of the Rules may be assigned with the class notation HVSC and ships having at least onboard receiving switchboard may be assigned with the class notation HVSC-Partial. (2022) ⚓

CHAPTER 10 BALLAST WATER MANAGEMENT

Section 3 Ballast Water Management Systems

302. Ballast water management systems (2022) [See Rule]

1. Safe location defined in **302. 2** (4) of the Rules as follows

- (1) inert gas or nitrogen product enriched air from
 - in-line (categories 3a and 3b) and in-tank (categories 3c and 8) de-oxygenation BWMS: the protection devices installed on the ballast tanks, nitrogen or inert gas generators, nitrogen buffer tank (if any); or
 - in-line ozone injection BWMS (categories 7a and 7b): the oxygen generator;safe locations on the open deck are:
 - not within 3 m of areas traversed by personnel; and
 - not within 6 m of air intakes for machinery (engines and boilers) and all ventilation inlets/outlets.
- (2) oxygen-enriched air from:
 - in-line and in-tank de-oxygenation BWMS (categories 3a and 8): the nitrogen generator; or
 - in-line ozone injection BWMS (categories 7a and 7b): the protection devices or vents from oxygen generator, compressed oxygen vessel, the ozone generator and ozone destructor devices;safe locations on the open deck are:
 - outside of hazardous area;
 - not within 3 m of any source of ignition and from deck machinery, which may include anchor windlass and chain locker openings, and equipment which may constitute an ignition hazard;
 - not within 3 m of areas traversed by personnel; and
 - not within 6 m of air intakes for machinery (engines and boilers) and all ventilation inlets.

303. Additional requirements for tankers (2022) [See Rule]

1. **303. 1.** (1) (A) of the Rules requirements does not apply to inert gas generators for which **Pt 8, Annex 8-5, 4 and 5** apply.
2. In application to **303. 1** (1) (B) of the Rules, the followings are to be considered.
 - (1) In-line full flow electrolysis BWMS (category 4) could be accepted in cargo compressor rooms of liquefied gas carriers and inside cargo pump rooms of oil tankers or chemical tankers if that cargo pump room is located above the cargo tank deck.
 - (2) For submerged cargo pumps, the room containing the hydraulic power unit or electric motors is not to be considered as the “cargo pump room”.
 - (3) Ballast pump rooms and other pump rooms not containing the cargo pumps are not to be considered as the “cargo pump room”.
3. In application to **303. 1** (2) of the Rules, when the Fore Peak Tank is ballasted with the piping system serving the other ballast tanks within the cargo area in accordance with **Pt 7 Ch 1 Sec 1, 1003. 3**, the ballast water of the Fore Peak tank is to be processed by the BWMS processing the ballast water of the other ballast tanks within the cargo area.
4. In application to **303. 1** (3) (A) of the Rules, the followings are to be considered.
 - (1) The means of appropriate isolation is necessary for the interconnection specified in said Paragraph regardless of the diameter of the piping.
 - (2) Refer to **305.** of the Rules, appropriate isolation is necessary for the interconnection specified in said Paragraph in the case of the active substance piping such as N₂ gas piping, inert gas piping, neutralizer piping, fresh water piping for filter cleaning, compressed air piping for remaining water purge and sea water piping for adjusting the salinity etc. At the discretion of the Classification

Society and for active substance piping and neutralizer piping (both up to 2 inches) only, alternative isolation arrangements, provided preferably on the open deck, offering enhanced safety and gastightness may be considered for penetration of the bulkhead separating the non-hazardous machinery space from a hazardous area (such as the cargo pump room) at as high an elevation in the machinery space as possible, preferably, just below the main deck. The arrangements are to provide suitable protection measures in addressing the pollution hazards and safety concerns due to the potential migration of hydrocarbon or flammable or toxic liquids or vapours from the hazardous areas.

- (3) The means of appropriate isolation described in (1) for the interconnection specified in said Paragraph need not be applied to the sampling lines described in **303. 1** (4) and (5) of the Rules.
5. In application to **303. 1** (3) (A) (a) of the Rules, as an alternative to positive means of closure, an additional valve having such means of closure may be provided between the non-return valve and the spool piece.
6. In application to **303. 1** (3) (A) (b) of the Rules, As an alternative to positive means of closure, an additional valve having such means of closure may be provided between the non-return valve and the liquid seal. For ships operating in cold weather conditions, freeze protection should be provided in the water seal. A portable heating system can be accepted for this purpose.
7. In application to **303. 1** (3) (A) (c) of the Rules, As an alternative to positive means of closure, an additional valve having such means of closure may be provided after the non-return valve.
8. In application to **303. 1** (3) (B) of the Rules, When the Fore Peak Tank is ballasted with the piping system serving the other ballast tanks within the cargo area in accordance with **Pt 7 Ch 1 Sec 1, 1003. 3**, the means of appropriate isolation described in **303. 1** (3) (A) and (B) of the Rules.
9. In application to **303. 1** (5) (A) (c) of the Rules, when the electrical equipment is of a certified safety type, the automatic disconnection of power supply is not required.

