Rules

2019

Rules for the Classification of Steel Ships

Part 9 Additional Installations

Guidance

2019

Guidance Relating to the Rules for the Classification of Steel ships

Part 9 Additional Installations

2019

Rules for the Classification of Steel Ships

Part 9

Additional Installations

RA-09-E

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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 2019.
2. The amendments to the Rules for 2018 edition and their effective date are as follows;

Effective Date : 1 July 2019

CHAPTER 2 CARGO HANDLING APPLIANCES

Section 2 Surveys

- 202. 1 (1) (B) has been amended.
- 203. 1 (3) has been amended.

CHAPTER 3 AUTOMATIC AND REMOTE CONTROL SYSTEMS

Section 5 Specific Automatic Equipment

- 502. has been amended.

CHAPTER 4 DYNAMIC POSITIONING SYSTEMS

Section 2 Requirements of Dynamic Positioning Systems

- 202. 2 (1) (B) has been amended.
- 203. 1 (4) and 2 (4) have been amended.

CHAPTER 7 DIVING SYSTEMS

Section 9 Compressors

- 901. 3 has been amended.

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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 : $CHClF_2$
R 134*a* : CH_2FCF_3
R 404*A* : *R* 125/*R* 143*a*/*R* 134*a* (44/52/4 *wt*%)
$CHF_2CF_3/CH_3CF_3/CH_2FCF_3$
R 407*C* : *R* 32/*R* 125/*R* 134*a* (23/25/52 *wt*%)
$CH_2F_2/CHF_2CF_3/CH_2FCF_3$
R 410*A* : *R* 32/*R* 125 (50/50 *wt*%)
CH_2F_2/CHF_2CF_3
R 507*A* : *R* 125/*R* 143*a* (50/50 *wt*%)
CHF_2CF_3/CH_3CF_3
R 717 : NH_3

(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. Special installations

The surveys and constructions of refrigerating installations to which the requirements in this chapter can not be directly applied for a special reason are to be deemed appropriate at the discretion of the Society.

3. Equivalency

Refrigerating installations, which do not comply with requirements of the Rules may be accepted, provided that they are deemed by the Society to be equivalent to those specified in the Rules.

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, evapo-

rators, 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)
R 22	1.9	1.5
R 134*a*	1.4	1.1
R 404*A*	2.5	2.0
R 407*C*	2.4	1.9
R 410*A*	3.3	2.6
R 507*A*	2.5	2.0
R 717	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* 134*a*, *R* 404*A*, *R* 407*C*, *R* 410*A* or *R* 507*A*, 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* 134*a*, *R* 404*A*, *R* 407*C*, *R* 410*A* or *R* 507*A*, 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 MΩ 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* 134*a*, *R* 404*A*, *R* 407*C*, *R* 410*A* or *R* 507*A* 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* 134*a*, *R* 404*A*, *R* 407*C*, *R* 410*A* 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℃ or higher than 220℃. In this case, such valves may be used at temperatures down to -50℃ even if the design temperature is lower than 0℃, 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 100 mm and design temperature is 150℃ 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 *R* 22, *R* 134*a*, *R* 404*A*, *R* 407*C*, *R* 410*A* or *R* 507*A*. 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 metalic 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℃, 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 *R* 717 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 m^3 : 4
(B) Volume up to 600 m^3 : 5
(C) Volume above 600 m^3 : 5 plus one for above 400 m^3 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 ± 0.5℃ in the range of below 0℃, and ± 0.3℃ in the range of 0℃ 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℃ 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 9-6** of the Guidance. *(2017)*

2. Equivalency

(1) Cargo gear, cargo ramps and loose gear which do not comply with the requirements of the Rules may be accepted, provided that they are considered by the Society to have the effectiveness equivalent to those complying with the Rules.

(2) 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 comply with any rules or standards recognized by the Society to be appropriate and have passed the tests and inspection required by the Society. **[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 sys-

tem 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 recongnized 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 : *AH* 32, *AH* 36 and *AH* 40
DH : *DH* 32, *DH* 36 and *DH* 40
EH : *EH* 32, *EH* 36 and *EH* 40

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]**

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 (G) are to be sub-

mitted 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 with respect to them subject to approval by the Society.

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

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 ascer-

tained 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
(a) 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.
(b) 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.
(c) 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
(a) 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.
(b) In case of a track-mounted cranes, the crane with the test weight suspended is to be transveresed 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 (F) 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) 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. 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. 4** to determine the dimensions of their members in accordance with the requirement in **Par 2** and **Par 3** 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/mm^2 and 45.1 kN/mm^2 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.**

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

Where,

σ_b : Compressive stress due to bending moment (N/mm^2)
σ_c : Compressive stress due to axial compression (N/mm^2)
τ : Shearing stress due to twisting of member (N/mm^2)

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. Minimum Plate Thickness of Posts

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

4. Construction of Posts

(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.

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.**

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

Where,

σ_b : Compressive stress due to bending moment $(\mathrm{N/mm^2})$

σ_c : Compressive stress due to axial compression $(\mathrm{N/mm^2})$

τ : Shearing stress due to twisting of member $(\mathrm{N/mm^2})$

Table 9.2.5 Allowable Stress σ_a

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

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.**

$$1.15\omega\sigma_c \qquad (\mathrm{N/mm^2})$$

Where,

σ_c : Axial compressive stress $(\mathrm{N/mm^2})$

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** $(\mathrm{N/mm^2})$

σ_{ca} : Allowable compressive stress to be taken as a quotient of σ_a divided 1.15 $(\mathrm{N/mm^2})$

σ_b : Compressive stress due to bending moment $(\mathrm{N/mm^2})$

σ_c : Compressive stress due to axial compression $(\mathrm{N/mm^2})$

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	$\frac{0.87+0.46(\lambda/\lambda_0)+0.12(\lambda/\lambda_0)^2}{1-0.5(\lambda/\lambda_0)^2}$

(NOTES)

1. λ is the slenderness ratio of the member subjected to compression to be obtained from the following formula:

$$l_e\sqrt{\frac{A}{I}}$$

where,

A : Sectional area of the member (m^2)
I : Moment of inertia of section of member (m^4)
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):

2. λ_0 is the value obtained from the following formula:

$$\sqrt{\frac{2\pi^2 E}{\sigma_y}}$$

where,

π : The circular constant
E : Young's modulus (N/mm^2)
σ_y : Specified yield stress or proof stress of material (N/mm^2)

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	-	-	-

(NOTES)
R : Rotation D : Displacement con. : constrained

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. Reinforcement of Derrick Booms

(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.

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.

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

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:

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

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.

$$\sum C_2 Wu \quad (\mathrm{cm}^3)$$

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 outreach (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:

$$10\frac{h^3}{d_m}\sum R \qquad (\mathrm{cm}^3)$$

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:

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

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:

$$C_P\left(C_1C_2\rho W-10\frac{h^3}{d_m}\sum R\right) \quad (\text{cm}^3)$$

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.

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

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' : Ration 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.

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

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:

$$C_B P l^2 \qquad (\mathrm{cm}^4)$$

where,

C_B : Value obtained from **Table 9.2.10**

I : 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

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

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

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

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.

6 (mm) for $P < 75.5$ (kN)

$5+0.0133P$ (mm) for $P \geq 75.5$ (kN)

(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.

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

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.

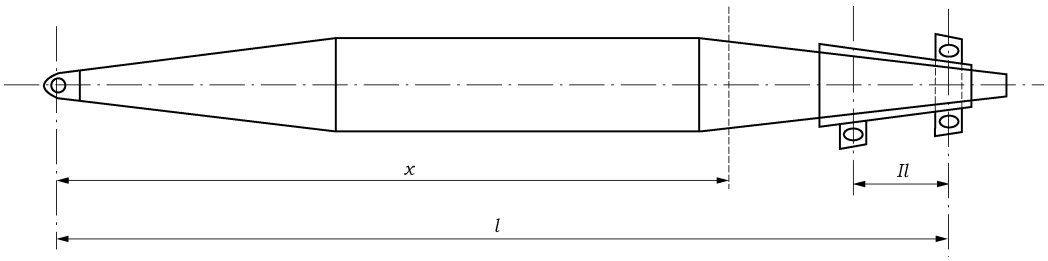


Fig 9.2.1 Derrick Boom with Whipped Rigging

Table 9.2.14 Values of σ_0 【See Guidance】

Safe working load W (t)	σ_0
$W \leq 10$	80.4
$10 < W < 15$	$4.04W + 40.0$
$15 \leq W \leq 50$	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 $(\mathrm{m/min})$

(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

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

where,

W : Safe working load (t)

R : Slewing radius (m)

v : Circular speed $(\mathrm{m/sec})$

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

$$\lambda D \quad (\mathrm{kN})$$

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:

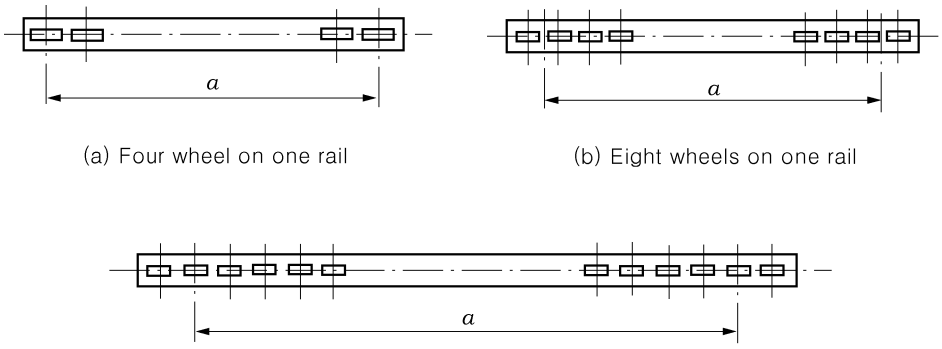
$$0.05 \quad \text{for} \quad \frac{l}{a} \leq 2$$

$$\frac{1}{60}\left(\frac{l}{a}+1\right) \quad \text{for} \quad \frac{l}{a} \leq 2$$

Where,

l : Span of rails (m)

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



(a) Four wheel on one rail (b) Eight wheels on one rail

(c) More than eight wheels on one rail

Fig 9.2.2 Measurement of Effective Wheel Base

5. Wind Loading

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

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

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 party 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)

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

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.

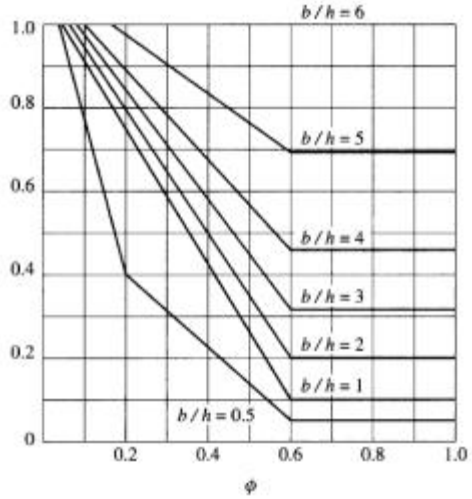


Fig 9.2.3 Repleteness Ratio, ϕ and versus Reduction Factor, η

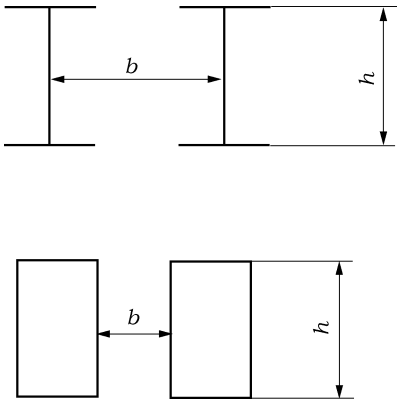
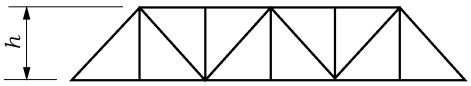
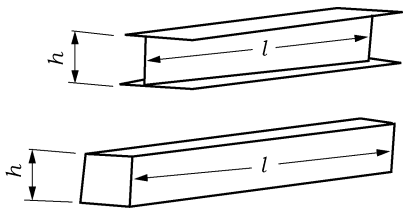
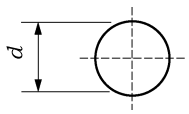


Fig 9.2.4 Distance between two neighbouring girders, b

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

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

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

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.**

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

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 $(\mathrm{N/mm^2})$

σ_c : Compressive stress due to axial compression $(\mathrm{N/mm^2})$

σ_a : Allowable bending stress given in **Table 9.2.19** $(\mathrm{N/mm^2})$. 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** $(\mathrm{N/mm^2})$. For fixed post at the base, however, the allowable stress $(\mathrm{N/mm^2})$ 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

Load Condition	Kind of stress					
	Tension	Bending	Shear	Compression	Bearing	Combined stress
Condition specified in **402. 9** (2)	$0.67\sigma_Y$	$0.67\sigma_Y$	$0.39\sigma_Y$	$0.58\sigma_Y$	$0.94\sigma_Y$	$0.77\sigma_Y$
Condition specified in **402. 9** (3)	$0.77\sigma_Y$	$0.77\sigma_Y$	$0.45\sigma_Y$	$0.67\sigma_Y$	$1.09\sigma_Y$	$0.89\sigma_Y$
Condition specified in **402. 9** (4) and (5)	$0.87\sigma_Y$	$0.87\sigma_Y$	$0.50\sigma_Y$	$0.76\sigma_Y$	$1.23\sigma_Y$	$1.00\sigma_Y$

(NOTES)
1. σ_Y : Specified yield stress or proof stress of material $(\mathrm{N/mm^2})$
2. The combined stress is to be the value obtained from the following formula:

$$\sqrt{\sigma_x^2+\sigma_y^2-\sigma_x\sigma_y+3\tau_{xy}^2} \quad (\mathrm{N/mm^2})$$

where,
σ_x : Applied stress in x-direction at the middle of plate thickness $(\mathrm{N/mm^2})$
σ_y : Applied stress in y-direction at the middle of plate thickness $(\mathrm{N/mm^2})$
τ_{xy} : Applied shear stress in the $x-y$ plane $(\mathrm{N/mm^2})$

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 $\mathrm{kN/mm^2}$ and yield stress exceeding 1.06 $\mathrm{kN/mm^2}$ 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.

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

where,
M : Upsetting moment $(\mathrm{N \cdot mm})$
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.

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

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

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

where,

P : Design axial compressive force acting on derrick boo (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 at 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.

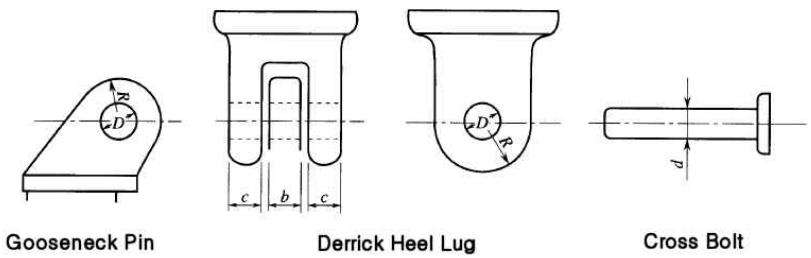


Fig 9.2.5 Gooseneck Pin, Derrick Heel Lug and Cross Bolt

Table 9.2.21 Values of e_1 [See Guidance]

Safe working load W (t)	e_1
$W \leq 10$	15.6
$10 < W < 15$	$18.8 - 0.32W$
$15 \leq W \leq 50$	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.

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

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

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:

$\alpha_1\alpha_2 \mathrm{W}g$ for topping lift

$\lambda \mathrm{W}g$ 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.

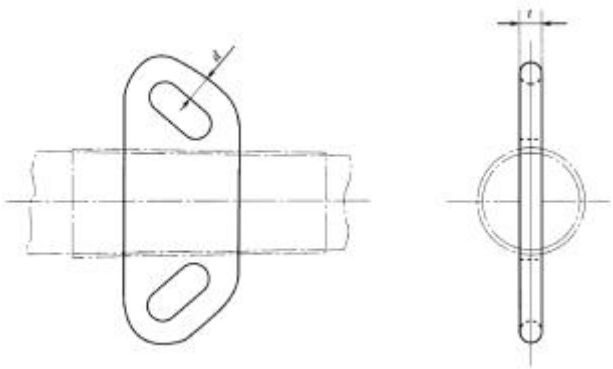


Fig 9.2.6 Cargo Fitting attached at Head of Derrick Boom

Table 9.2.22 Values of e_2 【See Guidance】

Safe working load W (t)	e_2
$W \leq 10$	12.5
$10 < W < 15$	$15.1 - 0.26W$
$15 \leq W \leq 50$	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.

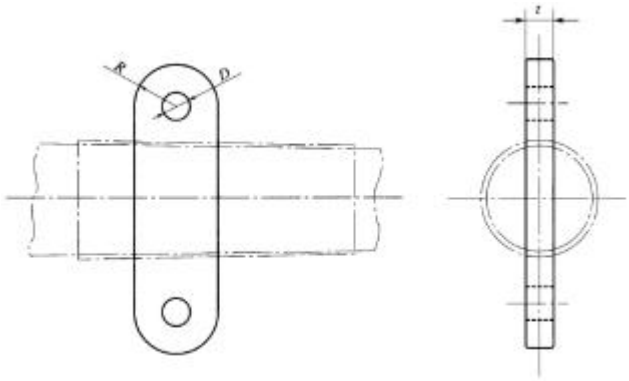


Fig 9.2.7 Fitting attached at Head of Derrick Boom

Table 9.2.25 Values of e_3 【See Guidance】

Safe working load W (t)	e_3
$W \leq 10$	122
$10 < W < 15$	$170 - 4.8W$
$15 \leq W \leq 50$	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.

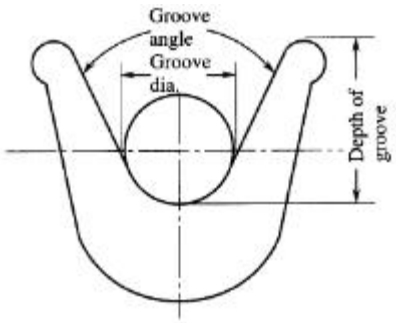


Fig 9.2.8 Sheave Groove

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.

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

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

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 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 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.

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:

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

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

$$\begin{cases} (38-45C_b')\left(1-\dfrac{x}{0.3L}\right)^2 & \text{for } x \le 0.3L \\ 0 & \text{for } x > 0.3L \end{cases}$$

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

Load Condition	Kind of stress					
	Tension	Bending	Shear	Compression	Bearing	Combined stress
Condition given in **802. 6** (2)	$0.67\sigma_Y$	$0.67\sigma_Y$	$0.39\sigma_Y$	$0.58\sigma_Y$	$0.94\sigma_Y$	$0.77\sigma_Y$
Condition given in **802. 6** (4) and (5)	$0.77\sigma_Y$	$0.77\sigma_Y$	$0.45\sigma_Y$	$0.67\sigma_Y$	$1.09\sigma_Y$	$0.89\sigma_Y$

(NOTES)

1. σ_Y : Specified yield stress or proof stress of material $(\mathrm{N/mm^2})$
2. The combined stress is to be the value obtained from the following formula:

$$\sqrt{\sigma_x^2+\sigma_y^2-\sigma_x\sigma_y+3\tau_{xy}^2} \quad (\mathrm{N/mm^2})$$

where,

σ_x : Applied stress in x-direction at the middle of plate thickness $(\mathrm{N/mm^2})$
σ_y : Applied stress in y-direction at the middle of plate thickness $(\mathrm{N/mm^2})$
τ_{xy} : Applied shear stress in the $x-y$ plane $(\mathrm{N/mm^2})$

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 according 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 (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.**
	Document in **904. 1** (C)	
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 (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
	Document in **904. 1** (E) and (F)	

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 predetermined 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 avaliable 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, CO_2 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 predetermined 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 it 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 switchboard 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 *(2017)*

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		c	c	c	s	s	c = common; s = separate
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	●					
Lubricating 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	●		●		●	
	Oil mist concentration in crankcase - H or Main, crank, crosshead bearing temp. (or bearing oil outlet temp).- H	H	●		●			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.
	Common rail servo oil pressure	L	●					
Turbocharger	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
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	●					

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		c	c	c	s	s	c = common; s = separate
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	●					
Compressed 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 turbocharger, temp.	H	●	●				
	Exhaust gas after each turbocharger, temp.	H	●	●				
Fuel valve Coolant	Coolant, pressure	L	●			●		
	Coolant, temp.	H	●					
	Coolant expansion tank, level	L	●					
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	●					

(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.**

(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 9.3.2 Trunk piston diesel engines *(2017)*

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		c	c	c	s	s	c = common; s = separate
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	●	●				
	Oil mist in crankcase, mist concentration(H) or main & connecting rod bearing temp. (or oil outlet temp.) (H) or an equivalent device	H	●				●	Only for medium speed engines having power ≧ 2250 kW or cylinder bore > 300 mm. Single sensor having two independent outputs for initiating alarm and for shutdown will satisfy independence of alarm and shutdown. (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	●	●		●		
Cylinder fresh water cooling	Water inlet, pressure low or flow	L	●	●	●	●		
	Water outlet (general), temp.	H	●	●	●			Two separate sensors are required for alarm and slowdown.
	Cooling water expansion tank, level	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		c	c	c	s	s	c = common; s = separate
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

(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

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		c	c	c	s	s	c = common; s = separate
Lubricating 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	●	●				
Lubricating 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 maneuvering signal.
Condensate	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

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]
Hydrau-lic oil	Delivery pressure or flow rate	L	●	●	
	Tank, level	L	●		

Table 9.3.6 Main boiler

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		c	c	s	s	c = common sensor; s = separate sensor
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

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 wind-box forms part of the combustion fan housing.