304. Special requirements for BWMS categories 2, 3a, 3b, 3c, 4, 5, 6, 7a, 7b and 8 generating dangerous gas or dealing with dangerous liquids. (2022) [See Rule]

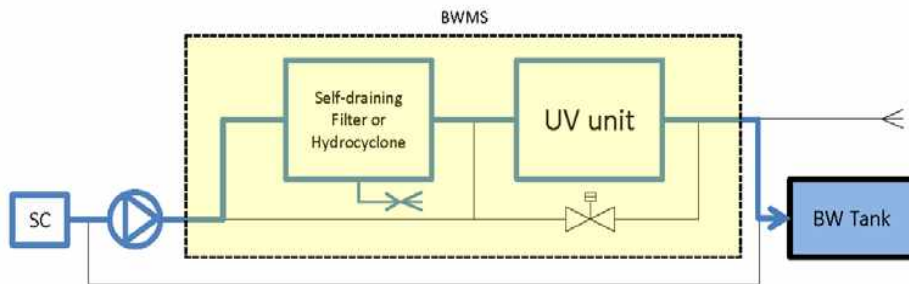
1. Safe location defined in **304. 1** (3) of the Rules as follows
- (1) For in-line ozone injection BWMS (categories 7a and 7b), vent outlet from O3 destructor device (ODS) can be considered as oxygen-enriched air provided that:
- the ODS are duplicated; and
 - the manufacturer justified that the quantity of consumable (activated carbon) used by the ODS is sufficient for the considered life cycle of the BWMS; and
 - ozone detection is arranged in the vicinity of the discharge outlet from the vent outlet of the ODS to alarm the crew in case the ODS is not working.
- (2) If one of the (1) is not fulfilled, the safe location from ODS on open deck are:
- outside of hazardous area;
 - not within 3 m of any source of ignition;
 - not within 6 m of areas traversed by personnel; and
 - not within 6 m of air intakes for machinery (engines and boilers) and all ventilation inlets.
2. In application to **304. 1** (4) of the Rules, as an alternative to the sensor for the gas detection, monitored under-pressurization inside the double walled spaces or pipe ducts could be provided with an automatic alarm and shut-down of the BWMS in case of loss of the under-pressurization. The monitoring can be achieved either by monitoring the pressure inside the double walled spaces or pipe ducts or by monitoring the exhaust fan.
3. Safe location defined in **304. 1** (5) of the Rules as follows
- (1) hydrogen by-product enriched gas from:
- in-line full flow electrolysis BWMS (category 4), in-line side-stream electrolysis BWMS (category 5) and in-line injection BWMS using chemical which is stored onboard (category 6): the hydrogen de-gas arrangement (when provided);
- safe locations on the open deck are:

- not within 5 m of any source of ignition and from deck machinery, which may include anchor windlass and chain locker openings, and equipment which may constitute an ignition hazard;
 - not within 3 m of areas traversed by personnel; and
 - not within 5 m of air intakes from non-hazardous enclosed spaces.
- (2) The areas on open deck, or semi-enclosed spaces on open deck, within 3 m of the outlets are to be categorized hazardous zone 1 plus an additional 1,5 m surrounding the 3 m hazardous zone 1 is to be categorized hazardous zone 2.
- (3) Electrical apparatus located in the above hazardous areas zone 1 and zone 2 is to be suitable for at least IIC T1.
4. In application to **304. 1** (6) and **304. 3** (1) (D) of the Rules, safe location means **302. 1**.
5. In application to **304. 2** of the Rules, the followings are to be considered.
- (1) This requirement is applicable to the injection lines conveying the dangerous gas or dangerous liquids but not applicable to the ballast water lines where the dangerous gas or dangerous liquids are diluted.
- (2) The IMO reports issued during the basic and final approval procedures of the BWMS that make use of active substances (G9 Guideline) could be used for assessing the hazards that could be expected from the media conveyed by the BWMS piping.
6. In application to **304. 2** (1) of the Rules, the followings are to be considered.
- (1) For piping class II with special safeguards conveying dangerous gas like hydrogen (H₂), oxygen (O₂) or ozone (O₃), the special safeguards are to be either double walled pipes or pipe duct.
- (2) For piping class II with special safeguards conveying dangerous liquids, other special safeguards could be considered like shielding, screening, etc.
- (3) Plastic pipes may be accepted after due assessment of the dangerous gas or dangerous liquids conveyed inside. When plastic pipes are accepted, the requirements of **Pt 5, Annex 5-6** apply.
7. In application to **304. 2** (3) of the Rules, safe location means **1.** and **3.**
8. In application to **304. 3** (1) (F) of the Rules, The IMO reports issued during the basic and final approval procedures of the BWMS that make use of active substances (G9 Guideline) could be used for this assessment.
9. In application to **304. 4** of the Rules, The IMO reports issued during the basic and final approval procedures of the BWMS that make use of active substances (G9 Guideline) could be used as a reference for this assessment.

Annex 9-3 BWMS Technologies categorization (Informative) (2022)

BWMS Technology Group no. 1 In-Line UV including UV + AOT Including UV+TiO₂)

Ballasting operation:



De-ballasting operation:

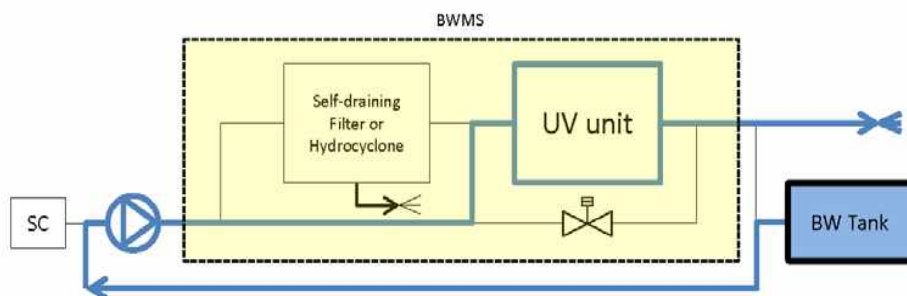
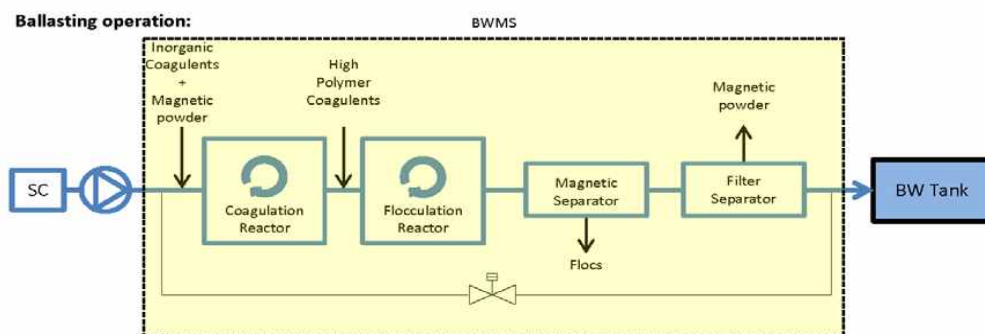


Fig 1

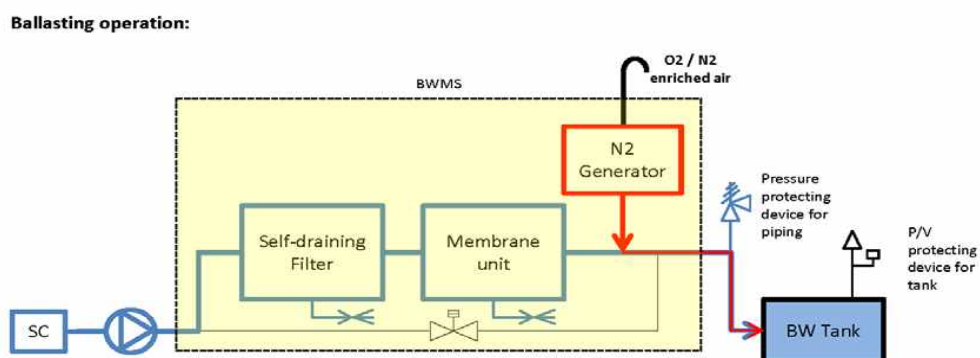
BWMS Technology Group no. 2 In-Line Flocculation