Table 9.3.8 Auxiliary diesel engines and auxiliary turbines *(2017)*

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	●	●			
		Oil mist in crankcase, mist concentration(H) or main & connecting rod bearing temp. (or oil outlet temp.) (H) or an equivalent device.	H	●			●	Only for medium speed engines having power ≧ 2250 kW or cylinder bore > 300 mm. Single sensor having two independent outputs for initiating alarm and for shutdown will satisfy independence of alarm and shutdown.(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.
		Common rail servo oil pressure	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
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

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	●	
	Staring 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.
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 electorial installations, **Pt 6, Ch 1;** For Automatic and remote control systems, **Pt 6, Ch 2.**
3. **Classes of dynamic positioning systems** Dynamic positioning systems are classified and defined by their worst case failure modes as follows:
   (1) DPS(0), DPS(1)
   Loss of position may occur in the event of a single fault.
   (2) DPS(2)
   A loss of position 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 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) **Dynamic positioning systems** comprise the following sub-systems, control panels, and back-up systems which are necessary to dynamically positioning the ship.
(A) Thruster system
(B) Power system
(C) Control system
(2) **Thruster system** comprise the followings:
(A) Thruster, power transmission gears driving thruster, thruster control hardware for control of thruster speed, pitch and heading
(B) Main propellers and other propulsion units when these are included in dynamic positioning control mode.
(3) **Power system** means all components and systems necessary to supply the dynamic positioning 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 management system
(4) **Control system** means all control components and systems, hardware and software necessary to dynamically position the vessel and include the followings.
(A) Control systems
(a) Remote control system(Joystick)
(b) Automatic control system
(B) Measuring system
(C) Control panel
(D) associated cabling and cable routing

(5) **Remote control system(Joystick)** is a semi-automatic control system, which enables the operator to give a defined thrust (force and direction) and a turning moment to the vessel.
(6) **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

(7) **Control panels** comprise centrally and locally situated panels for operating the dynamic positioning system.
(8) **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
(9) **Operational Mode** is the manner of control under which the dynamic positioning 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
(10) **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.
(11) **Reliability** is the ability of a component or system to perform its required function without failure during a specified time interval.
(12) **Worst case failure** is failure modes which, after a failure, results in the largest reduction of the position and/or heading keeping capacity. This means loss of the most significant redundancy group, given the prevailing operation.

103. Drawings and data

1. General In the case of the ships intended to be registered as ships provided with dynamic positioning 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 dynamic positioning 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 dynamic positioning 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 dynamic positioning 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 dynamic positioning 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 dynamic positioning 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

The ships intended to be registered as ships provided with dynamic positioning systems are to be provided dynamic positioning systems specified in **202.** and **203.**

202. Requirements of dynamic positioning systems

1. 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.

2. 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 dynamic positioning 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 dynamic positioning 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 dynamic positioning system even when one transformer is out of service.

(6) Alarm for electrical generating system

An alarm is to be initiated at the dynamic positioning 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.

3. 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 control station is to display information from the power system, thruster system and 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) Minimum number of control system, position reference system and environmental sensor for dynamic positioning 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

Class	Control system	Position reference system	Environmental sensor		
			Heading reference system	Vertical reference sensor	Means to ascertained the wind and direction
DPS(0)	Remote control system(1) 1 set	1 set	1 set	1 set	each 1 set
DPS(1)	Automatic control system(2) 1 set Remote control system(1)(2) 1 set	2 sets(3)	1 set	1 set	1 set
DPS(2)	Automatic control system(2) 2 sets	3 sets(3)(4)	3 sets(3)	3 sets(3)	each 3 sets(3)
DPS(3)	Automatic control system(2) 2 sets Emergency automatic control 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) 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 dynamic positioning system.
(4) Indicators
Indications of the following are to be provided at each station from which it is possible to control the dynamic positioning 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
(5) 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 dynamic positioning 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 dynamic positioning system is to be provided at the dynamic positioning control station to warn all relevant personnel in the event of a total. loss of dynamic positioning 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 dynamic positioning 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) 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 dynamic positioning 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 dynamic position 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). If necessary, power management system may be added.

(5) 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.

(6) 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) The divided power system is to be located in different spaces separated by A-60 class division.
(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 dynamic positioning 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) An emergency automatic control system is to be provided at an emergency control station, in a compartment separated by A-60 class division from that for the main control station. During DP-operation this emergency automatic control system is to be continuously updated by input from the sensors, position reference system, thruster feedback, etc., and be ready to take over control. The switch-over of control to the emergency automatic control system is to be manual, situated on the back-up computer and is not to be affected by failure of the main control system.
(6) Arrangements are to be provided such that in the event of a failure of the working and standby control systems a smooth transfer of control to the emergency control system may be effected from the emergency control station by manual means.
(7) 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.
(8) 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.
(9) Signals from the environmental sensors required by **Table 9.4.1** are to supply the emergency automatic control system.
(10) The emergency automatic control system is to be supplied from its own independent uninterruptible power supplies.
(11) 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 dynamic positioning 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 dynamic positioning 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 dynamic positioning system

Records and data regarding the performance capability of the dynamic positioning 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 dynamic positioning systems(DPS) 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 DPS, such as controllers and operating stations for DP and independent joystick, references systems, sensors and mode change system, are to be visually inspected.

(3) The technical condition of the DPS 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 class notation DPS(3), normal working condition of the back-up 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 centre 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 simu-

lation 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 centre 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 centre 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 DPS, such as controllers and operating stations for DP 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 class notation DPS(2) & DPS(3), the required redundancy with respect to defined single failures modes is to be verified by redundancy testing.

(13) For class notation 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 class notation DPS(2) & DPS(3), correct functioning of the Consequence Analysis facility is to be verified as far as possible.

(15) For class notation DPS(3), testing is also to be performed on the back-up DP control system. Switchover to back-up is to be tested, and monitoring of back-up 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 Annul 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**)

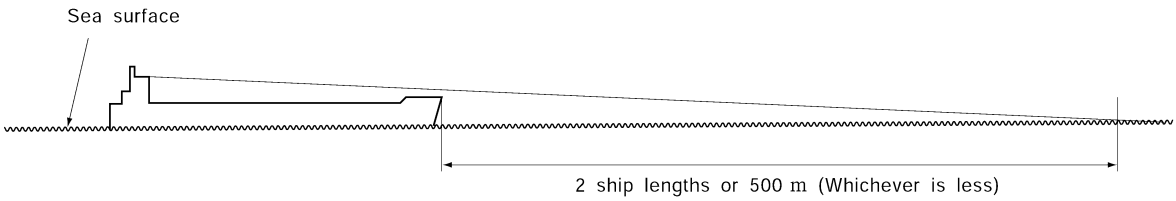


Fig 9.5.1 Forward view

(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 lighthouses, 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**)

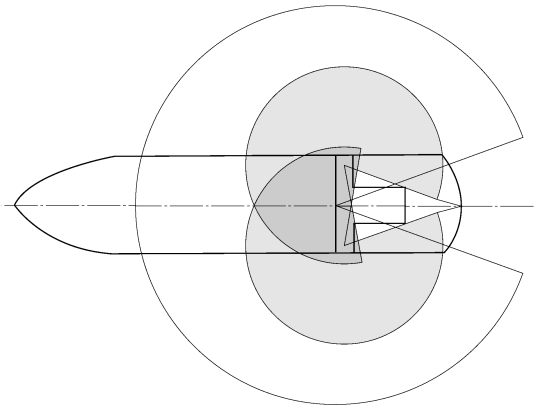


Fig 9.5.2 360° Field of vision

(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**)

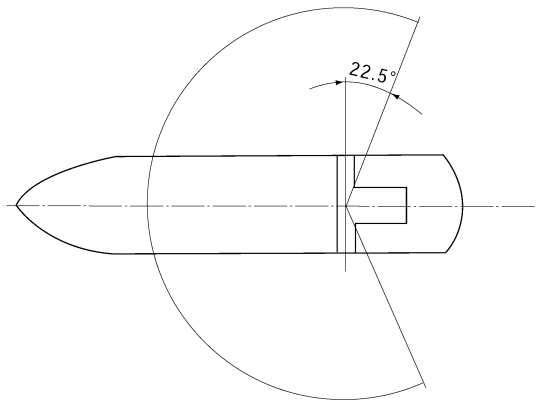


Fig 9.5.3 Navigating and maneuvering workstation and conning position

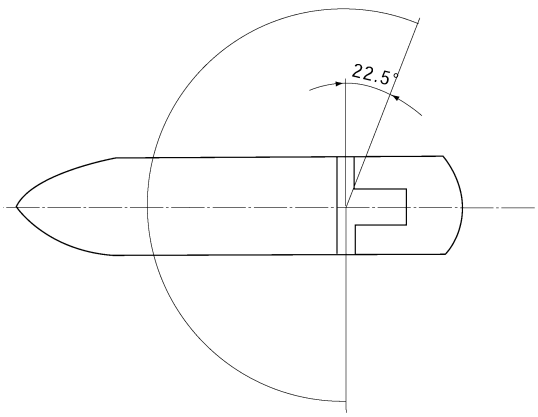


Fig 9.5.4 Monitoring workstation

(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.

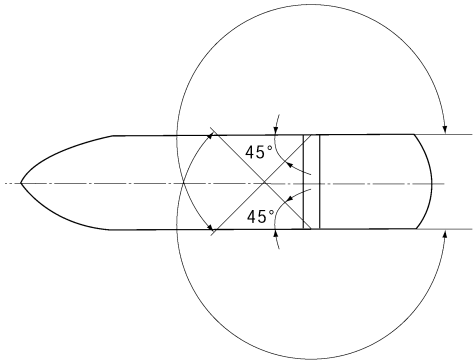


Fig 9.5.5 Bridge wing workstation

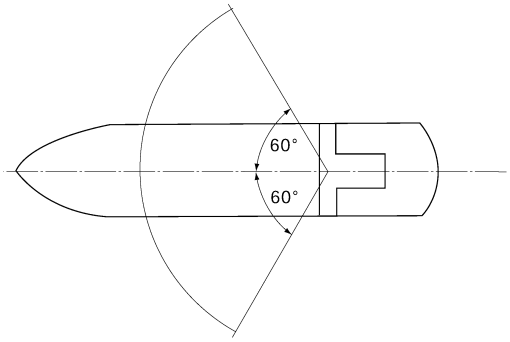
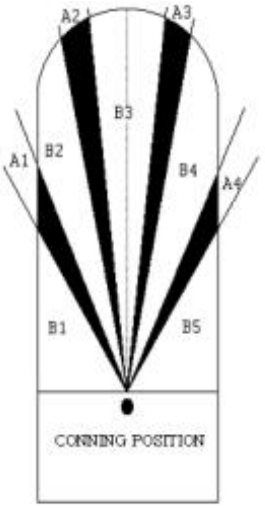


Fig 9.5.6 Helmsman's workstation

(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
∠(A1+A2+A3+A4+B1+B2+B3+B4+B5)= 180°

* each individual blind sector
∠(A2,A3) ≤5°
(over an arc from dead ahead to 10° on each side)
∠(A1,A4) ≤10°

* total arc of blind sectors
∠(A1+A2+A3+A4) ≤20°

* clear sectors between two blind sectors
∠B2,B3,B4 ≥5°

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 be 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. Date 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 $\mu\varepsilon$. 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 date 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 onboard 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 Classification

101. General

1. The requirements of this Chapter apply to 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. However, diving simulators are to be in accordance with the Guidance relating to the Rules.
2. Where diving systems have satisfactorily undergone the Classification Survey, the Certificate of Classification for diving systems is to be issued and that certificate is to be kept on board ship.
3. The ship is required to carry a diving system log book in which are entered detailed diving operations, repairs, etc. The diving system log book is to be submitted to the Surveyor on request.
4. Diving systems, which are not intending to be classed with the Society but which are constructed in accordance with the Rules and under survey of the Society by the Owner's application, may be issued an appropriate certificate from the Society.
5. When a diving system, which has the same type with those already classed with the Society, is intended to be under Classification Survey during Construction, the special consideration may be given in application of this Rule.
6. When diving systems and their parts thereof whose development is based on new principle and which have not yet been sufficiently tested in practical operation, additional tests may be required by the Society.

102. Class notations

When diving systems are intended to be installed on a vessel classed with the Society, the class notations shall be assigned in accordance with **Pt 1, Ch 1, Sec 2** of the Rules. However, the notation of "SUR", "BOU" or "SAT" shall be assigned as an Additional Installation Notation according to **602. 1.**

103. Maintenance of classification

1. To maintain the classification after Classification Survey, the diving systems are subject to the Periodical Surveys in accordance with the requirements of this Rules. The application for survey is to be made by the Owners or managers in substitute for the Owners.
2. If a diving system has suffered damage affecting its class or if such damage may be assumed, it is to be informed to the Society and those are to be surveyed before the systems begin operation.

Section 2 Classification Survey during Construction

201. Classification Survey during Construction

For diving systems requiring Classification Survey during Construction, the construction, materials, scantlings and workmanship of all systems, outfittings and equipment are to be examined in detail in order to ascertain that they meet the appropriate requirements of the Rules.

202. Approval of plans

For diving systems requiring Classification Survey during Construction, the plans and documents of all systems, outfittings and equipment are to be submitted in accordance with **604.** The same applies also to the cases of any subsequent modifications to the approved drawings or documents.

203. Survey during construction for main equipment

The parts and piping arrangements used for diving systems, which are intended to be classed with the Society or intended to be surveyed by the Society at the request of the Owner, are to be surveyed during construction. Various tests on any special part amongst the automatic or remote control systems and measuring devices considered necessary by the Society may be requested at the manufacturing sites.

204. Workmanship

For Classification Survey during Construction for a diving system, the materials, workmanship and arrangements are to be surveyed under the supervision of the Society's Surveyor from the commencement of the work until the completion of the diving system. When the machinery is constructed under classification survey, this survey is related to the period from the commencement of the work until the final test under working conditions. Any item found not to be in accordance with the Rules or the approved plans, or any material, workmanship or arrangement found to be unsatisfactory are to be rectified.

205. Test [See Guidance]

In the Classification Survey during Construction, hydrostatic, watertight and performance tests are to be carried out in accordance with the relevant part of the Rules. Also the control systems and measuring device after installation are to receive the tests deemed necessary by the Society.

Section 3 Classification Survey after Construction

301. Classification Survey after Construction

In the Classification Survey after Construction for a diving system, the actual scantlings of main parts of the diving system are to be measured in addition to such examinations of the construction, materials, workmanship and actual conditions of all systems, outfittings and equipment as required for the Special Survey.

302. Submission of plans

In the Classification Survey after Construction, plans and documents as may be required for Classification Survey during Construction are to be submitted. If plans cannot be obtained, facilities are to be given for the Society's Surveyor to take the necessary information from the diving system.

303. Classification Survey of diving systems classed by other Society [See Guidance]

When a diving system holding class with any Society which is subject to verification of compliance with QSCS(Quality System Certification Scheme) of IACS is intended for classification, plans and documents to be submitted and survey status, etc., are to be complied with as provided separately.

304. Tests [See Guidance]

In the Classification Survey after Construction, the hydraulic pressure tests, watertight tests and performance tests are to be carried out in accordance with the requirements of the Rules. However, these tests may be dispensed with provided that sufficient data on the previous tests are available and neither alteration nor repair affecting the previous data has been made since the previous tests.

Section 4 Kinds of Surveys

401. Intermediate Survey

Intermediate Surveys are to be carried out within 3 months before or after the anniversary date from the completion date of the initial Classification Survey or of the previous Special Survey.

402. Special Survey

Special Surveys are to be carried out at a date not exceeding 5 years from the completion date of Classification Survey or the due date of the previous Special Survey. However, if Special Surveys are carried out at a date which is to be more than 3 months earlier than the due date of Special Survey, the next Special Survey is to be assigned at the date of 5 years after the completion date of the concerned Special Survey.

403. Occasional Survey

All classed diving systems are to be subjected to Occasional Surveys when they fall under either of the following conditions at periods other than those of Special Survey or Intermediate Survey:

(1) When main parts of systems, or important fittings or equipment which have been surveyed by the Society, have been damaged, or are about to be repaired or altered.
(2) When safety valves are opened up or when settings of safety valves are altered.
(3) Other cases where surveys are designated or whenever survey is deemed necessary by the Surveyor.
(4) When the due dates of surveys are to be postponed.

Section 5 Performance of Survey

501. Intermediate Survey

The followings are to be tested and checked in Intermediate Survey. However, the test details are to be in accordance with the Guidance relating to the Rules.

(1) Examination of documents relating to the diving system and scrutiny of the operational records.
(2) The entire compression chamber system including all fixture, penetrations, doors and covers, seals, locking systems etc. is to be inspected for visible damage, cracks, deformation, corrosion attacks and fouling.
(3) All other pressure vessels and apparatus, valves, fittings and safety equipment are to be subjected to external inspection.
(4) The entire power supply system, including the emergency supply, of the diving system is to be subjected to external inspection.
(5) Switching from the main to the emergency electricity supply is to be tested.
(6) Insulation measurements are to be performed on the electrical equipment.
(7) The accuracy of all important instrument readings is to be checked (e.g. depth gauge, gas analyzer, etc.).
(8) All emergency systems are to undergo a functional test (e.g. the autonomous gas supply of the diving bell).
(9) The hand1ing system is to be checked for visible damages, cracks and deformations and is to undergo a functional test including a brake test (power failure).
(10) All high-pressure gas supply and charging hoses and the hoses belonging to the heating system and the umbilical are to be checked for visible damage and tightness.
(11) Performance of a tightness test on the compression chamber system at maximum permissible operating pressure using air.
(12) Verification of the set pressures and test pressures of compression chamber relief valves and of safety and warning systems.
(13) Functional test on mechanical and electrical equipment.
(14) Functional test on life support systems.
(15) Functional test on fine warning and extinguishing systems.
(16) Functional test on all alarm systems.
(17) Functional test and purity check on all breathing gas compressors.

(18) After ten years, all compression chambers are to undergo a hydrostatic internal pressure test. 【See Guidance】

(19) Check of acrylic viewport windows. (The maximum duration of using is to be in accordance with the Guidance relating to the Rules) 【See Guidance】

502. Special Survey 【See Guidance】

In Special Survey, the followings are to be tested and checked in addition to the items specified in **501.** However, the test details are to be in accordance with the Guidance relating to the Rules.

(1) A tightness test is to be performed on the compression chamber system at 1.1 times the maximum permissible operating pressure using air.

(2) Dimensional checks and non destructive wall thickness tests are to be performed on the diving bell. Where necessary, buoyancy aids, cladding and layers of thermal insulation are to be removed for this purpose.

(3) Emergency ballast release and buoyancy tests are to be performed with the diving bell.

(4) Pressure vessels and apparatus not capable of satisfactory internal inspection and those whose satisfactory condition cannot be definitely established by internal inspection are to be inspected by another non destructive method of examination or are to be subjected additionally to a hydraulic pressure test.

(5) Acrylic viewport windows are to be dismounted as deemed necessary by the Surveyors and examined for incipient cracks.

(6) Window seatings are to be examined for corrosive attack.

503. Postponement of Special Survey

If a diving system at the time of the Special Survey is not in a port in which it is to be surveyed or if a diving system is in transit to another port to be surveyed, the due date of Special Survey may be postponed within the period of 3 months at the request of the Owner through the approval of the Society.

504. Damage Survey

1. When the damage causing the affection to safety operation of diving system is occurred, damage survey is to be completed.

2. When the damage is occurred, the extent of the survey will be determined by the Society in each individual case.

505. Commission of Survey

If it is impossible to prepare equipments for internal survey or due to excessive cost, those tests at the request of Owners, may be accomplished in other site or company under supervision of Surveyors.

Section 6 General

601. Application 【See Guidance】

1. Wherever expedient and feasible, diving systems are to be designed and constructed in such a way that failure of any single component cannot give rise to a dangerous situation.

2. Diving systems and their components are to be designed to meet the service conditions specified in the specification of the system.

3. Diving systems are to be constructed to ensure that persons under pressure can be safely conveyed from the surface compression chamber to the underwater work location (and back).

4. All parts of a diving system are to be designed, constructed and mounted in such a way as to facilitate cleaning and disinfection.

5. Diving systems which can be operated with simultaneously differing chamber pressures are to be

provided with effective means of preventing any unintentional pressure drift within the chamber system.

6. The living compartment of diving systems which is occupied in respect of operating services, pressure and atmospheric conditions is to be so arranged that its occupants are not endangered or inconvenienced. In addition, it is so designed and manufactured that safe operation and suitable maintenance and surveys are available.

7. Refer to **603.** of Diving System, all components in a diving system should be designed, constructed and tested in accordance with the Rules.

8. Designs differing from this Rule of Construction may be permitted provided their suitability has been verified by the Society and they have been recognized as equivalent.

9. Diving systems and parts thereof whose development is based on new principles and which have not yet been sufficiently tested in practical operation require special approval by the Society.

10. The requirements do not cover diving techniques or procedural requirements for the instruction of diving techniques.

11. Special attention shall be given to Dynamic Positioning system of diving support vessel for diving systems.

602. 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)
d_{max} < 60 msw* T_{op} < 8 hours	d_{max} < 125 msw* T_{op} < 24 hours	None, except those imposed by the requirements and assumptions in the certificate.
Diving Bell(Wet and Closed) HSE unnecessary	Diving Bell(Closed) HES by means of bell allowed	Diving Bell(Closed) Dedicated HSE necessary
* msw is meters of sea water. * T_{op} is the maximum operation time of chambers when a diver lives in chamber * HES is Hyperbaric Evacuation System		

2. Main components of a diving system

A main component of a diving system means the equipment in accordance with **603.** of this chapter.

3. Area subject to explosion hazard

An area subject to explosion hazard means the followings:

Zone 0 : locations in which an explosive gas-air mixture is continuously present, or present for long periods

Zone 1 : gas-air mixture is likely to occur in normal operation

Zone 2 : gas-air mixture is not likely to occur in normal operation and if it does, will exist for only a short time.

4. Decompression chamber

A 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.

5. Living compartment

A living compartment means the part of the surface compression chamber which is intended to be used as the main habitation for the divers during diving operations and which is equipped for such purpose.

6. Diving bell

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.

7. Life support system

A life support system means the gas supply, breathing gas system, surveillance system and equipment required to provide a safe environment for the diver in the diving bell and the surface compression chamber under all possible pressures and conditions to which they may be exposed during diving operation.

8. Umbilical

An umbilical 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.

9. Gas storage cylinder and pressure vessel

A gas storage cylinder and a pressure vessel means a container capable of withstanding an internal working pressure of 1 bar and over which allows gas transfer and storage under pressure.

10. Oxygen systems

Systems intended for a gas with a higher oxygen percentage than 25.

11. Breathing gas or breathing mixture

Breathing gas or breathing mixture means that all gases or mixed gases which are used for breathing of divers during diving operation.

12. Built In Breathing System (BIBS)

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. Diver heating system

A system for actively heating the divers in the water or in the inner area.

14. Environmental Control Unit (ECU)

Environmental Control Unit. Maintains Temperature, reduces humidity and may include removal of carbon dioxide.

15. Hyperbaric Rescue Vessel (HRV)

IMO uses the term Hyperbaric Evacuation Unit (HEU). See above.

16. Mating device

A mating device means that the equipment necessary for the connection or disconnection of diving bell to a surface compression chamber

17. Handling and transfer system

Handling and transfer system means that the plant and equipment necessary for raising, lowering and transporting the diving bell between the work location and surface compression chamber.

18. Hyperbaric Evacuation System (HES)

System for evacuating divers under pressure. This includes the Hyperbaric Evacuation Unit (HEU), the handling and control systems.

19. Fixed diving system

A fixed diving system means a diving system installed permanently on ships or floating structures.

20. Temporary system

A temporary system means a diving system installed on ships or floating structures for a period not exceeding one year.

21. Maximum operating depth

A maximum operating depth means that the depth in metres of seawater equivalent to the maximum pressure for which the diving system is designed.

22. Depth

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.

23. Pressure control system

In relation to diving systems, this is the system for control of the pressure in the various systems, comprising the pressure regulating system, pressure safety system and associated instrument and alarm systems.

24. Pressure regulating system

In relation to diving systems, this is the system which ensures that, irrespective of the upstream pressure, a set pressure is maintained (at a given reference point) for the component.

25. Pressure safety system

The system which, independent of the pressure regulating system, ensures that the allowable set pressure is not exceeded.

26. Construction phase

All phases during construction, including fabrication, installation, testing and commissioning, up until the installation or system is safe and operable for intended use. In relation to diving systems, this includes manufacture, assembly, testing, commissioning and repair.

27. Design life

The initially planned time period from initial installation or use until permanent decommissioning of the equipment or system. The original design life may be extended after a re-qualification.

28. Design temperature, maximum

The highest possible temperature to which the equipment or system may be exposed to during installation and operation. Environmental as well as operational temperatures shall be considered.

29. Design temperature, minimum

The lowest possible temperature to which the equipment or system may be exposed to during in-

stallation and operation, irrespective of the pressure. Environmental as well as operational temperatures shall be considered.

30. 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.

31. Collapse pressure

Characteristic resistance against external over-pressure.

32. Design pressure

In relation to diving system assemblies, this is the maximum internal pressure during normal operation, referred to a specified reference point, to which the component or system section shall be designed. The design pressure must take account of the various pressurised components in the adjoining systems, and their relative design pressures.

33. System test pressure

In relation to diving systems, this is the internal pressure applied to the component or system during testing on completion of installation work to test the diving system for tightness (normally performed as hydrostatic testing).

34. Pressure test

The hydrostatic pressure test, initially performed at the manufacturer of the pressure vessel in accordance with requirements in the design code.

603. Components of diving systems

Where present, the following components from the part of the diving system and are to be designed, constructed and tested in accordance with the Rules.
(1) compression chamber
(2) diving bell
(3) permanently installed gas bottles
(4) pressure vessels for gas storage
(5) pipe, valves, fittings and hoses
(6) umbilicals
(7) breathing gas system
(8) life support system
(9) diver heating system
(10) sanitary system
(11) communication system
(12) control, automation and locating equipment
(13) gas analyzing system
(14) electrical system and equipment
(15) fire prevention, detection and extinguishing equipment
(16) compressor
(17) gas mixers
(18) helium reclaim system
(19) handling, transfer and mating systems
(20) hyperbaric evacuation system

604. Documents and drawings for approval

1. General

(1) 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 including 1 copy for the approval. All corrective actions are to be treated and approved by the Society before they are implemented.
(2) 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. Total system

The following documents are to be submitted:

(1) Diving procedure
(2) Maximum diving or observation depth, as applicable
(3) Maximum operating time
(4) Maximum number of divers per diving bell
(5) Maximum number of divers in system
(6) General arrangement drawings of the diving system (block diagrams)
(7) Installation drawings
(8) Formation drawings showing fixed points
(9) Drawings of supply and disposal systems (water and electricity)
(10) Drawings of consoles showing controls and instrument displays
(11) Test schedule

3. Decompression chambers and ancillary equipment and Pressure vessels for gas storage

(1) For the decompression chambers and pressure vessels, the followings are to be submitted;
  (A) Application of equipment and calculation sheet of strength
  (B) Drawings of general arrangements, assembly and installation including capacities of individual compartments
  (C) Media contained, together with operating pressures and temperatures
  (D) Proposed materials, thermal insulation materials, paints, buoyancy material
  (E) Welding specifications and materials
  (F) Heat treatment
  (G) Manufacturing tolerances
  (H) Non-destructive tests
(2) For the ancillary equipment of decompression chambers, drawings are also to be submitted of individual items of ancillary equipment such as;
  (A) Windows, window flanges, retaining rings, O-rings and gaskets
  (B) Details of valves and fittings
  (C) Bayonet locks
  (D) Coupling clamps
  (E) Integral opening reinforcements
  (F) Supply locks
  (G) Internal facilities

4. Gas supply

For the gas supply, the followings are to be submitted:

(1) Piping diagrams, block diagrams and descriptions are to be furnished for the entire gas supply system, including a list of valves and fittings
(2) Details of the umbilical structure
(3) Description of proposed cleaning procedure for breathing gas system
(4) Details of the gas analysis, including an equipment list
(5) Description of compressors and compressor drives including longitudinal and transverse sectional drawings of the compressors and a workshop drawing of the compressor crankshaft

5. Life support systems

For the life support system, the followings are to be submitted:

(1) Piping diagrams, block diagrams and descriptions of systems and equipment
(2) Calculations of the cooling and heating requirements
(3) Description and drawings of the water supply and disposal system
(4) Description and design details of the diver heating system

6. Automation, communications and locating equipment

For the automation, communications and locating equipment, the followings are to be submitted:

(1) General arrangement drawings/block diagrams of control equipment, including lists of measuring

points
(2) Equipment list covering sensors, indicating instruments etc.
(3) Drawings and descriptions of electronic components such as instrument amplifiers, computers and peripheral units
(4) General arrangement drawings and equipment lists for communications systems and signalling equipment
(5) Arrangement drawing and description of the TV system.

7. Electrical equipment

For the electrical equipment, the followings are to be submitted:

(1) A general arrangement drawing of the electrical equipment containing at least the following information
  (a) Voltage rating of systems
  (b) Power or current ratings of electrical consumers
  (c) Switch gear, indicating settings for short circuit and overload protection, fuses with details of current ratings
  (d) Cable types and cross sections
(2) The energy balance of the main and emergency power supply systems for diving systems with their own generating plant
(3) Drawings of switchgear and distribution equipment
(4) Complete documentation for electric motor drives with details of control, measuring and monitoring systems
(5) Battery installation drawing with details of battery types, chargers and battery room ventilation
(6) Details of electrical penetrations through compression chamber walls
(7) Drawings and descriptions of all electrical components installed in compression chambers

8. Fire protection

For the fire protection, the followings are to be submitted:

(1) A description of the preventive fire protection measures taken.
(2) Details of the fire loads in the system.
(3) Drawings and descriptions of the followings
  (a) Fire detection system
  (b) Fire extinguishing system
  (c) Fire alarm equipment

9. Handling, transfer and mating systems

For the handling, transfer and mating systems, the followings are to be submitted:

(1) A description of the system with details of operating conditions
(2) Installation drawing
(3) Construction drawings of:
  (a) Transfer equipment
  (b) Lifting equipment
  (c) Mating equipment
  (d) Substructures of handling gear, including winches
(4) Detailed drawings of interchangeable components and fittings
(5) Drawings of mechanical equipment items such as winches, drives etc.
(6) Piping and instrumentation diagrams of the hydraulic or pneumatic system, as applicable
(7) Control system diagram and description of safety equipment
(8) Details or ratings and protection class of electrical appliances
(9) Details of hoisting and guide ropes

10. Hyperbaric evacuation system

For the hyperbaric evacuation system, the followings are to be submitted:

(1) Description of system
(2) Arrangement drawing
(3) Construction drawing of evacuation system
(4) Drawing of the handling system, including a description of the power supply

11. Position keeping system

A position keeping system is in accordance with **Ch 4.**

605. Environmental conditions

1. Diving systems together with their accessories and ancillary equipment are to be designed for the environmental conditions likely to occur at the proposed point of installation or work location. As a minimum requirement, allowance is to be made for the following conditions:
2. The inclined positions specified in **Table 9.7.1**
3. The other environmental conditions specified in **Table 9.7.2.**
4. For all systems and components, they shall meet the requirements of sea conditions according to **Appendix 9-5.** **【See Guidance】**
5. For all systems and components, special considerations are to be given to the environmental condition with 1.5 Knots of underwater current. However, additional documents may be required to verify the compatibility in case of 1.5 Knots and above.

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	-	-

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

606. Arrangement

1. Diving systems on ships and other floating structures may only be located and operated in areas not subject to an explosion hazard. In exceptional cases, it is to be in accordance with the discretion of the Society. **【See Guidance】**
2. As far as possible, the area in which the diving system is installed is to be kept free of fire loads. In addition, only those electrical cables needed to operate the diving system should be routed through this area.
3. Diving systems and breathing gas storage facilities shall not be located in engine rooms.

4. Diving systems and breathing gas storage facilities are to be located in spaces which can be adequately ventilated and provided with suitable electric lighting.

5. Where parts of the diving system are located on the open deck, these are to be protected against damage due to other shipboard activities.

6. Supporting structure of pressure vessels for gas storage is to be designed and arranged with 30° fixed inclination within the range which is not exceeding bending stress of 160 fN/mm^2 and shear stress of 90 fN/mm^2. The supporting structure should be capable of withstanding a collision with the weight of half of the pressure vessel.(f : Dynamic Factor, above 1.6)

7. Dynamic factor of 2.2 and above is to be given to the launch and recovery system for diving bells (wet and closed) or diving stage and side structure adjacent to the moon pool should be capable of withstanding a collision with diving systems.

607. Tests and trials [See Guidance]

1. General

(1) Diving systems and their ancillary equipment are subject to constructional and materials tests as well as to pressure and tightness tests and trials. All the tests called for in the following paragraphs are to be performed under the supervision of this Society.

(2) 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]

(3) This Society reserves the right to extend the scope of the tests where necessary and also to subject to test those parts for which testing is not expressly prescribed in this Rule.

(4) After the compression chambers and ancillary equipment have been installed on board, the diving system together with its ancillary plant is to be subjected to functional test. All items of safety equipment are to be tested except where an adequate trial has already been performed on the manufacturer's premises in the presence of the Society's representatives.

2. Decompression chambers, diving bells and components

(1) On completion, decompression chambers and ancillary equipment are to be subjected to a constructional test. The constructional test includes verification that the chambers and ancillary equipment conform to the approved drawings and that the workmanship is satisfactory. All components are to be accessible to allow adequate inspection.

(2) The materials test certificates for the materials used and the reports on the non-destructive testing of welds are to be submitted together with the results of inspections of workmanship and evidence of the heat treatments applied, where appropriate.

(3) A hydraulic pressure test is to be performed prior to insulation and preservation treatment of the decompression chambers. Each decompression chamber compartment is to be tested individually. The walls may exhibit no permanent deformation or leakage.

(4) For decompression chambers and ancillary equipment, the test pressure shall normally be equivalent to 1.5 times the maximum permissible working pressure.

(5) Diving bells (closed) and auxiliary pressure vessels which may be exposed to an external pressure in service are also required to undergo an external pressure test. The external test pressure used shall normally be equivalent to 1.3 times the design pressure.

(6) The weight and buoyancy of diving bells are to be measured and their stability in normal and emergency operation is to be checked. The release of ballast weights and the operation of the device for the emergency release of the hoisting rope and the umbilical are to be tested in shallow water.

(7) Life support systems including decompression chambers, the gas storage supplying to the chambers and diving systems shall be tested for leakage at the maximum working pressure. The test shall be carried out with the gas type which has similar characteristics and equivalent properties. A leakage rate of Less than 1 % of pressure drop in 24 hours for the whole chamber system can be accepted.

(A) Decompression chambers are to be designed so that a pressure increase up to 2 bar in the living compartment of the compression chamber can be effected at a rate of at least 2 bar/min followed by a rate of 1 bar/min.

(B) The gas venting system of a decompression chamber or diving bell is to be designed so that the pressure in a compression chamber or diving bell can be reduced to 1 bar at a rate

of at least 1 bar/min.

(a) Recompression chambers for patient treatment are to be so designed that a working pressure of at least 5 bar can be reached and maintained without fail. Provision is to 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 is to be possible within one minute.

(8) The gas storage facility and the decompression chamber including the gas piping are to be subjected to a airtightness test using air at the maximum permissible working pressure.

(9) Gas bottles are to be checked to determine whether they bear the test date and marking applied by a recognized expert and whether the test period has not yet expired.

3. Decompression chambers and diving bell windows *(2017)*

(1) Each decompression chamber windows are to undergo a hydraulic pressure test which may be performed after installation together with the compression chamber or in a testing device. The test pressure shall normally be equivalent to 1.5 times the design pressure and inspection and tests shall be carried out in accordance with requirements of ASME PVHO-1, 2 in the presence of the surveyor.

(2) After the pressure test, windows may exhibit no scratches, cracks or permanent deformations.

4. Pressure vessels for gas storage and ancillary equipment

(1) Pressure vessels for gas storage and ancillary equipment shall be designed constructed in accordance with **Pt 5, Ch 5** and recognised national and international standards by the Society or the equivalents.

(2) For vessel and apparatus, the test pressure shall normally be equivalent to 1.5 times the maximum permissible working pressure.

5. Compressors

(1) Compressor components subjected to pressure are to undergo a hydraulic pressure test at a test pressure equal to 1.5 times the delivery pressure of the compressor stage concerned.

(2) On completion, compressors are to be subjected to a airtightness test at their maximum working pressure. In addition, a performance test and a purity test are to be carried out in which the final moisture content and any possible contamination of the compressed gas are to be determined. The safety devices are to be checked. **【See Guidance】**

6. Piping systems

(1) On completion of manufacture but before insulation or painting, all piping systems are to undergo a hydraulic pressure test at 1.5 times the design pressure.

(2) For the tightness test is specified in the above **2** (7) and carried out at least for 6 hours.

(3) Wherever possible, all butt welds in LSS piping systems are to be subjected to 100 % X-ray test.

(4) Piping systems for breathing gas and oxygen are to be subjected to a purity test.
【See Guidance】

7. Hoses and umbilicals *(2017)*

(1) Evidence of the bursting pressure of each hose type is to be submitted to the Society. For liquids, hoses may withstand at least 4 times, and for gases at least 5 times, the maximum permissible working pressure.

(2) Each hoes is to be subjected to a hydraulic pressure test at least 2 times the maximum permissible working pressure

(3) For hoses exposed to external pressure, proof is required that a differential ratio of 1.5 between the internal and external pressures can be withstood without failure.

(4) As proof of their mechanical properties, umbilicals are to be subjected to alternating bend tests and rupture tests. In addition, compact umbilicals are to undergo a airtightness test in which all hoses are to be subjected simultaneously to their maximum permissible working pressure and the electrical lines are to be checked for compliance with the specified insulation and impedance values.

8. Life support systems

A functional test is to be carried out to verify the satisfactory functioning of the life support systems under normal and emergency conditions.

9. Automation and communication systems

(1) Indicating and monitoring instruments are to be tested for the accuracy of their readings and their limit value settings.
(2) Automatic control systems are to be checked for satisfactory performance under service conditions.
(3) Norma1 and emergency communications equipment is to be subjected to a functional test. The effectiveness of the helium speech unscrambler is to be demonstrated for the maximum operating depth of the diving system.
(4) Proof is required of the autonomy of the safety systems.

10. Electrical equipment

(1) Electrical machines, components, cables and lines are to be tested in the accordance with **Pt 6**.
(2) Electrical protective devices are to be checked; in addition, an insulation test is to be performed on the electrical equipment in the compression chambers.

11. Fire protection

(1) The fire behaviour of the chamber equipment is to be checked by reference to the relevant test certificates and symbols, as applicable.
(2) A check is to be made as to whether the electrical heating systems and heaters are fitted with protection against overheating.
(3) Fire alarm, detection and extinguishing appliances are to be subjected to a functional test.

12. Various systems

The following systems shall be tested for proper functioning: sanitary/communication/fire protection installation/evacuation systems/diver heating. Other systems onboard the surface installations, significant for the safety of the diving system, are also to be tested.

13. Instrumentation

The correct calibration of all essential instrumentation (depth measuring instruments, gas analysis instruments etc.) shall be checked.

14. Environmental control systems

The limits and accuracy of monitoring system and automatic control system shall be tested. Final set points shall be approved by the Surveyor.

15. Handling, transfer and mating systems

(1) After installation on board, the handling system is to be loaded statically with a test load equal to 2.2 times the working load. In addition, a dynamic load test (braking test) is to be carried out at 1.25 times the working load.
(2) A test is to be performed to ensure that the mating, release, transfer, lowering and raising of the diving bell proceed smoothly and safely under normal and emergency operating condition.
(3) A test is to be performed to verify that the mating device can be released and the diving bell transported only when the trunk is not under pressure.

16. Hyperbaric evacuation system

A functional test is to be performed to demonstrate that the hyperbaric evacuation system is able to convey divers under pressure from the ship or floating structure to a safe position where they can be monitored and supplied.

608. Marking

1. All decompression chambers and diving bells are to be fitted in a prominent position with a permanently mounted name plate containing at least the following details:
(1) Name of manufacturer
(2) Serial number and year of manufacture
(3) Maximum permissible working pressure or operating depth
(4) Test pressure
(5) Capacity (of each chamber compartment)

(6) Maximum permissible number of divers
(7) Date of test and test stamp

2. All pressure vessels for gas storage are to be permanently marked with the following details:
(1) Name of manufacturer
(2) Serial number and year of manufacture
(3) Capacity
(4) Test pressure (bar)
(5) Empty weight (of gas bottles)
(6) Date of test and test stamp

3. Permanently installed pressure vessels for gas storage, gas containers and gas piping systems are, in addition, to be marked with a permanent colour code in accordance with **Table 9.7.3** and with the chemical symbol designating the type of gas concerned. The marking of pressure vessels for gas storage are to be visible from the valve side.

Table 9.7.3 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

4. All valves, fittings, controls, indicators and warning devices are to be provided with identification plates made of a material which is at least flame retardant. The identifying marks are to be clear and unmistakable (e.g. stating the short designation and/or the function of the item concerned).

5. The handling transporting and mating appliances are to be fitted with a prominent and permanently mounted name plate containing at least the following information in easily legible characters:
(1) Name of manufacturer
(2) Serial number and year of manufacture
(3) Static test load
(4) Operational test load
(5) Maximum working load
(6) Date of test and test stamp

609. Sea trials [See Guidance]

Sea trials may be done under unattended persons if deemed necessary by the Society. And while sea trials, the handling system shall be examined by lowering a diving bell (wet, closed and diving stage) with maximum load to maximum operating depth, thereafter it shall be confirmed for the communication system of diving bell and the leakage condition.

Section 7 Gas Cylinders, Decompression Chambers and Diving Bells

701. General

1. The requirements of this Section are applicable to decompression chambers and diving bells (closed) which are used in diving systems and in which persons live in breathable atmosphere at pressures exceeding atmospheric pressure.

2. Diving systems are to be designed in such a way that injured divers can be carried on a stretcher inside the compression chamber system.