De-ballasting operation: no requirement for after-treatment

Fig 2

BWMS Technology Group no. 3a In-Line membrane separation and de-oxygenation (injection of N₂ from N₂ Generator)



De-ballasting operation: no requirement for after-treatment

Fig 3

BWMS Technology Group no. 3b
In-Line de-oxygenation
(injection of inert gas from either an oil fired inert gas generator or inert gas from treatment of the flue gas from main or auxiliary boilers)

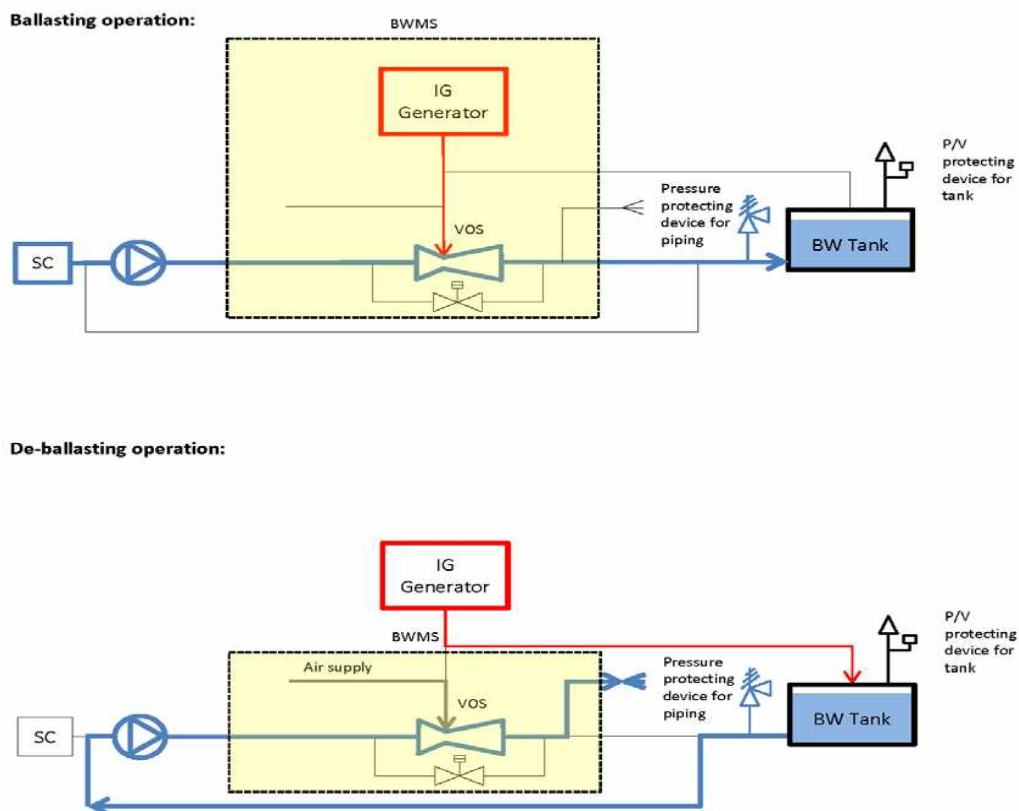


Fig 4

**BWMS Technology Group no. 3c
In-tank de-oxygenation with IGG**

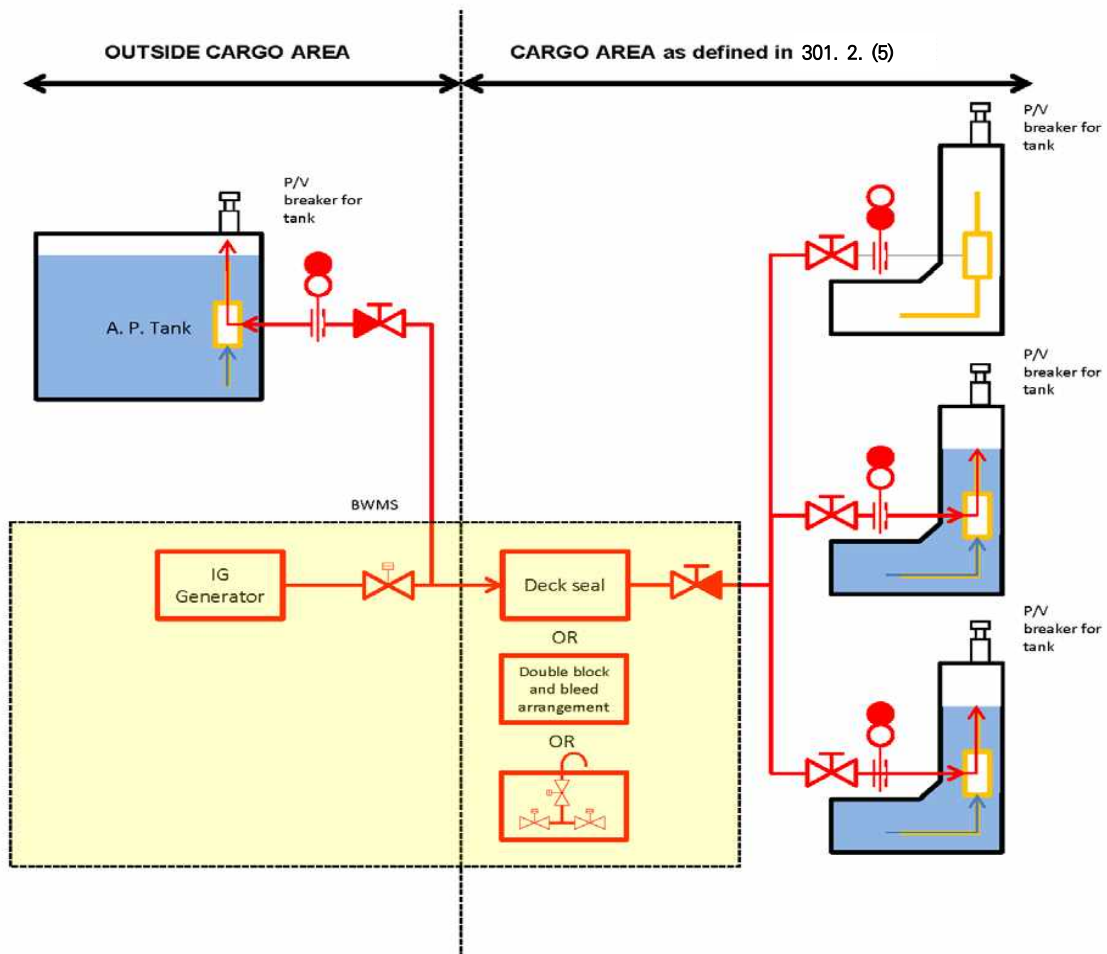
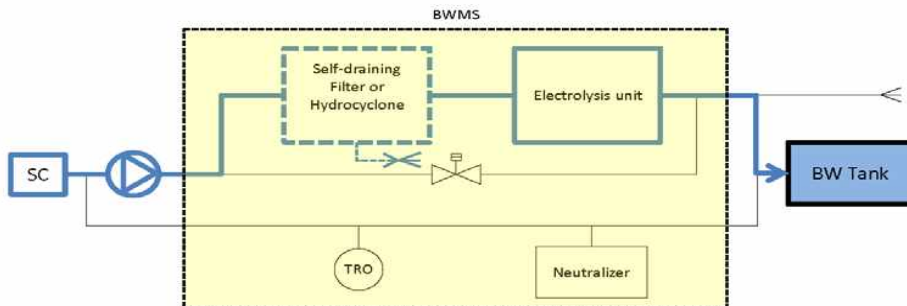


Fig 5

BWMS Technology Group no. 4 In-Line Full flow electrolysis

Ballasting operation:



De-ballasting operation:

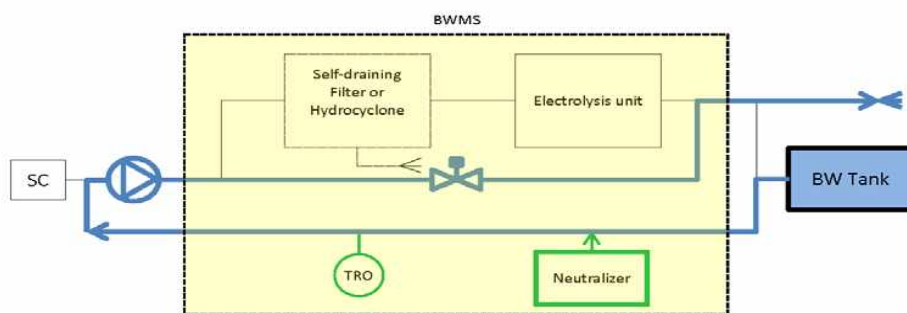
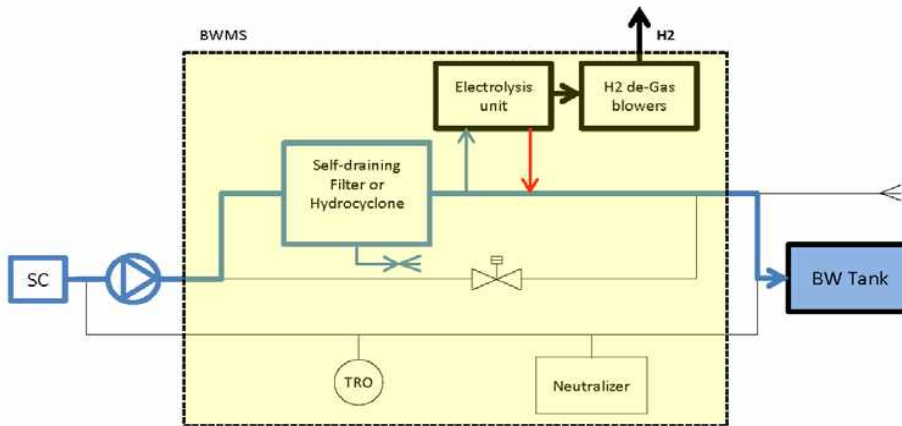