3. The documents and drawings for the approval is to be specified in **604.**

4. Tests and marking for the diving system are specified in **607.** and **608.**

702. Conditions in decompression chambers and diving bells

1. Diving systems are to be so equipped that a breathable atmosphere can be maintained in decompression chambers and diving bells (closed) throughout the entire operating period.
2. Facilities are to be provided for keeping the partial pressure of the CO_2 in the chamber atmosphere permanently below 0.005 bar assuming a CO_2 production rate of 22 L/h per diver at 20 °C In diving bells (closed) it is to be possible to keep the partial pressure of the CO_2 below 0.015 bar as a minimum requirement. Under emergency conditions it is to be possible to hold the partial pressure of the CO_2 below 0.02 bar for at least 24 h.
3. Diving systems using mixed gas and designed for operating periods of more than 12 hours at a time are to be capable, under steady conditions, of keeping the temperature in the surface compression chamber constant to 1°C in the 27 ~ 36 °C range while maintaining a relative humidity of at least 50 %.
4. Decompression chambers and diving bells (closed) are to be designed and equipped in such a way that a homogeneous atmosphere (CO_2 and O_2 concentrations, temperature and humidity) can be maintained in the chamber.
5. In the steady state, the permanent noise level (over 8 hours) in the living compartment and surface compression chamber may not exceed 65 dB(A).

703. Decompression chambers, diving bell equipment and fittings

1. The equipment and fittings of decompression chambers and diving bells (wet and closed) are to be suitable for operation in hyperbaric atmospheres. Under these conditions they are not to give off any toxic or strongly irritant gases. The same also applies to protective coatings and paints used inside the chambers.
2. Only incombustible or at least flame retardant materials are to be used in the chambers (refer **1301. 1** or **2**).
3. In addition to decompression chambers, diving bells(wet and closed), diving stage and their main components, equipment and fittings which are supposed to be installed are to be in accordance with the requirements of this chapter.

704. Corrosion protection

1. Diving systems and all their accessories are to be effectively protected against corrosion.
2. Anti-corrosion coatings exposed to the conditions within the chambers are to conform to the requirements specified in **703.** In addition, they may not tend to blister of flake under hyperbaric conditions.

705. Design principles

1. Decompression chambers

(1) Each compression chamber or compartment thereof is to be so equipped that it is fully protected against excessive working pressures and inadmissible pressure drops.
(2) Compression chambers are to be so designed that at least two persons can simultaneously pass in or out through the locks without exposing the other divers in the system to a pressure change. However, it may be dispensed with the discretion of this Society **[See Guidance]**
(3) In diving systems where divers are required to remain under pressure for a continuous period of more than 12 hours and/or for decompression chambers of saturation diving system (DSV-SAT), the living compartment is to be so designed and equipped that persons are able to stand upright in it and each diver is provided with a bunk on which he is able to stretch out comfortably. A toilet and shower are also to be provided. The toilet and shower are to be accommodated in a separate compartment. Toilet facilities capable of discharging the waste to outside are to be

equipped with suitable interlocks to prevent pressure losses in the chamber system.

(4) The living compartment of compression chambers and other compression compartments are to be provided with a lock through which provisions, medicines and equipment items can be passed to and for without exposing the occupants of the chamber to a pressure change.

(5) Locks are to be designed to prevent accidental opening under pressure: if necessary, suitable interlocks are to be fitted.

(6) 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.

(7) 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.

(8) 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.

(9) Each compression chamber compartment is to be provided with view ports enabling all occupants to be observed from inside and outside.

(10) Wherever necessary, compression chamber windows are to be protected against mechanical damage from inside and outside.

(11) Decompression chambers are to comprise at least a main chamber and an antechamber. They should also be equipped with a connecting flange for transportable rescue chambers.

(12) The configuration of the main chamber shall provide space for one person laying down and two persons seated. The number of occupants allowed in the main chamber is to be stated on a plate prominently and permanently fixed above the entrance.

(13) Seats are to be provided in sufficient number for the number of persons admitted. Seats are to be designed to provide each person with a seat width of at least 0.5 m and a seat depth of at least 0.4 m and are to avoid loss of body heat due to contact with cold surfaces.

(14) After deduction for interior equipment, the chamber is to provide at least 0.5 m^3 of space for each person to be accommodated.

(15) The main chamber is to be equipped with means of changing the air.

(16) Each person to be accommodated is to be provided in the main chamber with a source of oxygen supplying at least 75 ℓ/min at atmospheric pressure. The oxygen is to be supplied to the breathing connection via a demand breathing system at the pressure prevailing in the chamber. The exhaled gas may not be introduced in the chamber atmosphere.

(17) Main chamber and antechamber are to be separately supplied with air and oxygen for breathing. Means are to be provided to prevent the pressure in the antechamber exceeding that in the main chamber.

(18) The main chamber is to be equipped with heating. The heating capacity is to be equivalent to at least 0.25 kW per m^3 of chamber volume and is to have at least 3 settings.

(19) The main chamber is to be provided with a supply lock. The dimensions of the supply lock is not to be less than 200 mm in diameter and 300 mm in length. The means of closure of the supply lock are to be inter-locked in such a way that they can on no account open simultaneously. Pressure equalizing apertures are to be safeguarded to prevent them from being rendered ineffective by obstructions. The pressure in the supply lock chamber is to be indicated by a pressure gauge mounted externally close to the lock controls.

(20) The vessel wall of the main chamber is to be fitted with at least one with 80 mm nominal bore flange for later installations.

(21) The main chamber is to be provided with easily accessible means of mounting a pressure gauge for test purposes.

(22) The configuration of the antechamber shall be such that it can accommodate two seated persons.

(23) Each pressurized gas supply and exhaust line are to be fitted with a shutoff valve immediately at the pressure chamber wall. This shutoff valve may be deleted if the connection between the pressure chamber and the line valve is short and well protected.

(24) Decompression chambers are to be so designed and equipped that the noises in the chamber

do not exceed a peak level of 90 dB(A) measured as an A(pulse) acoustic pressure level or an evaluation level (over 3 hours) 70 dB(A).

(25) The interior equipment of decompression chambers should be made of materials which are at least flame retardant. The use of plastics for the interior equipment of chambers is to be kept to a minimum.

(26) Each decompression chamber compartment is to be adequately lit.

2. Diving bells

(1) Each diving bell is to be so equipped that it is fully protected against excessive working pressures and inadmissible pressure drops.

(2) Each diving bell is to be provided with an extra lifting point designed to take the entire dry weight of the bell including ballast and equipment plus the weight of the persons inside the bell.

(3) Close to main lift attachment, the diving bell is to be provided with spare connections for hot water (3/4" NPT female thread) and breathing gas (1/2" NPT female thread). The manifold is to be clearly marked and effectively protected.

(4) Diving bells are to be designed to allow entry and exit even in an emergency.

(5) Diving bells are to be equipped with a device for the recovery of an unconscious diver.

(6) The dimensional design of diving bells is to be such as to provide adequate space for the proposed number of divers and their equipment.

(7) Seating is to be provided for each diver in the diving bell.

(8) Diving bells are to be provided with view ports so that divers working outside the bell can be observed from within the chamber.

3. Doors and access ports

(1) Diving bell hatches and mating devices which are not sealed by pressure are to be fitted with a locking mechanism which precludes opening under pressure. The locking mechanism is to be so designed that the correct closure position is clearly apparent before pressure is applied.

(2) Devices are to be fitted to enable doors to be opened from both sides. Hatch trunks are to be fitted with pressure compensating valves.

(3) The door opening of decompression chamber shall allow the passage of a patient laying flat on a stretcher. Round door openings are to have a clear diameter of at least 700 mm. Doors fitted with an interlock are to be capable of being operated from both sides when the pressure has been equalized. For diving bell lockout/in hatches the clear diameter shall be at least 800 mm

(4) For diving systems with an operational period exceeding 12 hours, the chamber should have a size over to length of 198 cm and breadth of 80 cm.

(5) For decompression chambers except transportable and rescue chambers for 2 people or less, the minimum inner height shall be above the limits as given in the table below:

SUR	170 cm
BOU	183 cm
SAT	200 cm

(6) The length of the bell hatch trunk shall not exceed the diameter.

4. View ports

(1) The following requirements apply to windows made from cast stock of unlaminated polymethyl methacrylate plastics, in the following denoted acrylic plastic, with a design life of 10 years from the manufacturing date, suitable for:

(A) 10,000 load cycles

(B) sustained temperatures in the range -18℃ ~ +66℃

(C) pressurisation or depressurisation rates not exceeding 10 bar/second

(D) use in environments that cannot cause chemical or physical deterioration of the acrylic plastic (i.e. resistant against saltwater and gases used in life support systems).

(2) View ports for decompression chambers and diving bells shall be manufactured and tested in accordance with **Annex 9-2.** 【See Guidance】

5. Air/Oxygen supply and piping system

Air/Oxygen supply and piping system shall be complied with the requirements of this chapter to life support system and piping system, valves, fittings, hoses and umbilicals, etc for the operation of the decompression chamber.

6. Electrical equipment

(1) All electrical equipment including lighting are to conform to **Pt 6** and relevant rules of this chapter.
(2) All electrical equipment is to be safeguarded to prevent overheating.
(3) The lighting in the antechamber and main chamber of decompression chambers and diving bells are to provide nominal illumination of at least 200 lux at the seating level. It is to be possible to illuminate lying surfaces with an illuminance of 500 lux (e.g. by adjustable spotlight).
(4) An emergency power supply is to be provided to illuminate the antechamber and main chamber of decompression chambers, diving bells' lighting, the control console and all consumers necessary to operational safety. In case of mains failure, this is to take over the power supply to the consumers and is to ensure continued operation for at least 5 hours.

7. Control, communications and safety equipment

(1) Indicating and monitoring instruments are to be tested for the accuracy of their readings and their limit value settings.
(2) Automatic monitoring systems are to be checked for satisfactory performance under service conditions.
(3) Normal and emergency communications equipment is to be subjected to a functional test.
(4) Proof is required of the autonomy of the safety systems.
(5) A communication system with loudspeaker is to be provided between antechamber and control console and between main chamber and control console. The communication system is to be permanently switched to "Receive" on the control console, and reversal of the direction of communication shall be possible only by self resetting switches.
(6) A telephone link independent of the mains supply is to be provided in addition to the communication system called for in (5).
(7) At least one emergency signalling system each is to be installed between the antechamber and the control console and between the main chamber and the control console. The signal buttons in the chambers are to be clearly marked and easily accessible.
(8) Control, communication and safety equipment is to conform to the relevant requirements of this chapter for the operation of decompression chambers and diving bells.

8. Fire protection equipment

Decompression chambers and diving bells are to be equipped with suitable fire extinguishing appliances required by this chapter (e.g. deluge system, bucket spray, fire extinguishing blanket).

9. Fire protection

(1) The fire behaviour of the chamber equipment is to be checked by reference to the relevant test certificates and symbols, as applicable.
(2) A check is to be made as to whether the electrical heating systems and heaters are fitted with protection against overheating.
(3) Fire extinguishing appliances are to be subjected to a functional test.

10. Mating systems

A check is to be carried out to verify that the bayonet flange connection cannot be subjected to pressure until the inner ring of the bayonet mechanism has turned fully home, and that the bayonet flange connection cannot be opened until the pressure has been relieve. Furthermore, the pressure relief device of the flange connection is to be checked.

11. Materials

(1) General
(A) The materials for pressure vessels are to be suitable for the proposed application and are to be complied with the **Pt 2, Ch 1**. Unless otherwise specified, the stipulated impact energy is to be verified on ISO V-notch specimens at the following test temperatures:

Thickness(mm)	Test Temp. (°C)
20 or less	0
21 ~ 40	-20
41 ~ 60	-40
Exceeding 60	by agreement with the Society

(B) For parts welded directly to pressure vessel walls, e.g. reinforcing rings, mountings, brackets etc., The use is to be made of materials with guaranteed welding properties which are compatible with the base material.
(C) Welded structures are in accordance with **Pt 5, Ch 5**, recognised national and international standards by the Society or the equivalents.
(D) For corrosion protection is to be in accordance with **704.**

(2) Approved materials
The materials specified in **Table 9.7.4** are to be used for decompression chambers and diving bells.

Table 9.7.4 Approved Materials

Material form	**Pt 2, Ch 1**
Steel plates, section and bars	**302.** Rolled steel plate for boiler **303.** Steel plates for pressure vessels(Inspection for all) **305.** Rolled stainless steels or steel plates in accordance with recognised international standards by the Society.
Pipes	**401.** Steel tubes for boiler and heat exchangers **402.** Steel pipes for pressure piping or pipes in accordance with recognised international standards by the Society.
Forgings	**601.** Forgings (Boilers and Pressure vessels)
Screws and nuts	In accordance with recognized standards approved by the Society
Steel castings	**501.** Steel castings
Non-metals	It is to be in consent of the Society
NOTES : The materials not mentioned in the above, (e.g., Special grain refined structural steels, FRP and etc.) is to be in accordance with the discretion of the Society. **【See Guidance】**	

(3) Material testing
(A) Tests are to be in accordance with **Pt 2, Ch 1**, recognised national and international standards by the Society or the equivalents when it is deemed appropriate by the Society.
(a) all walls subjected to pressure with the exception of small parts such as welding lugs, reinforcing plates, pipe connections and flanges not exceeding 32 mm
(b) forged flanges where the product of design pressure [bar] × nominal diameter (mm) is exceeding 2500 or the nominal bore diameter exceeding 250 mm
(c) screws and nuts of size M 30 and over where made of steels with a tensile strength of more than 500 N/mm^2 and for sizes exceeding M 16 in the case of nuts over 600 N/mm^2 and screws made of quenched and tempered steels.
(B) For all parts not subject to materials testing by the Society, some other proof of the material characteristics such as acceptance test certificates to the related International Standards is to be submitted.
(C) Components such as mountings, brackets and the like which are not subject to materials testing are to be manufactured from materials compatible with their application in accordance with International Standards approved by this Society.

12. Manufacture and construction

(1) Manufacturing process
Technical importance is to be considered in material manufacturing process. Materials whose grain structure has been impaired by hot or cold working are to be heat treated in accordance with **Pt 2, Ch 1**.

(2) Welding
(A) Welding work, approval of company and welder performance qualification test is to be in accordance with **Pt 2, Ch 2**.
(B) In welding work, allocation of weld factor J =1.0 is to be considered.
(C) Reinforcement of cutouts
Due to allowance is to be made of the weakening of walls by cutouts, and reinforcement is to be provided where necessary. The reinforcements are to be integrated with shell or nozzle and the reinforcement pads are not to be used.

(3) Ends
(A) The nuckle area of dished ends is not to be unduly inhibited by fixtures of any kind such as restraining plates, stiffeners etc. Supporting legs may only be fixed to ends which have been adequately dimensioned for this purpose.
(B) Where covers or ends are secured by swing bolts, measures are to be taken to prevent these slipping off.

(4) Nozzles
(A) The wall thickness of nozzles are to be designed to withstand safely any additional external loads. The wall thickness of welded-in nozzles shall be compatible with that of the component into which they are welded. The walls are to be securely welded together.
(B) Pipe connections are to be in accordance with **Pt 5, Ch 6**.

(5) Screws and bolts
(A) Stud bolts screwed directly into the wall of a pressure vessel are to have within the vessel wall a load-bearing length at least equal to the bolt diameter. Bolt holes shall not perforate the vessel wall.
(B) For the testing of screws and bolts, see **Par 11** (3).

13. Calculations

(1) Principles of calculation
(A) Decompression chambers, hatches, locks, windows, suspensions, pressure vessels for gas storage, etc. are to be calculated in accordance with the Rules or International Standards approved by this Society. Diving bells for external pressure are also to be calculated. The collapse loading case is not applicable.
(B) The calculations underlying the dimensional design are to be submitted to the Society. Where the calculations are to be performed by computer, proof of the suitability of the programs is to be furnished to the Society.
(C) Load factors for dynamic loads are to be agreed with the Society.
(D) Allowance is to be made for the fatigue strength of the material. Surface compression chambers and diving bells are to be designed for at least 5000 operating cycles.
(E) For the efficiency of welds, see **Par 12** (2) (B).
(F) The allowance for corrosion and wear is normally 1 mm. This allowance may be dispensed with in the case of plate with a thickness of 30 mm and over and with stainless steels and other corrosion-resistant materials.
(G) The wall thickness of the casings and ends of seamless and welded vessels should not normally be less than 3 mm. A smaller wall thickness may be agreed for tubular and corrosion-resistant vessel casings.

(2) Design data
(A) The design pressure (internal pressure, external pressure) is to be determined by reference to the system specification. Where applicable, allowance is to be made for additional forces. The design pressure is normally the maximum permissible working pressure or the maximum operating depth of the diving system.
(B) For pressure vessels subjected to external excess pressure, the calculation is to encompass the following cases:
(a) Buckling of the unstiffened shell
(b) Buckling of the shell reinforced with light stiffeners
(c) Buckling of the shell reinforced with heavy stiffeners (where applicable, transverse bulk-

heads or ends). The safety factors against elastic buckling are specified in **Pt 1, Ch 5, Sec 5.** of the Rules.

(C) For design temperatures, see **605. 5.**

(3) Permissible stresses

The lesser of the following two values is applicable:

$$\frac{R_{20}}{A}, \quad \frac{E_T}{B} \quad \text{or} \quad \frac{E_T}{B'}$$

R_{20}: guaranteed minimum tensile strength $\mathrm{N/mm^2}$ at room temperature(may be dispensed with for established grain refined steel where $E_T \leq 360\mathrm{N/mm^2}$)

E_T: guaranteed yield point or minimum value of 0.2 % proof stress at design temperature.

A, B, B' : As specified in **Table 9.7.5.**

Table 9.7.5 Safety factor

Material	Operation		Test
	A	B	B'
Ferrite material	2.7	1.7	1.1
Austenitic material	2.7	1.7	1.1
Aluminium	4.0	-	1.1

706. Rescue chambers (transportable for 2 people or less)

1. The general design principle set out in **701.** to **705.** applicable to rescue chambers (transportable for 2 people or less). The following additional requirements **2** to **21** also apply.

2. A supply of compressed air is to be provided for the operation of the decompression chamber which is sufficient to

(1) raise the pressure in the main chamber once and in the antechamber twice from 0 bar to 5 bar excess pressure.

(2) hold an overpressure of 5 bar in the main chamber for 30 minutes with an adequate rate of air change, hold an overpressure of 1 bar in the main chamber for 300 minutes with an adequate rate of air change. The design of the air change system is adequate if it is capable of exchanging 30 litres of air per minute per person at working pressure. In the main chamber it is to be possible to effect the aforementioned pressure rise within 6 minute.

3. The air supply system is also to be equipped with an air compressor at least capable of meeting the air change requirements stipulated in **2.**

4. The capacity of the air compressor called for in **3** may be reduced provided that the Rescue chamber is equipped with an efficient CO_2 absorber and suitable quantities of lime are carried.

5. Notwithstanding **3** an air compressor may be dispensed with if an additional emergency air supply is carried in compressed air containers which corresponds to at least 50 % of the quantity of air specified in **2.**

6. The air supply system is to be provided with an additional inlet for compressed air.

7. The air supplied to the chamber is to conform at least to the purity requirements specified in International Standards recognized by this Society.

8. An oxygen supply of at least 20 $\mathrm{m^3}$ is to be available for oxygen respiration.

9. Rescue chambers are to have an inside length of at least 2.0 m and are to have an access port with a clear diameter of at least 0.5 m.

10. It is to be possible to lodge the diver in the rescue chamber securely enough to prevent injury due to motions during transfer. Suitable restraints are to be provided.

11. The total weight of rescue chamber(excluding divers) may not exceed 250 kg.

12. Rescue chambers are to be equipped with lifting handles, at least two fastening eyes and the necessary hoisting sling.

13. Rescue chambers are to be fitted with a bayonet flange connection to enable them to be coupled to a surface compression chamber.

14. The design must ensure that, in normal operation, the means of closure of the rescue chamber cannot be opened until it is subjected to the same pressure from inside and out.

15. Rescue chambers are to be equipped with compressed air containers with at least 8000 litres air supply. This supply of air is intended for the sole purpose of renewing the atmosphere in the event of an interruption of the normal air supply. Adequate renewal of the atmosphere means 25 L/min per person measured at the maximum pressure in the vessel.

16. Rescue chambers are to be equipped with at least the following controls and monitoring instruments:

(1) Air inlet valve
(2) Exhaust air valve
(3) Pressure gauge (class 0.25) for chamber pressure
(4) Pressure reducing valve, with inlet and outlet pressure gauge, to which the compressed air containers called for in **15** are connected
(5) An additional means of connection, with shutoff device, comprising a suitable high pressure hose at least 1.5min length for connecting the operational compressed air supply to the pressure reducing valve
(6) Measuring instrument for monitoring of the oxygen volume concentration or partial pressure.

17. The controls and indicating instruments are to continue to be capable of being operated or observed when the rescue chamber is coupled to the surface compression chamber. They are to be located close to a window in the vessel in such a way that the operating personnel can observe the occupants of the rescue chamber without having to change position.

18. It is to be possible to adjust the flow of renewal air to at least 25 L/min per person (measured at the chamber pressure) at each pressure stage.

19. For the purpose of scavenging rescue chambers may be operated only with breathing air meeting the purity. Connections for sources of oxygen as per **705. 1** (16) are to be provided.

20. A communication system with loudspeakers are to be provided between the inside of the rescue chamber and the outside controls. On the outside, the system is to 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 to also be equipped with a head set.

21. Rescue chambers are to be provided with a supply lock as per **705. 1** (19)

707. Gas storage cylinders

1. General

(1) For gas storage cylinders installed in decompression chambers and diving bells, etc, a manufacturing process for the material shall be approved by the Society and gas cylinders in oxygen systems supplying breathing air to divers shall be approved and inspected by the Society when:

$$P * V \geq 1.0$$

where,

P : design pressure (bar)

V : volume(m^3)

(2) They shall be designed, constructed and tested according to **Pt 2** and **Pt 5, Ch 6** or recognised international standards.

(3) Corrosion allowance shall be specified according to the intended use of the gas cylinder, but shall be less than 1 mm.

2. Heat treatment

Heat treatment shall follow the requirements given in the Rules or recognised international code or standards.

3. Tolerances and surface conditions

Tolerances and surface condition shall meet the criteria given in the Rules or recognised international code or standards.

4. Production tests

Production tests shall be carried out in accordance with the requirements given in the Rules or recognised international code or standards. For the tests, the Society may require additional references or tests.

Section 8 Pipes, Valves, Fittings, Hoses and Umbilicals

801. General

1. The requirements of this Section apply to piping systems, including valves and fittings, needed for the operation of the diving system and its ancillary equipment. All other pipelines are to conform to **Pt 5, Ch 6**.
2. The documents to be submitted to the Society for approval are listed in **604.**
3. The necessary tests and markings are specified in **607.** and **608.**
4. Pipes are subdivided in three pipe classes in accordance with **Table 9.7.6** and **Pt 5, Ch 6**, recognised national and international standards by the Society or the equivalents can be applied.

Table 9.7.6 Pipe classes

Pipe classes / Medium carried	Class I	Class II	Class III
	Design Pressure P [bar]		
Air, gas, lubricating oil, hydraulic oil, water, brine in refrigerating systems	P > 40	P ≤ 40	P ≤ 16
Refrigerants	-	all	-
Open-ended lines without shut-off such as drains, vent lines, overflow lines and bow off lines	-	-	all

802. Design principles

1. Piping systems

(1) Piping systems are to be constructed and manufactured on the basis of standards generally used in shipbuilding.
(2) Expansion in piping systems is to be compensated by pipe bends or compensators. Attention is to be given to the suitable siting of fixed points.
(3) Means are to be provided for the complete evacuation, drainage and venting of pipelines.
(4) Pipelines which may be subjected in service pressures higher than the design pressure is to be fitted with overpressure protection.
(5) Pipe penetrations in the compression chambers and diving bells are to be fitted with 2 shutoff devices located immediately at the chamber wall. Wherever possible, one of these devices are to be a check valve.
(6) Suction ends in compression chambers and diving bells are to be protected against inadvertent

covering and suction.

(7) For pipelines where high pressure is reduced to low pressure, filtration equipment shall be installed at the high pressure pipes to protect pressure reducing equipment.

(8) Gas lines and electrical cables are to be routed separately.

(9) Pipelines carrying gas or oxygen under high pressure shall not be routed through accommodation spaces, engine rooms or similar compartments.

(10) Pipelines for diving bells shall be equipped with alarming device for over pressure.

(11) Pipelines for mixed gases containing more than 25 % oxygen are to be treated as pure oxygen lines.

(A) Wherever possible, the pressure in oxygen lines is to be reduced at the gas storage facility to a pressure which is still compatible with an adequate gassupply to the diving system.

(B) Oxygen shall be stored and distributed in containers and piping systems exclusively intended for oxygen systems.

(C) Containers for oxygen shall be stored in open air or in rooms exclusively intended for oxygen. The rooms shall be separated from adjacent spaces and ventilated and shall be fitted with an audio-visible oxygen alarm, at a manned control station.

(D) The pressure in the oxygen systems shall be reduced from storage pressure to the minimum pressure necessary for proper operation. The pressure reduction shall be arranged as close as possible to the storage containers. (A maximum pressure of 40 bar will normally be accepted when dmax is less than 350 m.)

(E) Components fitted in oxygen systems shall be of types especially designed and tested for this purpose.

(F) Oxygen shall not be stored or ducted in any form close to combustible substances or hydraulic equipment. Oxygen dumped from the diving system shall be ducted to a safe dumping place.

2. Pipe connections

(1) Wherever possible, pipes are to be joined by full penetration butt welds.

(2) Screwed pipe connections may only be made using bite joints approved by the Society.

(3) Flanged connections may be used provided that the flanges and flange bolts conform to a recognized standard. **[See Guidance]**

3. Valves and fittings

(1) Shutoff devices are to be conformed to a recognized standard. Valves with screw-down bonnets or spindles are to be protected against unintentional unscrewing of the bonnet. **[See Guidance]**

(2) Manually operated shutoff devices are to be closed by turning in the clock- wise direction.

(3) The closed and open positions of functionally important shutoff valves are to be clearly indicated.

(4) Although ball valves may be used for emergency shutoff at the chamber wall, oxygen lines may only be fitted with screw-down valves which are stable to the oxygen and oxygen cleaning shall be carried out.

(5) Hose fittings are to be made of corrosion-to resistant material and are to be so designed that they cannot be disconnected accidentally.

4. Hose lines and umbilicals

(1) Except for umbilicals, non-metal hoses are to be reduced to a minimum and are only to be installed in short lengths.

(2) Hose lines, including their connectors, are to be of proven suitability for the media, pressures and temperatures concerned. When selecting the material, special attention is to be paid to toxicity, incombustibility, gas permeability and, where applicable, to compatibility with oxygen. Only types approved by the Society may be used.

(3) Hose lines for liquids/gases are to be designed for a bursting pressure equivalent to at least 4 and 5 times respectively the maximum permissible working pressure.

(4) Hoses are to be permanently coupled to their connectors.

(5) Systems with hose lines are to be fitted with a device for relieving the pressure before the hoses are disconnected.

(6) Unless equipped with load cables, umbilical hose lines are to be fitted with load relieving devices.

(7) Umbilicals are to be protected against abrasion and damage. Where protective sheathing is used, care is to be taken to ensure that minor leaks cannot lead to an internal pressure build-up.

Metal inserts are to be avoided.

(8) Electrical cables in the umbilical are to be complied with both of the requirements specified in **Pt 6** and ISO 13628-5 or the latest API specification 17E.

803. Materials

1. General requirements

(1) Materials are to be suitable for the proposed application and are to be complied with **Pt 2, Ch 1**, recognised national and international standards by the Society or the equivalents

(2) Welds are to conform to **Pt 2** and **Pt 5**.

(3) Materials for breathing gas systems are not to form any toxic or combustible products.

(4) In oxygen systems, only those materials may be used which are approved for use with oxygen and which are suitable for the proposed operating conditions.

2. Approved materials

(1) Steel

(a) Carbon and carbon-manganese steels may be used for pipes, valves and fittings. Pipes belonging to classes I and II are to be seamless drawn or produced by a welding procedure approved by the Society.

(b) For oxygen lines with an operating pressure of more than 40 bar, use is to be made of high alloy Cr-Ni steels with an aggregate chromium and nickel content of at least 22 %, or of Cr-Ni steels with a chromium content of at least 22 %.

(2) Copper and copper alloys

Copper and copper alloy pipes in pipe classes I and II are to be seamless drawn pipes which meet the requirements **Pt 2, Ch 1**, recognised national and international standards by the Society or the equivalents.

(3) Nodular cast iron, cast steel

(a) Ferritic nodular cast iron valves and fittings are permitted only in special cases.

(b) Cast steel is approved for general application up to design temperatures of 300 °C

(4) Non-metals

Non-metal pipes, valves and fittings are permitted only in special cases.

(5) Other materials **【See Guidance】**

When the other materials are used, it is to be in accordance with the discretion of this Society

3. Material testing

(1) For piping systems belonging to class I and II, the components listed below are to be subjected to tests in accordance with **Pt 2, Ch 1**.

(a) Pipes, bends, fittings

(b) Valve bodies and flanges of nominal bore exceeding 32 mm

(c) Made of steel, cast steel or nodular cast iron where Designed pressure P [bar] × nominal bore [mm] exceeding 2500 or the nominal bore is exceeding 250 mm :

(d) Made of copper alloy where designed pressure P [bar] × nominal bore [mm] is exceeding 1500.

(e) Bolts and nuts of M 30 and above made from steel with a tensile strength above 500 N/mm^2 , 600 N/mm^2 for nuts, and bolts made of alloy or quenched and tempered steels of M 16 and above.

(2) For parts not subject to materials testing by the Society, proof of quality is to be supplied in some other form e.g. Acceptance Test Certificate in accordance with the International Standards recognized by the Society. **【See Guidance】**

(3) Welded joints in pipes of classes I and II are to be inspected in accordance with International Standards recognized by the Society. **【See Guidance】**

(4) Valves and fittings in pipe classes I and II are to be subjected to a hydraulic pressure test at 1.5 times the nominal pressure on the manufacturer's premises in the presence of the Surveyor. The tightness of the closure is to be tested with air at 0.5 bar and at 1.1 times the nominal pressure.

804. Calculation of pipe wall thickness

1. Minimum wall thickness

(1) The minimum wall thicknesses specified in **Table 9.7.7** are to be adhered to unless the strength calculation demands greater wall thickness. Slightly smaller wall thickness can be permitted for pipes manufactured to a recognized standard. 【See Guidance】

Table 9.7.7 Minimum thickness of pipe (mm)

Outside diameter(mm)	Steel	Austenitic steel	Copper	Copper alloys
8 - 10	1.6	1.0	1.0	0.8
12 - 20	1.8	1.2	1.2	1.0
20 - 44.5	2.0	1.6	1.5	1.2
50 - 76.1	2.6	2.0	2.0	1.45
88.9 - 108	2.9	2.3	2.5	2.0

2. Calculation of pipe wall thickness

Calculation of pipe wall thickness is specified in **Pt 5, Ch 6, 102. 6**.

3. Design temperature

The design temperature is the maximum temperature of the medium carried.

Section 9 Compressors

901. General

1. The requirements of this Section apply to compressors, including components, used in diving systems for compressing breathing gases. Where the compressors are electrically driven, the motors and other electrical equipment are to be complied with **Pt 6.**

2. The documents to be submitted to the Society for approval are listed in **604.**

3. Performance tests for compressors shall be carried out according to **607.** and recognised international standards such as BS EN 12021. *(2019)*

902. Design principles

1. Compressors are to be designed for the required delivery rates, types of gas and delivery pressures.

2. Compressors are to be so designed that no lubricating oil can penetrate the gas circuit.

3. Compressors are to be so installed that no harmful gases can be sucked in.

4. Where a compressor is used for the divers air supply, a receiver is to be interposed for the compensation of pressure variations.

5. Oxygen compressors (or booster pumps) are to be installed in separate spaces with adequate ventilation.

6. Compressed air discharged from air compressor must have air purity not exceeding followings and compressed gas discharged from pure oxygen and mixed gas compressor (or booster pumps) shall be complied with other specified requirements decided by the Society.

(1) water 50 mg/m^3
(2) Oil 1 mg/m^3
(3) CO_2 500 ppm
(4) CO 10 ppm

903. Materials

1. The materials of compressor parts are to be suitable for the application concerned. They are to be specified with due attention to the operating conditions and the nature of the gas.
2. Proof is to be furnished of the quality of the materials used for all components under pressure.
3. A materials test is to be performed on the crank shafts of reciprocating compressors with a calculated crank pin diameter of more than 50 mm. Finished shafts are to undergo magnetic particle inspection.

904. Equipment

1. Compressors are to be equipped with adequately designed suction filters, coolers and water separators.
2. Each compressor stage is to be equipped with a pressure relief valve or rupture disc, neither of which can be disabled. This safety device is to be designed and set in such a way that the specified pressure in the compressor stage concerned cannot be exceeded by more than 10 %. The setting is to be safeguarded against unauthorized alteration.
3. Each compressor stage is to be provided with a suitable pressure gauge indicating clearly the final pressure of that stage.
4. Where a compressor stage comprises more than one cylinder and each cylinder can be closed off individually, a pressure relief valve and a pressure gauge is to be provided for each cylinder.
5. Cooling liquid systems with a shutoff device is to be so designed that the specified coolant pressure cannot be exceeded.
6. Dry running reciprocating compressors are to be equipped at each stage with a device which activates a warning signal and shuts down the drive motor if the final compression temperature specified in the operating instructions is exceeded.
7. Diaphragm type compressors are to be equipped at each stage with a diaphragm rupture indicator which shuts down the compressor as soon as damage occurs to the drive or compressor diaphragm.

905. Marking

A manufacturer's data plate containing the following details are to be permanently fixed to each compressor:
(1) Type designation
(2) Manufacturer's name
(3) Serial number
(4) Year of manufacture
(5) Capacity
(6) Delivery pressure
(7) Revolutions per minute.

Section 10 Life Support Systems

1001. General

1. The requirements of this Section apply to components and parts of gas storage facilities, gas distribution, oxygen system, piping system and gas control system which are needed to ensure life support and a safe environment for the occupants of decompression chambers diving bells and diver stages.
2. The documents to be submitted to the Society for approval are listed in **104.**
3. The necessary tests and markings are specified in **105.** and **106.**

1002. Gas supply

1. Gas storage facilities

(1) Each diving system is to be provided with a permanently installed gas storage facility or with a suitable place for the storage of portable gas containers.

(2) The capacity of the gas store is to be such that, for all the planned diving operations, a sufficient number and quantity of gas mixtures are available to supply all the compression chambers, diving bells and divers with an adequate quantity of the correct gases at all operating depths and under normal and emergency conditions.

(3) The gas supply for the provision of emergency breathing gas is to be stored separately in bottles which are not to be opened for normal operation.

(4) The diving bell is to be provided with its own bottles so that the occupants of the chamber can in an emergency be supplied with a sufficient quantity of breathing gas mixture for at least 24 hours at the maximum operating depth. An oxygen bottle for supplementing the oxygen supply is also to be carried on the diving bell.

(5) Oxygen bottles are to be placed in well ventilated positions and may not be stored close to combustible materials.

(6) Spaces in which oxygen is stored are to be separated from the adjoining spaces by bulkheads and decks of Type "A"-60 and are to be arranged to facilitate speedy exit in case of danger.

(7) 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.

(8) The minimum gas storage capacity of fixed installed containers or space for portable containers intended for emergency operations shall be sufficient to the followings:

(A) Pressurise the inner area once and the bell(s) and transfer compartments once more to maximum depth, dmax, with suitable breathing gas, and

(B) For diving systems with an operational time exceeding 12 hours it shall provide suitable gas to pressurise the largest compartment once, to dmax.

(C) Maintain a proper oxygen partial pressure in the inner area and supply for masks for at least:

(a) 24 hours, diving systems with an operational time not exceeding 12 hours or

(b) 48 hours, diving systems with an operational time exceeding 12 hours.

(D) For pure oxygen, the minimum volume may be taken as:

(a) 2 Nm^3 for each diver for a diving system with an operational time not exceeding 12 hours or

(b) 4 Nm^3 for each diver for diving systems with an operational time exceeding 12 hours.

**1 Nm^3 is given as 1 cubic metre of the gas at 0℃ and 1.013 bar standard condition.

(9) For emergency use of masks there shall be sufficient facilities to supply adequate quantities of gases. The facilities shall be capable of providing a relevant delivery rate both at maximum depth and during decompression. minimum adequate quantities may be taken as of followings:

(A) 2 m^3 at the pressure of the inner area with an oxygen partial pressure between 0.18 and 1.25 bar for each diver, and in addition

(B) 15 m^3 at the pressure of the inner area with an oxygen partial pressure between 1.5 and 2.5 bar at depths greater than 18 m, to each of the maximum number of divers in one of the living compartments for diving systems with an operational time exceeding 12 hours.

(10) The storage capacity for emergency gas shall be provided in separate containers, and shall not be included in the containers for current gas supply.

(11) The bell shall have a self-contained emergency gas storage with minimum capacity to supply the following:

(A) 1 Nm^3 oxygen for each diver, and

(B) Suitable breathing gas mixtures. The capacity shall be the greater of the two:

(a) that which is sufficient to empty a bell filled with 40 % water at dmax or that which is sufficient to supply each of the bell divers with suitable breathing gas for 15 minutes.

(b) The gas volume respirated by one diver in 15 minutes may be taken equivalent to 0.8 m^3 at ambient pressure dmax. The minimum gas storage volume, Vg (m^3), of deep mix on the bell considering a minimum overpressure in the containers, and sufficient time for the operations to avoid significant temperature differences, may be estimated as follows:

$$Vg = (V \times Pb) / (Pg - Pb) - 3$$

where

V = volume (m^3) at ambient pressure dmax of the supply to the divers or 0.4 times the internal volume of the bell.

Pg = pressure (bar) in gas storage containers.

Pb = pressure (bar) in the bell corresponding to the depth

(12) Pressure vessels shall be fitted with over pressure relief devices and shut off valves.

(13) Pressure vessels without individual shut-off valves and with: $PV < 50$, installed in groups with a total $PV < 100$, can have a common overpressure relief device and shut-off valve.

p = design pressure in bar

V = volume in m^3 (standard conditions)

(14) For gas storage of breathing gases and oxygen, the pressure relief device shall be a safety valve. Safety valves shall be set to open at a pressure approx. 3 % above the developed pressure at 55℃, based on filling the cylinders at 15℃ to maximum filling pressure. The total relieving capacity shall be sufficient to maintain the system pressure at not more than 110 % of design pressure.

(15) Containers where water can accumulate shall be provided with drainage devices. (e.g. volume tanks and filters)

(16) Gas supply to divers or decompression chambers in low pressure shall be equipped with volume tanks to prevent the failure of the primary supply facility and fluctuation.

2. Gas distribution

(1) General

(A) The gas supply is to be designed so that a pressure increase up to 2 bar in the living compartment of the compression chamber can be effected at a rate of at least 2 bar/min followed by a rate of 1 bar/min.

(B) The gas venting system is to be designed so that the pressure in a compression chamber or diving bell can be reduced to 1 bar at a rate of at least 1 bar/min.

(C) Sets of breathing apparatus which, activated by respiration, supply breathing gas to persons exposed to excess pressures and also remove exhaust gas independently of the chamber atmosphere are to be designed for a gas flow equal to 3 times the required breathing rate per minute (BRM). The required breathing rate per minute depends on the proposed activity and the environmental conditions. When designing the supply and exhaust facilities for breathing masks, the number of persons simultaneously connected to the system is to be allowed for as follows:

Table 9.7.8 Quantity of breathing gas for the number of persons

Number of persons	Quantity of breathing gas (ℓ/min)
1	BRM × 1 × 3.0
2	BRM × 2 × 1.6
3	BRM × 3 × 1.8
4	BRM × 4 × 1.4
5	BRM × 5 × 1.3
6	BRM × 6 × 1.2
7	BRM × 7 × 1.1
8	BRM × 8 × 1.1
z > 8	BRM × z × 1.0

(D) The gas circulating systems are to be so designed that the chamber conditions specified in **203.** are maintained.

(E) Each compression chamber compartment and each diving bell is to be equipped with at least the following gas systems.
- 2 independent gas supply systems for compression which may deliver into a single inlet pipe immediately at the chamber
- 1 chamber exhaust gas system
- 1 built in breathing systems (BIBS)
- 1 mask exhaust gas system
- 1 gas circulating system for maintaining the breathable chamber atmosphere. Where pure oxygen or gas containing more than 25 % O_2 by volume is supplied to the chamber, a separate piping system is to be provided for this purpose.

(F) Valves in gas systems are to be so arranged that a valve leakage cannot lead to an unintended mixture of gases and oxygen or oxygen like gas cannot penetrate into lines intended for other gases. Intersections between oxygen and non-oxygen systems are to be isolated by twin shutoffs with venting valves in between.

(G) Filters and automatic pressure reducers are to be so arranged that they can be dismounted without interrupting vital gas supplies.

(2) Compression chambers

(A) At least one breathing mask is to be provided for each occupant inside each separately pressurized chamber compartment.

(B) The masks are to be connected to the mask gas supply and exhaust gas system either permanently or by plug and socket connectors.

(C) The exhaust gas (exhalation line) side of the masks is to be protected against any inadmissible pressure drop or inadmissible pressure difference.

(D) The supply of gas to the chamber is to be arranged so as to ensure a homogeneous gas distribution inside the chamber is achieved as quickly as possible.

(3) Diving bells

(A) Besides their normal breathing gas supply, an independent reserve gas supply is also to be carried to diving bells and divers.

(B) The supply of breathing gas to the diving bell is to be designed in such a way that, should the diving bell umbilical fail, the reserve chamber supply can be switched manually or automatically to the divers without flowing back into the chamber umbilical.

(C) The divers umbilical system is to be so designed that each diver has his own independent supply.

(D) In the diving bell at least one breathing mask is to be provided for each diver, and this is to be connected to both the normal and the reserve gas supply. Divers masks and helmets with a gas supply may be recognized as breathing masks.

(E) Automatic pressure reducers are to be provided for the breathing masks.

(F) The emergency oxygen supply is to be fitted with a dosage system to enable the oxygen in the diving bell to be maintained at the correct partial pressure.

(G) The diving bell is to be equipped with two independent exhaust gas lines, which is to be arranged to avoid flooding of the electrical equipment. An exhaust gas valve is to be mounted close to the divers exit.

3. Conditioning of chamber atmosphere

(1) Each compression chamber living compartment is to be equipped with an oxygen dosing device and a chamber gas circulating unit in which the CO_2 can be absorbed and the air temperature and humidity can be regulated. The rate of circulation shall be such as to satisfy the conditions specified in **203.**

(2) Each diving system is to be equipped with at least 2 chamber gas treatment units so arranged that they can be switched to adjacent chambers.

(3) Diving bells are to be equipped with a chamber gas treatment unit and also with an autonomous reserve CO_2 absorption unit for emergency use.

(4) Diving bells are to be equipped with a heating system provided with redundant supplies and so designed that the divers in the diving bell and in the water are maintained in a thermal balance. For diving operations at depths greater than 100 m breathing gas pre-heaters are also to be provided for the divers in the water.