Fig 6

BWMS Technology Group no. 5 In-Line Side-Stream electrolysis (electro-chlorinization)

Note: In-line side stream electrolysis may also be applied in-tank in circulation mode (no treatment when ballasting or de-ballasting)

Ballasting operation:



De-ballasting operation:

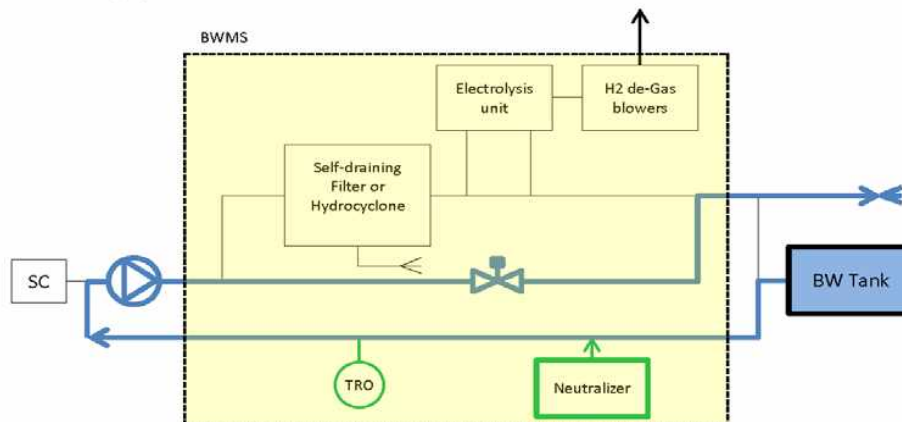
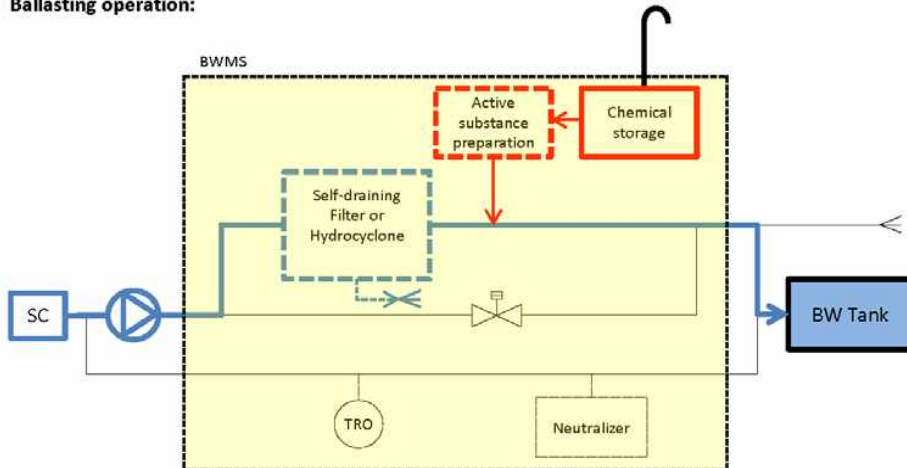


Fig 7

BWMS Technology Group no. 6 In-Line Chemical injection

Ballasting operation:



De-ballasting operation (when neutralization is required by the Type Approval certificate):