(5) Measures are to be taken to enable the divers within the diving bell to be maintained in a safe thermal balance for at lest 24 hours in an emergency.

4. Breathing gas treatment and mixing

The use of closed breathing gas circuits, gas mixing systems for direct breathing gas supply and helium reclaim systems requires the Society's approval.

1003. Control and instrumentation

1. Central control position

(1) Diving systems are to be so arranged and equipped that centralized control of the safe operation of the system can be maintained under all weather conditions.
(2) For monitoring and controlling the diving system, a central control position is to be provided at which all important data relating to the chambers and the operating states of the ancillary equipment are displayed and where the chamber pressures can be controlled and the gases distributed to the various chambers.
(3) At the Central Control Position are to be grouped all the controls needed for the operation of the diving system, including the TV monitoring and communications equipment.
(4) Only those items of equipment may be installed at the Central Control Position which are essential to the operation of the diving system and do not impair its surveillance and control.
(5) The Central Control Position is to be separated from the other spaces in the ship or floating structure by bulkheads and decks of type "A"-60.
(6) The Central Control Position is to be equipped with a separate ventilation system, the intake duct of which is to be routed from an area not subject to an explosion hazard.

2. Instrumentation

(1) Indicating instruments
(A) Instruments for the surveillance, control and operation of the diving system are to be grouped and arranged in the Central Control Position in accordance with the principles of safety technology and ergonomics.
(B) The Central Control Position is to be equipped with suitable instruments for the surveillance of each manned compression chamber compartment and each diving bell. (See **Table 9.7.9**).

Table 9.7.9 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

(C) The instrument indicating the pressures in compression chambers and diving bells are to be accurate to 0.3 % of the whole scale with a maximum deviation of 30 cm water column. All other pressure readings shall be accurate to 1 % of the whole scale.
(D) The Central Control Position is also to be equipped with indicating instruments for the following parameters:
- Pressure of connected breathing gas receivers/bottles
- Pressure downstream of pressure reducers
- Oxygen content in supply lines to:
- Umbilical, Chamber compartments, Breathing masks in chambers.

(E) Inadmissible deviations from the reference values of the vital parameters shall actuate a visual and audible alarm at the Central Control Position. Automatically actuated switching oper-

ations in the gas supply system and similar functions shall also trip such alarm.

(F) The compartments of compression chambers are to be fitted with pressure and temperature gauges which can be read from inside. Diving bells are to be equipped with instruments indicating the internal and external pressure and the pressure of the independent gas supply. In addition, the diving bell is to be equipped with an autonomous unit for monitoring the oxygen and CO_2 levels.

(G) Pressure gauges connected directly to the compression chamber system are to be fitted with a shutoff valve.

(2) Analyzing equipment

(A) Each diving system is to be equipped with at least one oxygen and one CO_2 analyzing system.

(B) Throughout the entire operating period, the oxygen analyzing system may give a reading accurate to ±0.015 bar partial oxygen pressure.

(C) Throughout the entire operating period the CO_2 analyzing system may give a reading accurate to 0.001 bar partial CO_2 pressure.

(D) In addition, autonomous instruments for monitoring the oxygen and CO_2 levels are to be provided in diving bells and the living compartments of compression chambers.

(E) Where gases other than air, helium-oxygen mixtures or $He/N_2/O_2$ mixtures are used for diving operations, the instrumentation required shall be agreed with the Society in each case.

(F) A system is to be provided for analyzing the chamber atmosphere for impurities such as CO, NO, NOx and hydrocarbons. Test tubes may be recognized for this purpose.

3. Control equipment

(1) The Central Control Position is to be fitted with controls for at least the following functions:

(A) Pressurization and pressure control for each compression chamber compartment capable of independent operation and for each diving bell

(B) Decompression of each compression chamber compartment capable of independent operation and of each diving bell

(C) Pressure equalization between chamber compartments

(D) Supply of oxygen to the chamber compartments

(E) Control of gas supply to breathing masks

(F) Control of temperature and humidity in compression chambers

(2) To the gas distribution control position is to be fitted a mimic diagram showing the functions of the various valves and the different gas lines in colour.

(3) Chamber temperature control systems shall be able to control the temperature according to the minimum duration of stay for each diving condition and the temperature control range is as follows:

Temperature	Max. duration of stay
over 40℃	Not allowed.
34.4 ~ 40℃	2 hrs.
29 ~ 34.4℃	6 hrs.
below 29℃	No limits.

Section 11 Automation, Communication and Locating Equipment

1101. General

1. The requirements of this Section apply to the construction and use of surveillance, control, communications, TV monitoring and locating equipment in diving systems.

2. The documents to be submitted are listed in **604.**

3. The necessary tests and markings are listed in **607.**

1102. Automation

1. Design principle

(1) All equipment for the automatic surveillance and control of diving system operating parameters is to be designed and constructed so that it works properly under the design and environmental conditions specified for the diving system.
(2) All items of surveillance and control equipment are to be clearly inscribed and identified.
(3) Indicating instruments and synoptic displays are to be designed and inscribed in such a way that they can be read quickly and clearly.
(4) Any fault or failure which may occur in the automation system shall not provoke a critical operating condition in the compression chamber or diving bell.
(5) As far as possible, automation equipment is to be safeguarded against faulty operation.
(6) Automation equipment are to be compatible with the operating conditions of the diving system.
(7) Any inadmissible variations in the operating parameters must actuate an automatic/visual and audible) alarm at the Central Control Position. The same shall also occur in the event of automatic switching operations in the gas and power supply systems or faults in the control and surveillance system.
(8) In addition to electronic control and surveillance equipment, independent safety devices are to be fitted which prevent a fault in one system from provoking an improper response in another system.
(9) Automatic surveillance and control equipment is to be capable of being switched to manual operation at all times.
(10) The response values of automation equipment are to be so coordinated with each other that, when a threshold is reached, a warning is initiated, followed, after a certain warning period or if the process variable continues to change at a preset speed, by the actuation of safety devices.
(11) The integral operation of automation systems are to be designed to take account of the lags and time constants of the units and elements making up the system (e.g. by allowing for the length and cross section of piping systems and the response times of gas analyzers).
(12) It is to be possible to check the function of important indication lamps during operation.

2. Construction

(1) Electronic automation systems should comprise easily replaceable assemblies, of the plug-in type wherever possible. Standardization of units is to be encouraged and the number of assembly types is to be kept small in order to minimize the spare parts inventory.
(2) Plug-in cards are to be clearly marked or coded to prevent inadvertent confusion.
(3) Measures are to be taken to prevent condensation inside electronic units, even when switched off. Shutdown heating is recommended.
(4) Wherever possible, automation equipment should be capable of operation without forced ventilation. Any cooling system used is to be monitored.
(5) Components are to be effectively secured. Any mechanical loading of wires and soldered connections due to vibration or jolting is to be reduced to a minimum.
(6) The construction of systems and units is to be simple and straightforward. Good accessibility is to be ensured to facilitate measurements and repairs.

3. Circuitry

(1) Signalling equipment and control systems with a safety function are to be designed on the fail-safe principle, i.e. faults due to short-circuit, earthing or circuit breaks shall not be capable of provoking situations hazardous to personnel and/or the system. In this respect, it is to be assumed that faults occur singly. The failure of one unit, e.g. due to short-circuit, shall not result in damage to other units.
(2) In stored program control systems, the electrical characteristics of the signal transmitters shall conform to the safety requirements for instruction and control devices.
(3) Instruction and control units for safety functions, e.g. emergency stop buttons, are to be independent of stored program control systems and shall act directly on the output unit, e.g. the STOP solenoid.
(4) Stored program control systems are to be reactionless and, in case of fault, should cause no malfunctions in program independent safety interlocks or stepped safety circuits for fixed subroutines.
(5) Freely accessible potentiometers and other units for equipment trimming or operating point settings are to be capable of being locked in the operation position.

(6) Interfaces with mechanical switchgear are to be so designed that the operation of the system is not adversely affected by contact chatter.
(7) Conductive tracks forming part of circuits which extend outside the enclosure housing the circuit boards are to have qualified short-circuit protection, i.e. in case of an external short-circuit only the safety devices provided may respond without destroying the conductive tracks.
(8) The equipment is not to be damaged by brief over voltages in the ship's power supply, due for example to switching operations. The design is to allow for over voltages equal to approximately 2.5 times the rated voltage and lasting 1 ms. Where systems are supplied by static converters, it may be necessary to make allowance for periodic voltage pulses lasting about 0.5 ms. The pulse amplitude depends on the converter type and is to be investigated in each case.

4. Power supply

(1) Main units for automation equipment must contain at least one short circuit protection and one overload protection device.
(2) The reference conductor system is to be designed to preclude circuit breaks as far as possible. This may, for example, be achieved by duplicating exposed reference conductor joints and connections.
(3) Automation equipment must be capable of reliable operation under the conditions of voltage and frequency variation specified in **Pt 6. Ch 2**.

5. Tests

Automation equipment of novel design must have been type tested by this Society. The nature and scope of the type test will be determined by this Society in each case.

1103. Communication equipment

1. Voice communication systems

(1) Diving systems are to be equipped with a suitable communication system providing direct voice communication between the control stand and
(A) Divers in water
(B) Diving bell
(C) Each compartment of the chambers
(D) Diving system handling position
(E) Dynamic positioning room and bridge.
(2) In diving systems using helium, gas mixtures, each compression chamber compartment and the diving bell are to be connected to a speech unscrambler. The unscrambling devices should be designed to achieve maximum noise suppression and the automatic compensation of sound level fluctuations.
(3) It is recommended that the Central Control Position should be equipped to record all voice communications with the divers.
(4) Voice communications between the compression chamber compartments and the Control Position and between the diving bell and the Control Position must be provided by a communication system with loudspeaker which is permanently switched to 'Receive' on the control console. Switches for reversing the direction of communication must be of the self-resetting type. In addition, each compression chamber compartment is to be provided with at least one headset.
(5) A telephone link independent of the mains power supply must also be provided in addition to the communication system specified in (4).
(6) Electrically powered voice communication systems shall be provided with a reliable power supply. This normally means that the equipment shall be supplied from a storage battery with a parallel connected main units and battery charger supplied with energy.
(7) In wet rooms microphone and receiver systems must be constructed to prevent the penetration of water. Where considerations of design render this impossible, the penetration of water shall not permanently impair the serviceability of the equipment.
(8) Microphone and receivers in diver's masks and helmets are to be functionally separated from each other.

2. Television surveillance equipment

(1) If the divers are to stay more than 12 hours in the chamber, television surveillance equipment is to be fitted

(2) The number of cameras and their viewing angles shall be selected so as to give, wherever possible, a complete picture of the whole interior of the chamber under surveillance.
(3) A sufficient number of TV monitors must be provided. Each TV monitor must indicate clearly which space is being viewed at any time

3. Other signalling systems

(1) Diving bells are to be equipped with an independent underwater communication systems for use in emergencies.
(2) Suitable alternative communication equipment (e.g. a 3-button signalling system) is to be provided in all compression chamber compartments and in the diving bell.

4. Emergency location and communication *(2017)* **[See Guidance]**

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 Code of Safety for Diving Systems, IMO A.536(13)** and its revision **A.583(14).**

Section 12 Electrical Equipment

1201. General

1. The documents to be submitted to the Society are listed in **604.**

2. The necessary tests and markings are specified in **607.** and **608.**

1202. Design principles

1. General principles

(1) All electrical systems and equipment are to be constructed and installed in such a way that they are serviceable and perform satisfactorily under the design conditions specified for the diving system.
(2) Provision must be made for maintaining the diving system in a normal operating condition without recourse to the emergency power supply.
(3) Even under emergency conditions, the operation of equipment important to the divers safety must be guaranteed.
(4) Measures must be taken to exclude any electrical hazards either to divers or to personnel operating diving systems.
(5) All the electrical operations shall be designed to minimize hazards including fire, explosion, electric shock, fume release and galvanic corrosion of pressure vessels etc.

2. Materials and insulation

(1) The materials used in the construction of electrical machines, cables and apparatus must be resistant to moist and salty sea air, seawater and oil vapours. They may not be hygroscopic and must be flame retardant and self extinguishing. In addition, materials installed inside compression chambers and diving bells must be approved for operation in hyperbaric atmospheres and shall not liberate toxic gases or fumes under these conditions.
(2) Materials with high tracking resistance are to be used for the supports of live parts. Leakage paths and air gaps are to be calculated in conformity with International Standards recognizes by the Society. **[See Guidance]**
(3) Materials and insulations for electrical equipment used in water are to be agreed with the Society in each instance.

3. Supply systems

(1) Approved supply systems are:
(A) Direct current and single-phase alternating current: 2 conductors insulated from ship's hull
(B) Three-phase alternating current: 3 conductors insulated from ship's hull.
(2) The use of the diving system, the ship's hull or parts thereof for the return of electrical current

is not permitted.
(3) Systems earthing is not permitted. Exceptions may be allowed in the case of subsystems using isolating transformers and high-resistance systems earthing.

4. Maximum permissible operating voltages

(1) The following maximum voltages are permitted for electrical equipment inside compression chambers (only in dry chamber compartments):
(A) For permanently installed electrical drives and heating systems: 250 V
(B) For lighting networks and socket circuits, communications and display equipment and all consumers supplied via cables not permanently installed: 30 V
(2) 30 V is the maximum permissible voltage for all electrical equipment in diving bells and wet chambers.
(3) Voltages higher than those specified in preceding (1) and (2) may be approved where additional safety measures are taken which afford an equivalent level of safety.
(4) The permissible voltages for electrical equipment used in water are to be agreed with the Society in each case.

5. Protective measures

(1) All electrical equipment is to be protected in accordance with **Pt 6**.
(2) To protect divers against excessive contact voltages and electric shock, additional safety measures are to be taken to avoid or restrict dangerous fault currents. These measures are to be agreed with the Society in every distance.

1203. Power supply

1. Principles

(1) All electrical equipment important to the safety of divers and diving operations is to be connected to a mutually independent main and emergency power supply.
(2) Where provision is made for automatic switching from the main to the emergency power supply, each such switching operation must actuate in the diving system control room a (visual and audible) signal requiring acknowledgement. An indicator must show which supply is connected.
(3) The main power supply to the diving system can be taken direct from the main switchboard of the support vessel or from the main power source of the diving system.
(4) The following may be used as an independent emergency power source:
(A) An electrical generator with its own drive
(B) An emergency battery of sufficient capacity
(C) The emergency power supply of the support vessel provided that this is designed to meet the additional emergency power requirements of the diving system.
(5) The emergency power source for the diving system must be installed in a space separated from the main power source and the main switchboard so that it remains operational in case of a fire or other major damage affecting the main power supply.

2. Main power supply

(1) A power balance must be prepared to prove that units for the generation, storage and conversion of electric power are adequately rated. This balance shall take account of the full power consumption of those consumers which are permanently required in service.
(2) The power consumption of consumers which are connected for limited periods may be determined by applying a simultaneity factor.
(3) Evidence is required of the availability of reserve capacity to meet the power requirements during brief peak loads, e.g. when motors are started automatically.
(4) The main power supply must be designed to ensure that an adequate supply of energy to all consumers important to the operation of the diving system can be maintained should a generator or its prime mover fail.
(5) The generating equipment of the main power supply is to be so designed that the voltage and frequency variations allowed by the provisions of **Pt 6.**

3. Emergency power supply

(1) The emergency power supply must be able to meet the emergency power requirements of the diving system for a period of at least 48 hours.
(2) The emergency power supply must be able to meet simultaneously the requirements of at least

the following items of equipment:
(A) Emergency lighting systems in compression chambers and diving bells
(B) Emergency communication systems
(C) Emergency life support systems
(D) Emergency diving system handling equipment
(E) Emergency surveillance and alarm systems.
(F) Control and handling system

(3) In the design of the emergency power supply system, appropriate reserve capacity is to be provided to meet peak loads (e.g. caused by the starting of electric motors). In determining the necessary battery capacity, allowance is also to be made for the cut off voltage and voltage drop of battery.

(4) Diving bells are to be equipped with their own independent emergency power supply capable of meeting the power requirements of the autonomous life support system of the diving bell for at least 24 hours.

4. Storage batteries

(1) When installing storage batteries, the relevant provisions of **Pt 6, Ch 1**.

(2) In the case of battery installations equipped with a catalytic converter which ensures that at least 95 % of the hydrogen produced is recombined, separate ventilation of the battery room can be dispensed with. The same applies when gastight battery casings are used.

(3) When using none lead-acid type batteries, they shall be either type approved by the Society or proved with test reports and operation data, which guarantee technical specifications and reliability.

1204. Power distribution

1. Distribution and switchgear

(1) Electrical distribution systems are to be so designed that a fault or failure in one circuit cannot impair the operation of other circuits or the power supply.

(2) The following consumers at least are to be supplied via individual circuits equipped with all necessary safety devices and switchgear from a distribution panel supplied direct from the main switchboard of the support vessel:
(A) The diving system handling equipment on the support vessel
(B) The compression chamber and diving bell lighting system
(C) The electrical consumers of the life support systems
(D) The communication systems.

(3) In normal operation the emergency power distribution system may be supplied via a transfer line from the main power distribution system.

(4) Distribution boards with their own individual feed circuits may not be mounted in a shared casing, i.e. each of these switch gear units must have its own enclosure.

(5) Effective measures are to be taken to prevent the occurrence of vagabond voltages inside switch gear. Circuits at protective low voltage may not be routed with circuits at higher voltage in a joint conductor bundle or cable duct. Terminals for different voltage levels are to be arranged separately and are to be clearly identified.

(6) The test of Switchgear units is to be in accordance with **Pt 6**.

(7) Emergency source of power shall be supplied within 45 seconds when blackout occurred, and transfer to emergency source of power shall be alarmed. In addition, recovery to normal source of power shall be carried out manually.

2. Switching and protective devices

(1) Each circuit is to be protected against overload and short-circuit.

(2) All consumers circuits are to be fitted with switches. The switching action must be on all poles.

(3) Electrical switches for circuits with a current rating above 0.5 A are permitted inside compression chambers and diving bells only subject to the use of additional safety features (such as pressurized enclosure in protective gas).

(4) Electrical fuses may not be located inside compression chambers and diving bells. Wherever possible, fuses for the independent emergency power supply to the diving bell are to be located outside the chamber. If installed inside the diving bell, special protective measures are necessary.

The fuses shall in any case be protected against intervention by the occupants of the chamber.

(5) Electric motors installed inside chambers are to be fitted with an over current alarm. The alarm must be tripped in good time before the motor protection responds. This does not apply to those electric motors which cannot be endangered by over current. For motors in the diving bell, the alarm may take place in the diving bell.

(6) Devices are to be fitted which, in the event of danger, enable the power supply to all the electrical consumers in the compression chamber to be quickly disconnected. The switches needed for this purpose are to be mounted at the Central Control Position. Means must be provided to enable the disconnection separately for each chamber.

(7) All unearthed distribution systems, including the groups of consumers and individual consumers supplied via isolating transformers, safety transformers, rectifiers and inverters, are to be equipped with a continuously operating insulation monitoring system. For systems using protective low voltage, an alarm must be actuated at the Central Control Position if the insulation value drops below a preset limit. For higher voltage systems, the insulation monitor must trip an alarm at the Central Control Position when a predetermined fault current is reached, and the system concerned must be automatically disconnected. For the electrical equipment of the diving bell, the alarm actuated by the insulation monitoring system may take place in the diving bell.

3. Enclosures for electrical equipment

(1) All items of electrical equipment belonging to a diving system are to be encased or sealed in a suitable enclosure compatible with their nature, location and protection class.

(2) The enclosures of electrical equipment installed inside compression chambers and diving bells or operated in water must have been approved by the Society.

(3) Pressure tight enclosures inside compression chambers and diving bells are to be tested at 1.5 times the maximum working pressure of the chamber. Enclosures mounted on the outside of diving bells are to be tested at 1.3 times the design pressure of the diving bell.

4. Earthing

(1) Diving bells are to be equipped with an earthing and potential equalizing system. Connections for external earthing are to be provided in all chambers.

(2) The connections between the earthing conductor and the chamber and to the ship's earth are to be made with corrosion resistant screw unions effectively safeguarded against accidental loosening. The dimensions of the screw unions are to be compatible with the requisite cross sections of the earth conductor to be connected and may not be used for other purposes.

(3) All metal parts of electrical installations with the exception of live components are to be earthed. The casings of electrical equipment mounted directly against the inside wall of compression chambers and diving bells are considered to be effectively earthed only if the contact surfaces are permanently free from rust, scale and paint and the casings are fastened with at least two corrosion-resistant screws secured to prevent accidental loosening. If these conditions are not met, earthing must be effected by separate earthing conductors.

(4) The casings of electrical equipment in water are always to be earthed by an earthing conductor included in the supply cable. Where this is not possible, casings mounted on the outside of the diving bell may also be provided with a separate external earth. In this case, however, the entire earth connection (connecting screws and earthing conductor) is to be corrosion resistant.

(5) Earth connections must be accessible for maintenance and inspection. Wherever possible, they are to be marked. Earthing conductors in multi-core cables are to be marked green and yellow, at least at the terminals.

(6) Earthing conductors are to be provided with corrosion protection compatible with their place of installation.