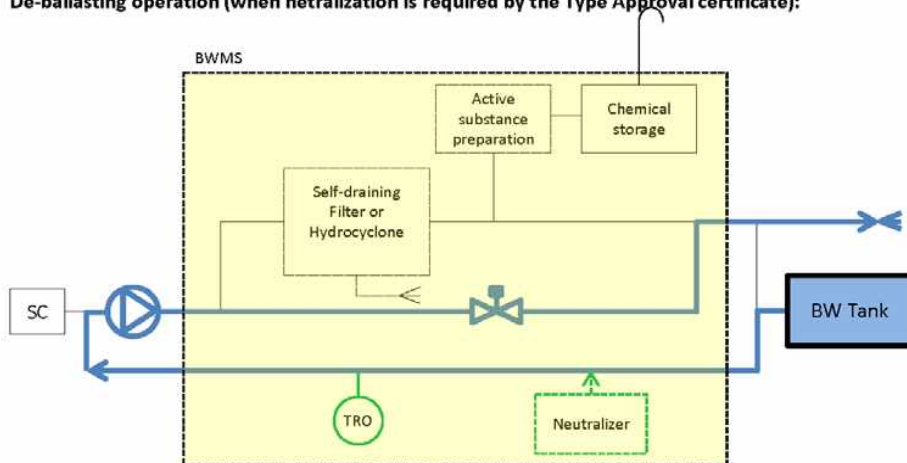


Fig 8

BWMS Technology Group no. 7a
In-Line Side-stream Ozone injection without gas/liquid separation tank and without discharge water treatment tank

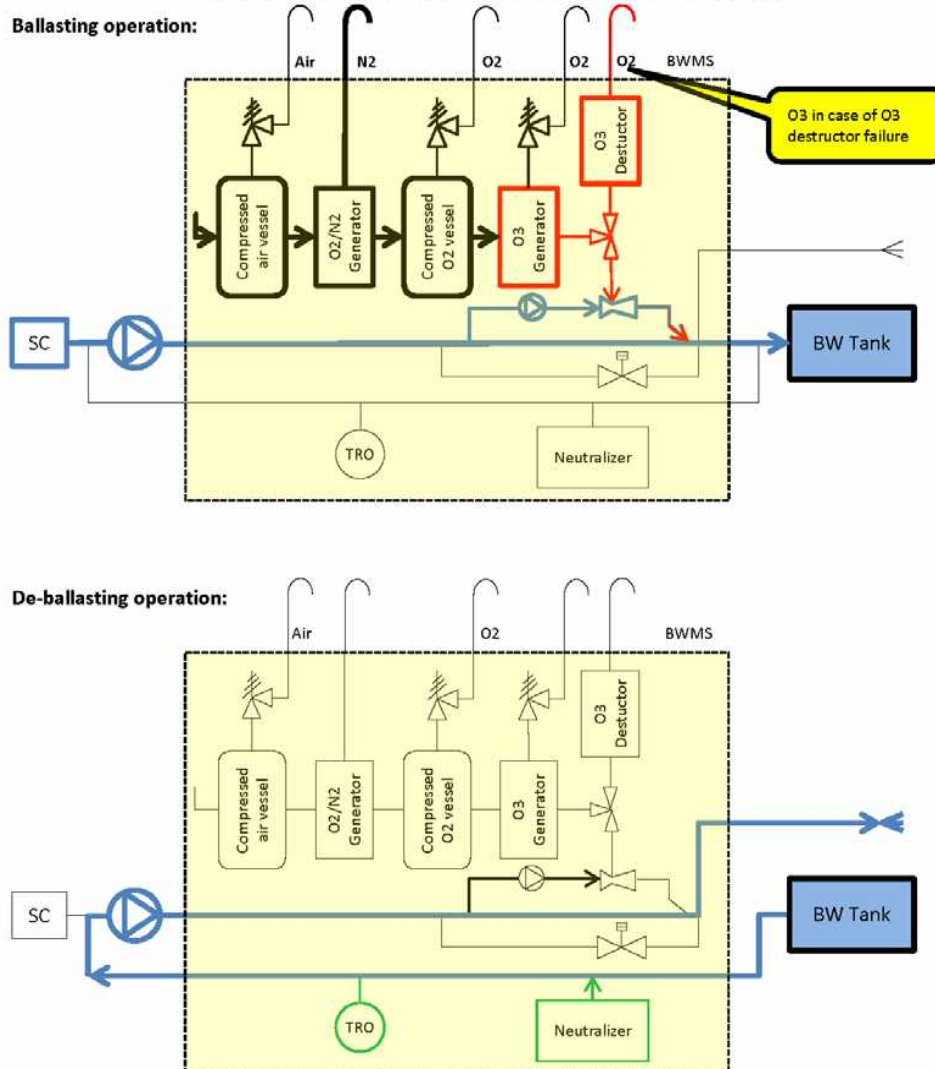


Fig 9

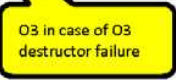
BWMS Technology Group no. 7b

Fig 10

BWMS Technology Group no. 8 In-tank Pasteurization + de-oxygenation with N2 Generator