(7) Copper earthing conductors are subject to the following minimum cross sections:

(A) External connections on ship and water : 10 mm^2

(B) External connections inside chambers and living compartments : 6 mm^2

(C) Separate earthing conductors inside switchgear and casings : 4 mm^2

(D) Earthing conductors in multi-core cables up to a conductor cross-section of 16 mm^2 must correspond to the cross-section of the main conductor subject to a minimum of 1 mm^2

(E) Earthing conductors in multi core cables with a conductor cross-section of more than 16 mm^2 equal to at least half that of the main conductor. If other materials are used, the minimum cross-section is to be determined by the ratio of the electrical conductivity of these materials to the electrical conductivity of copper.

(8) Cable sheaths and armouring may not be used as earthing conductors.

5. Cables and lines

(1) Cables and lines for diving systems must be suitable for the proposed application. Their use is subject to approval by the Society.
(2) The selection, dimensions and installation of cables and lines shall comply with the provisions of **Pt 6**.
(3) In addition, the materials of cables and lines inside compression chambers and diving bells and in water must meet the requirements specified in **1202. 2**
(4) Underwater cables and lines must be designed for an external hydrostatic excess pressure equal to 1.3 times the maximum permissible operating depth. The pressure resistance is to be verified by pressure testing each made up length after the connectors have been fitted.
(5) Electric umbilicals are to be tested in the manufacturer's works in the presence of the surveyor.
(6) In cables for winding on drums, no mechanical forces may be transmitted by electrical components of the cable.

6. Electrical penetrations in compression chamber walls, underwater plug connections

(1) Penetrations in compression chamber walls must be gas and watertight. Their tightness must be guaranteed even should the connected cables be damaged or shorn off.
(2) Compression chamber wall penetrations and underwater plug connections must have been type tested. Type testing is performed, on application, in the manufacturer's works and comprises at least the following individual tests:
(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

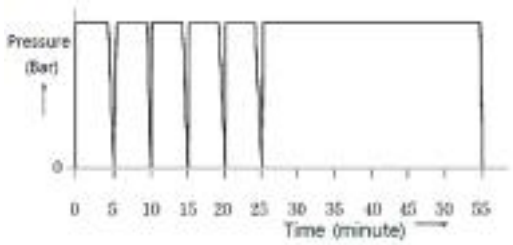


Fig 9.7.1 Test pressure/time curve

(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 2 times 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 MΩ. 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.
(3) 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.
(4) The necessary test conditions applicable to plug connections in medium voltage systems are to be agreed with the Society in each case.

7. Interior lighting in compression chambers and diving bells

(1) Each decompression chamber compartment and each diving bell is to be equipped with a suitable normal and emergency lighting system.
(2) The emergency lighting system is to be designed and installed in such a way that a diver inside the chamber is fully able to take readings and operate controls in every compartment.
(3) Safeguards against the bursting of light fittings are to be agreed with the Society in each case.

Section 13 Fire Protection and Extinction

1301. General

1. The requirements of this Section apply to the fire protection of diving systems holding this Society class which are permanently or temporarily installed on a ship or similar floating structure.

2. The documents to be submitted to the Society for approval are listed in **604.**

3. The necessary tests and marking are specified in **607.** and **608.**

4. Structure, knob, paint, furniture of diving systems shall be complied with IMO Res.MSC61(67) (FTP Code) and other recognised international standards.

1302. Structural fire protection

1. 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 provisions of the **1974 International Convention for the Safety of Life at Sea.**
(2) In the areas of installation of the diving system, the gas storage facility and the control room, sources of ignition and fire loads must be reduced to a minimum. As far as possible, materials which are at least flame-retardant are to be used. Heat insulation is to be made of incombustible materials.
(3) Diving systems on ships and other floating structures may only be installed and operated in areas not subject to an explosion hazard in accordance with **606.**
(4) Where diving systems or parts thereof are installed in enclosed spaces, these spaces are to be separated from the deck and the rest of the ship by partitions of type **'A'-60.**
(5) Enclosed spaces for diving systems or parts thereof are to be provided with a forced ventilation system capable of effecting at least 8 changes of air per hours. The air must be drawn from an area not subject to an explosion hazard.

2. Interiors of compression chambers and diving bells

(1) As far as possible, all materials used in compression chambers or diving bells must be at least flame retardant (for the purpose of this Rule, 'flame retardant' refers to materials which do not continue to burn spontaneously in a compressed air atmosphere of at least 6 bar).
(2) As far as possible, fire loads and sources of ignition are to be avoided. Electrical heating appliances and heaters are to be fitted with protection against overheating.
(3) Components and materials are to be selected with a view to minimizing the danger of static charges.

1303. Fire surveillance

1. Fire detection and alarm systems

(1) Interior spaces containing diving equipment such as surface compression chambers, diving bells, gas storage facilities, compressors and control stands are to be monitored by an automatic fire detection system.
(2) The occurrence of fire must be signalled visually and audibly in at least one permanently man-

ned control room.
(3) The fire alarm may be actuated manually from the permanently manned control room or may be automatically activated by the fire detection system.

2. Fire detection systems

(1) Fire detection systems including central fire detection stations, fire detectors and the wiring of the detection loops require the approval of this Society
(2) Fire detection systems must be so constructed that any fault, e.g. supply failure, short-circuit or wire breakage in the detection loops, or the removal of a detector from its base triggers a visual and audible signal at the central fire detection station.
(3) The design and arrangement of fire detection and alarm systems are to conform to **Pt 6**.

1304. Fire extinguishing systems

1. Area of installation of diving system

(1) Every ship or floating structure on which a diving system is installed must be equipped with a general water fire extinguishing system as well as with portable and mobile fire extinguishers and extinguishing equipment in accordance with **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.
(3) For pressure vessels installed on the open deck, cooling by means of fire hoses connected to the general fire extinguishing system is permitted.
(4) Interior spaces containing diving systems or parts thereof are to be additionally equipped with approved manual fire extinguishers. One of the portable fire extinguishers shall in every case be situated close to the entrance to the space concerned.

2. In compression chambers

(1) Each compartment of a surface compression chamber is to be equipped with suitable means for extinguishing a fire in the interior by providing for the rapid and efficient distribution of the extinguishing agent to any part of the chamber.
(2) The fire extinguishing system is to be designed and constructed in such a way that it can safely deal with every conceivable outbreak of fire under all the environmental conditions for which the diving system is designed. Actuation of the fire extinguishing system may not cause any unacceptable pressure drop inside the chamber. The extinguishing system may be actuated by hand. It must at all times be possible to stop the extinguishing operation from the chamber and from the control room.
(3) Water is the preferred extinguishing agent. Extinguishing agents with a toxic or narcotic effect are not permitted.

1305. Other fire protection equipment

Diving system control rooms are to be equipped with at least one independent compressed air respirator of approved design having an operating capability of at least 30 minutes and fitted with equipment for voice communication with the divers.

Section 14 Handling, Transfer and Mating Equipment

1401. General

1. The requirements of this Section apply to all equipment for the handling, transfer and mating of the diving bells of diving systems.
2. The documents to be submitted to the Society are listed in **604.**
3. The necessary tests and markings are specified in **607.** and **608.**

1402. Design principles

1. Diving systems are to be provided with handling and transfer equipment capable of ensuring the safe transfer of the diving bell between the work location and the surface compression chamber
2. The handling system shall provide means for the safe and easily controllable transport of the diving bell.
3. For the eventuality of single component failure in the main handling system, an alternative means is to be provided to enable the divers to be brought back to the surface compression chamber. This alternative system must be supplied with power independently of the main handling system. In addition, provision is to be made for emergency retrieval of the bell should both the main and alternative systems fail. Diving bells whose emergency ascent is initiated by the release of ballast must be equipped with devices for releasing the hoisting and lowering strength member/umbilical and the ballast weight. The equipment shall be so designed that two mutually independent operating actions have to be performed inside the chamber to initiate the release of ballast. After release of the ballast weights, the diving bell, at its maximum service weight and with its trunk flooded, must exhibit a positive buoyancy equal to at least 3 % of its displacement at maximum operating depth. In these circumstances, the bell should have sufficient stability to maintain a substantially upright position.
4. The mating system shall enable the connection and disconnection of the diving bell and surface compression chamber to be effected easily and securely even under conditions where the support ship is rolling, pitching or listing to predetermined degrees.
5. Where a power actuating system is used for mating operations, an auxiliary power actuating system or an appropriate means is to be provided to connect the diving bell to the surface compression chamber in the event of failure of the normal power actuating system.
6. The mating system is to be provided with a safety interlock between the diving bell and the surface compression chamber.
7. Handling system shall be arranged for automatic stop when the operating handle is not operated.
8. Hoisting systems shall be fitted with a mechanical brake, which shall be engaged automatically when the hoisting motor stops. In the event of failure of the automatic brake a secondary means shall be provided to prevent the load from falling.

1403. 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 tape 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 ex-

ceed 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 **Annex 9-5**.

7. Rope tension shall not exceed the design load below.
   (1) Wire rope's safety factor is 4 times design load factor. (Design load shall not exceed 1.5 times working weight.)
   (2) Synthetic fiber's safety factor is 5 times design load factor.

1404. Construction

1. The handling system must be provided with suitable means for preventing any excessive rotation of the diving bell (e.g. non-spin rope).

2. The use of fibre ropes is permitted only in special cases with the consent of the Society

3. Precautions are to be taken to prevent the diving bell from jarring against the ship's hull or the handling gear.

4. 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.

5. The driving power of the handling system is to be sufficient to lift 1.5 times the working load.

6. Before assembly, all interchangeable components are to be subjected to individual component load testing.

7. The rupture strength of ropes is to be verified by a full tensile breaking test.

Section 15 Hyperbaric Evacuation System

1501. General

1. 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).** If the pressure chamber of hyperbaric evacuation system is also to be used as a surface chamber for diving system, it is to be applied with **Annex 9-4.** in this Rule.

2. The documents to be submitted to the Society for approval are listed in **604.**

3. The necessary test are specified in **607.**

1502. Design principles

1. Pressure chamber

(1) The pressure chamber of the hyperbaric evacuation system shall be so designed that all the divers in the diving system can be rescued simultaneously at maximum operating depth. At least one seat with safety harness is to be provided for each diver.
(2) The pressure chamber is to be equipped with a supply lock.
(3) The connection flange of the pressure chamber is to be so designed that it is also able to mate to a different system.
(4) The pressure chamber is to be fitted with view ports in such a way that, wherever possible, all the occupants can be observed from outside.
(5) The pressure chamber is to be provided with the necessary connections to enable the internal pressure, temperature, gas composition and humidity to be maintained.
(6) The pressure chamber is to be adequately lit.

2. Hyperbaric evacuation system

(1) The hyperbaric evacuation system is to be so designed that its behaviour in a seaway corre-

sponds to that of an enclosed lifeboat.

(2) The system is to be self propelled and capable of navigation or is to be provided with means (e.g. suitably equipped ancillary boat) enabling the hyperbaric evacuation system to be towed away quickly after launching.

(3) The hyperbaric evacuation system is to be equipped with its own life support system enabling the pressure, temperature, humidity and gas composition in the pressure chamber to be maintained for at least 72 hours. The life support systems are to be provided with connections for external supply and surveillance.

(4) The hyperbaric evacuation system is to be equipped with the controls needed to maintain a safe environment for the divers.

(5) The hyperbaric evacuation system is to be equipped with a communication system for talking to the divers.

(6) The hyperbaric evacuation system is to be equipped with its own power supply capable of keeping the electrical installations in operation for at least 72 hours.

(7) The hyperbaric evacuation system is to be provided with lifting attachments enabling it to be hoisted by a standard ship's crane.

(8) The hyperbaric evacuation system is to be constructed of materials which are at least flame retardant and is to be equipped with a water spray system for cooling the surface in the event of fire.

1503. Mating and handling systems

1. The mating system of the hyperbaric evacuation system is to be designed to permit rapid and safe connection and disconnection.

2. The design and testing of the handling system is to be in accordance with separately provided. **【See Guidance】**

3. The handling system is to be capable of safely launching the hyperbaric evacuation system and, where applicable, of effecting also the retrieval and mating operations.

4. Disconnection and launching of the system is to also be possible in the event of failure of the ship's power supply.

Section 16 Position Keeping System

1601. General

1. Diving support vessel shall be provided with a system keeping its position safely during diving operations.

2. The requirements for mooring systems with anchors shall be especially considered to keep its position during diving operations.

3. Adequate communication equipment and alarm system shall be installed between DPS control room and dive operation center.

4. The components of Dynamic Positioning System shall be designed, constructed and tested in accordant with **Pt 9, Ch 4.** ⚓

CHAPTER 8 HIGH VOLTAGE SHORE CONNECTION 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 high voltage shore connection systems, which have been summarized referring to IEC/ISO/IEEE 80005-1.
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 menas 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 and data

1. **General** In the case of the ships intended to be registered as ships provided with high voltage shore connection systems, the drawings and data 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) H.V plugs & sockets
  - (c) Transformer
  - (d) H.V cable
  - (e) Cable reel
  - (f) Control & monitoring system
  - (g) Onboard receiving switchboard

(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
(B) overtension on the flexible cable (mechanical stress)
(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
(D) at the circuit-breaker locations for shore connections

202. Ship to shore connection and interface equipment

1. 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.

2. Plugs and socket-outlets

(1) General
(A) Details including general arrangement of plug and socket-outlet are to be in accordance with IEC/ISO/IEEE 80005-1 Annex, IEC 62613-1 and IEC 62613-2.
(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.

3. 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, disconnector and earthing switch
(A) In order to have the installation isolated before it is earthed, the circuit-breaker, disconnector 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. Shop Tests

1. Type approval

(1) Electrical equipment and cables required by **Pt 6, Ch 1, 103. 1,** (1) are to be type approved, in principle, according to the test methods approved by the Society before the commencement of work.

(2) The high voltage shore connection switchboard and the high voltage onboard receiving switchboard are to be type approved.

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 shipside installations like power management system, integrated alarm, monitoring and control system work properly together with the new installation

303. Survey assigned to maintain classification

Periodical survey items of high voltage shore connection system are to be applied as follows.

1. Special survey

(1) visual inspection
(2) high voltage test
(3) insulation resistance measurement
(4) measurement of the earthing resistance
(5) function test 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)

2. Annual survey

(1) visual inspection
(2) insulation resistance measurement ⚓

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 connection with each Section are as follows:
   (1) Ships which comply with **Ch 2** are considered meeting the requirements for vapour emission control systems in accordance with **IMO MSC/Circ. 585**.
   (2) Ships which comply with **Ch 3** are considered meeting the requirements for vapour emission control systems in accordance with **USCG CFR 46 Part 39**.
   (3) Ships which comply with **Ch 4** are considered meeting the requirements for vapour emission control systems in accordance with **USCG CFR 46 Part 39** and additional requirements also for lighting operation.

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**.)

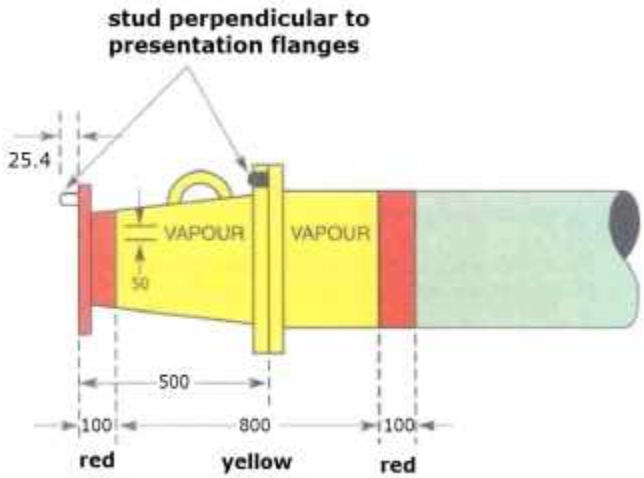


Fig 9.9.1 Identification of vapour manifold

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. Cargo tank high level alarm

1. Each cargo tank is to be equipped with an high level alarm. The high level alarm 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;
   (3) give a visual and audible tank overflow 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.

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:

$$VGR = 1 + 0.25\frac{P_v}{0.0862}$$

$$\rho_{va} = (SG_v \cdot V_v + V_a)10.9 \cdot P_{p/v} \quad (\mathrm{kg/m^3})$$

$$V_v = \frac{P_v}{P_{p/v}}, \quad V_a = \frac{P_{p/v} - P_v}{P_{p/v}}$$

VGR : vapour growth rate(dimensionless); to be as calculated above or 1.25, whichever is larger

P_v : saturated vapour pressure at 46.1 ℃ (MPa, absolute)

$P_{p/v}$: cargo tank PV valve pressure setting at 46.1 ℃ (MPa, absolute)

ρ_{va} : vapour-air mixture density at 46.1 ℃ ($\mathrm{kg/m^3}$)

SG_v : specific gravity of cargo vapour (dimensionless)

V_v : partial volume of vapour at 46.1 ℃ (dimensionless)

V_a : partial volume of air at 46.1 ℃ (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.

$$Q_A = Q_L \cdot VGR \cdot C \quad (\mathrm{m^3/h})$$

$$C = \sqrt{\frac{\rho_{va}}{\rho_a}}$$

Q_A : required air equivalent volumetric flow rate ($\mathrm{m^3/h}$)

Q_L : cargo transfer rate ($\mathrm{m^3/h}$)

C : density correction factor (dimensionless)

ρ_{va} : vapour-air mixture density at 46.1 ℃ ($\mathrm{kg/m^3}$)

ρ_a : air density at 46.1 ℃ ($\mathrm{kg/m^3}$)

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. Overfill Alarm

1. Each cargo tank of a tanker is to be equipped with an overfill alarm system (High-high level) which complies with the followings:

(1) The overfill alarm system is to be independent of the cargo gauging system and the high level alarm system;

(2) At each cargo control station, the high level alarms required by **204.** and the overfill alarms are to be identified with the labels "HIGH LEVEL ALARM" and "TANK OVERFILL ALARM" respectively, in black letters at least 50 mm high on a white background;

(3) The high level alarm required by **204.** is to be set at no less than that corresponding to 95 % of tank capacity. The overfill alarm is to come into operation after the high level alarm, but early enough to allow for action to prevent tank overflow;

(4) The overfill alarm system is to give a visual and audible tank overfill alarm to the ship's operator;

(5) Visible and audible alarms are to be fitted so that it can be seen and heard at the cargo control station and in the cargo deck area; **[See Guidance]** *(2018)*

(6) The overfill alarm system 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

(7) The overfill alarm system 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 transfering 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 high level
(d) Cargo tank overfill (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 control equipment, monitoring equipment and sampling facilities.
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. **Organization** means the International Maritime Organization (IMO).
8. **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

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 in accordance with **Guidelines G8, Guidelines for Approval of Ballast Water Management Systems (IMO Res. MEPC.174(58))** *(2018)*
(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** 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 equipment. 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. *(2017)*
(2) **Dangerous gas** means any gas which may develop an explosive or toxic atmosphere being hazardous to the crew and the ship, e.g. hydrogen(H2), hydrocarbongas,ozone(O3), chlorine(Cl2) and andchlorine dioxide(ClO2), etc.
(3) **Dangerous liquid** means any liquid that is identified as hazardous in the Material Safety Data Sheet or other documentation relating to this liquid.

302. Ballast water management systems

1. General

(1) The Ballast water management systems (BWMS) is to be operated at a flow rate within the Treatment Rated Capacity (TRC) range specified in the Type Approval Certificate. *(2017)*
(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) In the event of an emergency, suitable by-passes or overrides to protect the safety of the ship and personnel is be installed.

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 may occur in the ballast line due to the height difference, a suitable protection means is to be provided, e.g. P/V valves or breather valves, and their outlets are to be led to safe area on open deck.

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) The electrical load of a BWMS is to be included in an electrical load analysis to demonstrate the adequate electrical generating capacity.
(3) Arrangements of electrical equipment installed in hazardous are to comply with **Pt 6, Ch 1, Sec 9**.
(4) 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

(5) In case of any by-pass or override operation of BWMS, an audible and visual alarm is to be given and these events are to be automatically recorded in control equipment. The valves in the by-pass line which trigger the by-pass operation are to be remote-controllable by control equipment or fitted with open/close indicator for automatic detection of the by-pass event.

303. Arrangement of BWMS

1. Where the operating principle of the BWMS involves the generation of a dangerous gas, the following requirements are to be satisfied:

(1) A gas detection equipment is to be fitted in the spaces where dangerous gas is likely to be present, and an audible and visual alarm is to be activated at a local area and a manned BWMS control station in case of leakage. Gas detection device is to be designed and tested in accordance with **IEC 60079-29-1** or recognized standards acceptable by the Society.

(2) The ventilation line of a space where dangerous gas may be present is to be led to a safe area on open deck.

(3) The arrangements used for gas relieving, i.e. degas equipment or equivalent, are to be provided with monitoring measures with independent shutdown. The open end of the gas relieving device is to be led to a safe area on open deck. **[See Guidance]** *(2018)*

2. Ballast piping, including sampling lines from ballast tanks considered as hazardous areas, is not to be led to an enclosed space regarded as a safe area, without any appropriate measures, except ships carrying liquefied gases in bulk. However, a sampling point of ballast water containing dangerous gas may be located in a safe area for checking the performance of BWMS provided the following requirements are fulfilled:

(1) 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 (C) are to be complied. *(2017)*

(A) In the cabinet, a stop valve is to be installed in each sample pipe.

(B) A gas detection equipment is to be installed in the cabinet and the valves specified in (A) above are to be automatically closed upon the activation of gas detection.

(C) Audible and visual alarm signals are to be given at a local area and a manned BWMS control station when the concentration of explosive gases reaches 30 % of the lower flammable limit(LFL) of the concerned product.