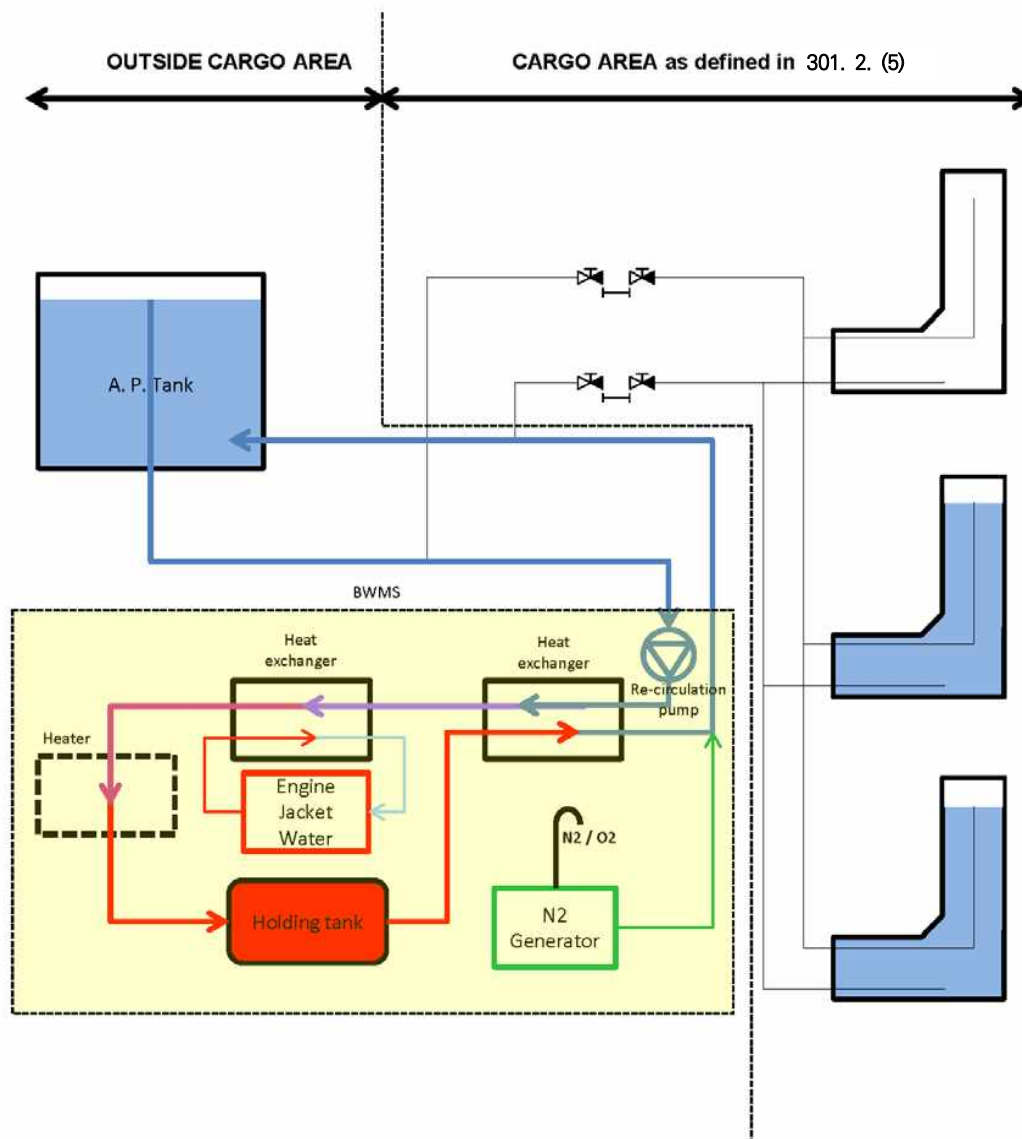


Fig 11



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

PART 9 ADDITIONAL INSTALLATIONS

Published by

KR

36, Myeongji ocean city 9-ro, Gangseo-gu,
BUSAN, KOREA

TEL : +82 70 8799 7114

FAX : +82 70 8799 8999

Website : <http://www.krs.co.kr>

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