(2) The standard internal diameter of sampling pipes is to be the minimum necessary in order to achieve the functional requirements of the sampling system. *(2017)*

(3) The measuring system is to be installed as close to the bulkhead as possible, and the measuring pipe is to be as short as possible in safe areas.

(4) Stop valves are located in both the suction pipe and return pipe near the penetrations of bulkhead at safe side. A warning plate stating "Keep valve closed when not performing measurements" is to be provided near the valve.

(5) In order to prevent the backflow, a water seal is to be installed on the hazardous area side of the return pipe.

(6) A safety valve is to be installed on the hazardous area side of a sampling line.

3. For the spaces, including hazardous areas, where toxicity, asphyxiation, corrosivity or reactivity is present, these hazards are to be taken into account and additional precautions for the ventilation of the spaces and protection of the crew are to be considered. *(2017)*

4. The following requirements are to be applied for tankers.

(1) Hazardous area classification is to be in accordance with **IEC 60092-502**.

(2) For tankers carrying flammable liquids having a flashpoint not exceeding 60 ℃ or products listed in the IBC Code having a flashpoint not exceeding 60 ℃ or cargoes heated to temperature above their flashpoint and cargoes heated to temperature within 15 ℃ of their flashpoint, in general, two independent BWMS may be required – i.e. one for ballast tanks in hazardous areas and the other for ballast tanks in non-hazardous areas.

(3) The interconnection of ballast piping between hazardous areas and in non-hazardous areas may be accepted if an appropriate isolation arrangement is applied. Means of the appropriate isolation are as follows: *(2017)*

(A) Two(2) screw down check valves in series with a spool piece (refer **Fig 9.10.2(a)**), or

(B) Two(2) screw down check valves in series with a liquid seal at least 1.5 m in depth (refer

Fig 9.10.2(b)), or

(C) Automatic double block and bleed valves and a non-return valve (refer **Fig 9.10.2(c)**)

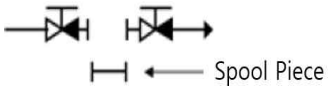


Fig 9.10.2(a)

Fig 9.10.2(b)

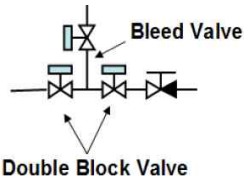


Fig 9.10.2(c)

(4) In association therewith, the examples of appropriate isolation arrangement are shown in **Fig 9.10.3(a)** and **Fig 9.10.3(b)**. Means of the appropriate isolation is to be fitted on the exposed deck of hazardous area.

(5) Ballast water originating from a hazardous area is not to discharge into a non-hazardous area, except as given by **2**.

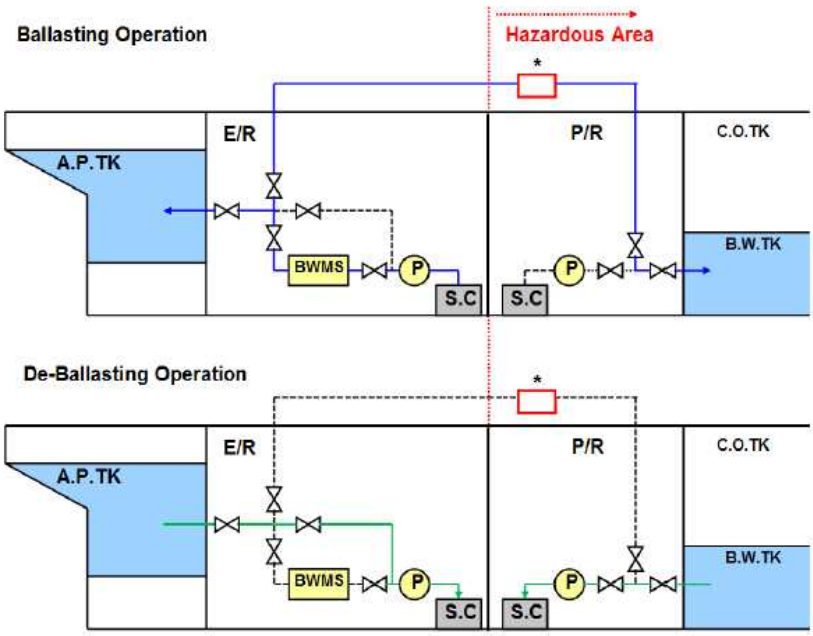


Fig 9.10.3(a) BWMS which does not require after-treatment

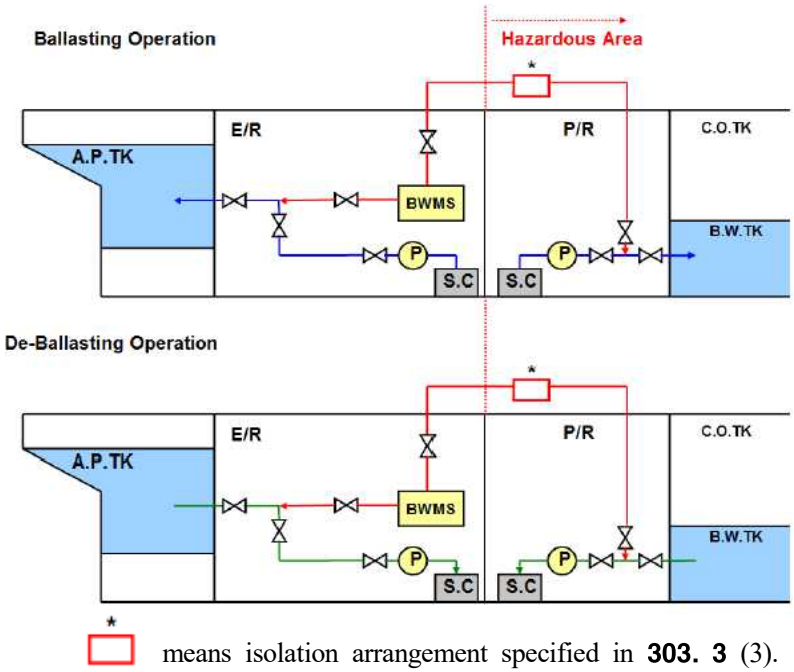


Fig 9.10.3(b) BWMS which requires after-treatment (Injection type)

304. Ventilation

1. BWMS not in hazardous areas

(1) A BWMS that does not generate dangerous gas is to be located in an adequately ventilated area.

(2) A BWMS that generates dangerous gas is to be located in a space fitted with a mechanical ventilation system providing at least 6 air changes per hour or as specified by the BWMS manufacturer, whichever is greater.

2. BWMS in hazardous areas

(1) A BWMS, regardless of generating dangerous gas, is to be located in a space fitted with mechanical ventilation complying with relevant requirements, i.e. **IEC60092-502**, **Pt 7, Ch 5** and **Pt 7, Ch 6**, etc.

305. Handling and storage of gases and chemicals used to treat ballast water

1. Length of pipe and the number of connections are to be minimised in piping systems containing dangerous gases and liquids in high concentration. The following requirements are also to be satisfied:

(1) Pipe joints are to be of welded type except for connections to shut off valves, double walled pipes or pipes in ducts equipped with mechanical exhaust ventilation. Alternatively it is to be demonstrated that risk of leakage is minimized and the formation of toxic or flammable atmosphere is prevented.

(2) Location of piping system is to be away from heat sources and protected from mechanical damage.

2. For the BWMS using chemical substance, handling procedures are to be in accordance with the Material Safety Data Sheet (MSDS) and **BWM.2/Circ.20**, and the following measures are to be taken as appropriate:

(1) The material used for the chemical storage tanks, piping and fittings are to be resistant to such chemicals.

(2) Chemical storage tanks are to have sufficient strength and to be constructed so that maintenance and inspection can be easily carried out.

(3) Air pipes of chemical storage tanks are to be led to a safe area on open decks.

3. An operation manual containing chemical injection procedures, alarm systems, means in case of emergency, etc, is to be kept onboard.

4. Where the BWMS is installed in an independent compartment, the compartment is to be:
   (1) Provided with fire integrity equivalent to other machinery spaces;
   (2) Positioned outside of any combustible, corrosive, toxic, or hazardous areas unless otherwise specifically approved; and
   (3) Arranged with no direct access to accommodation spaces, service spaces, machinery spaces, control stations or other spaces containing sources of ignition, unless otherwise specifically approved.

5. A risk assessment may be conducted to ensure that risks, including but not limited to those arising from the use of dangerous gas affecting persons on board, the environment, the structural strength or the integrity of the ship are addressed.

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

(1) Drawings and data
For the BWMS 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) General arrangement drawings of the BWMS
(B) Ballast piping diagram
(C) The location of ballast water and sediment sampling openings
(D) Electrical schematic drawing of BWMS
(E) Drawing of tanks containing liquid chemicals including air pipes, sounding and drain systems from drip trays
(F) Arrangement of detection system associated with toxic or flammable gases
(G) Test plan for onboard or sea trial
(H) Ballast water management plan
(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 **G8 Guidelines**(IMO Res. MEPC.174(58)), Paragraph 8.1 is on board
(C) 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 ⚓

2019

Guidance Relating to the Rules for the Classification of Steel Ships

Part 9

Additional Installations

GA-09-E

KR

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 2019.
2. The amendments to the Guidance for 2018 edition and their effective date are as follows;

Effective Date 1 July 2019

CHAPTER 2 CARGO HANDLING APPLIANCES

Section 1 General

- 103. Table 9.2.1 has been amended.

CHAPTER 9 CARGO VAPOUR EMISSION CONTROL SYSTEMS

Section 3 Requirements for VEC2 Notation

- 302. 1 has been 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%) $CHClF_2/CClF_2CF_3$)
(4) *R* 13*B*1 (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℃ for fruit, and 10℃ 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 resisters 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)*

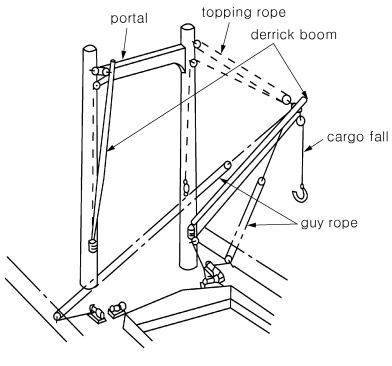
(3) The cargo handling appliances installed in the ships other than those specified in (1) and (2) above, for which the assignment of the safe working load, etc. is requested.

2. Equivalency [See Rule]

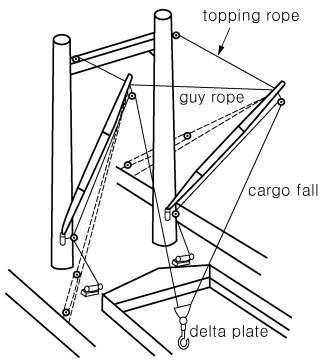
In **101. 2** (2) of the Rules, the "any rules or standards recognized by the Society" means the rules of any Society which is subject to verification of compliance with QSCS(Quality System Certification Scheme) of IACS and International Standard(ISO) or equivalent standards and "Tests and inspection 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.

102. Definitions [See Rule]

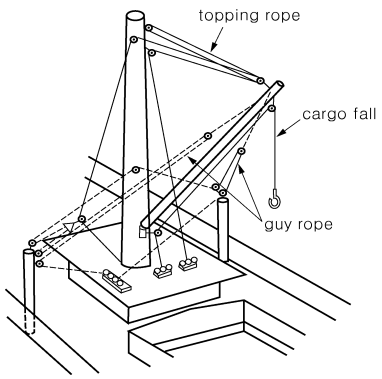
The derricks come under the requirements of the Rules include those illustrated in **Fig 9.2.1.**



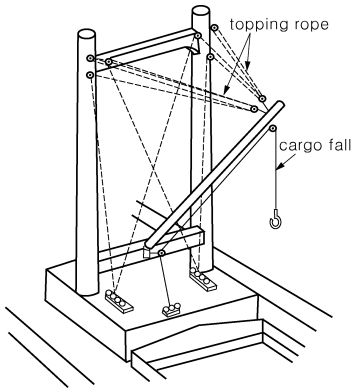
(1) Swinging derrick system



(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 handing 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:

$$5.0K+1.0 \quad (\mathrm{mm})$$

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:

$$5hK \quad (\mathrm{cm})$$

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:

$$5.0K+1.0 \quad (\mathrm{mm})$$

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" menas 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 recongnized 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 (℃)	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℃ 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.

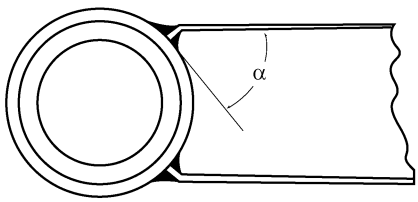


Fig 9.2.2 Welding for Portal and Post

(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 *F*1 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 downfall 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" menas 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.

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

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 my 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:

$$\text{Test load} = \alpha \times \{(\text{maximum cargo mass}) + (\text{mass of cargo holding gear})\}$$
$$\text{Safe working load} = (\text{maximum cargo mass}) + (\text{mass of cargo holding gear})$$

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.

$$\text{Test load} = \alpha \times (\text{maximum cargo mass})$$
$$\text{Safe working load} = \text{maximum cargo mass}$$

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 sponson 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.

(5) In application to Table 9.2.2, the "load as considered appropriate by the Society" means the case where the test load are $1.1 \times SWL$.

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 date 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 recongnized 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 9-6 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 [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.** or **105.** of the Guidance.

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 [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.** or **105.** of the Guidance.

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.

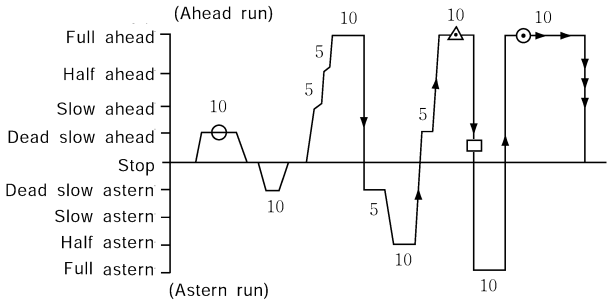


Fig 9.3.1 Trial Procedures for Diesel Ships

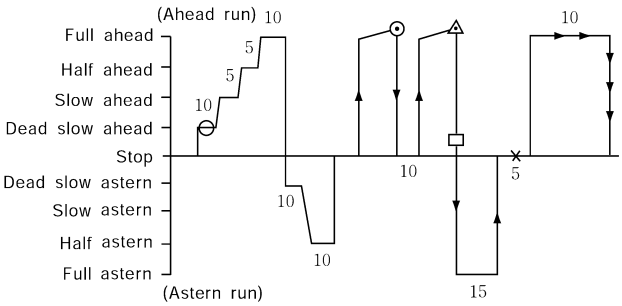


Fig 9.3.2 Trial Procedures for Steam Turbines Ships

[Remarks]

1. ⊖signifies putting over the rudder to hard port or bard 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.
8. Numerals signify running hours(in a unit of minute).

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 [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.** or **105.** of the Guidance.

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, menas 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 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 [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.** or **105.** of the Guidance.

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.** or **105.** of the Guidance. [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.** or **105.** of the Guidance. [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 [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.** or **105.** of the Guidance.

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

Section 2 Requirements of Dynamic Positioning Systems

203. Additional requirements for dynamic positioning 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 [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.** or **105.** of the Guidance.

2. Shop tests [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.** or **105.** of the Guidance.

203. Survey Assigned to Maintain Classification

1. Annual survey [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.** or **105.** of the Guidance.

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]

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.** or **105.** of the Guidance.

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 [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.** or **105.** of the Guidance. ⚓

CHAPTER 7 DIVING SYSTEMS

Section 2 Classification Survey during Construction

205. Tests [See Rule]

In application to **205.** of the Rules, "the tests deemed necessary by the Society" means the performance test to assess control systems, measuring devices, etc. in sea trial and the requirements of **Pt 6, Ch 2, 302.** of the Rules.

Section 3 Classification Survey after Construction

303. Classification survey of diving systems classed by other classes [See Rule]

In application to **303.** of the Rules, "as provided separatedly" means as follows, In compliance with the specification and purpose of the submersible, if deemed necessary by the Society, the additional drawings and documents may be requested to add.

1. Submission of plans and documents

(1) Two(2) copies for drawings and documents specified in **Ch 7, 604. 2** to **10** of the Rules.
(2) Two(2) copies for results of sea trial and equipment performance tests or calculation data.

2. When the drawing and documents related to the above **1** are submitted to the Society, they may be accepted.

3. Notification of appraisal results for drawing and documents, etc.

After the Society appraises the drawings and documents required in the above **1**, the results shall be given to the owner. However, if it is difficult for these data to be appraised, the visual condition of the ship may be applied.

304. Tests [See Rule]

In application to **304.** of the Rules, on the basis of the survey status given from the previous class, it is to be carried out for the survey regarding to the recommendation and overdue items. When unpracticable, it shall be implemented by the instruction from our Head office. And the diving system and diving simulators after construction shall be carried out for the following test and examination according to the ship's age.

1. Ship's age exceeding 5 years up to 10 years

(1) Examination specified in the requirements of **Ch 7, 501.** of the Rules.
(2) Internal examination after sampling 10 % of gas bottles of all kinds except ones containing airs.
(3) Internal examination after sampling 20 % of all kinds of gas bottles containing airs.
(4) Performance test for all the handling and transfer, and mating devices.
(5) Exchanging the rope end of all the winch. (However, if it is not exceeding 30 months from the previous date of rope end changed, the rope end may be extended to 30 months, but in 30 months it shall be replaced with new one.)

2. Ship's age exceeding 10 years up to 15 years

(1) Examination specified in the requirements of **Ch 7, 502.** of the Rules.
(2) If the gas bottle are used exceeding 10 years, after sampling 50 % of gas bottles of all kinds except ones containing airs, the internal examination is carried out. However, when 10 years of age or less, 20 % of the bottles shall be examined.
(3) Internal examination after sampling all kinds of gas bottles containing airs.
(4) Performance test for all the handling and transfer, and mating devices.

3. Ship's age exceeding 15 years

(1) In addition to the examination and inspection of the above **2**, Performance test for all the handling and transfer, and mating devices, and measuring the rope length.
(2) All break bands used for breaking shall be renewed.
(3) Performance test of safety valves and discs for all gas bottles.

Section 5 Performance of Survey

501. Intermediate Survey

1. In application to **501.** (18) of the Rules, in considering the effects of equipments inside compression chamber, the hydraulic test may be replaced with the airtightness test and the following requirements shall be complied with; **【See Rule】**

(1) When the compression chamber is operated, the airtightness test shall be done by gases using for pressuring or decompressing.

(2) Test pressure for compression chamber shall be given to maximum operating depth.

2. In application to **501.** (19) of the Rules, the Guidance means **Annex 9-2** of the Guidance. **【See Rule】**

502. Special Survey **【See Rule】**

1. In application to **502.** of the Rules, the Guidance means **Annex 9-3** of the Guidance.

Section 6 General

601. General **【See Rule】**

In application to **Sec 2** of the Rules, for dive Control Stations the followings are to be added :

1. Location of Dive Control Station

(1) A dive control station may be located on the shore or on deck close to and in sight of the diving location. The position of the dive control station is to allow the operations control personnel an overview of all systems and activities associated with the operations of the underwater vehicle and the dive.

(2) When selecting the location of the dive control station, ship's motion or support structure vibrations are to be considered.

(3) The dive control station is to be provided with sir conditioning for control consoles when required by the operational characteristics of electronic components within the consoles.

(4) The leading of pipes in the vicinity of control consoles is to be avoided as far as possible. When such leads are necessary, care is to be taken in order to fit no flange or joints over or near the consoles, or stands, unless provision is made to prevent any leakage from injuring equipment.

(5) The dive control station is to provided with effective fire protection on all delimiting walls, bulkheads and decks.

2. Construction and Mechanical protection

All enclosures in the dive control station are to be drip-proof and corrosion resistant when completed and are to be made of one or a combination of the following materials :

(1) Cast metal, except die-cast metal, at least 3 mmhick at every location.

(2) Non-metallic materials that have acceptable strength, are non-combustible and non- absorptive, e.g. laminated phenolic material.

(3) Sheet metal of adequate strength. The supporting framework for all panels is to be of rigid construction. No wood is to be used, except for hardwood for non-conducting handrails.

(4) The dive control station is to be located in a dry place. Clear working space is to provided around panels, consoles and stands to enable doors to be fully opened and equipment removed for maintenance and replacement. Consoles, panels and stands are to be firmly secured to a solid foundation, be self-supported or be braced to the bulkheads.

3. Enclosed Dive Control Stations

(1) Enclosed dive control stations are to have two means of access located as remote from each other as practicable.

(2) Glass windows in the control station are to be of shatter-resistant type.

(3) Sufficient light fixtures are to be installed to provided 540 lumens/m^2 (50 foot-candles) over all control stands, consoles and panels.

4. Controls, Displays and Alarms

(1) General
(A) Consoles, displays and alarms are to be provided for safe and reliable performance of all the required functions carried out from the dive control station.
(B) Fire detection and fire fighting systems are to be provided for the protection of the station and are to be operable from outside the protected space.
(C) Controls for fire fighting systems intended for the protection of diving facilities (e.g. deck decompression chamber handling systems) are to be located in or as close as possible to the control station.

(2) Control Consoles
(A) All controls, displays and alarms are to be located and arranged in centralized position and constructed in accordance with practices suitable for the service.
(B) A separate control console is to be provided for each independently operated deck decompression chamber and underwater unit, and its handling system.

(3) Displays and Alarms
The following operating parameters are to be monitored at the dive control station for each manned chamber and underwater unit.
(A) Pressure or depth
(B) Temperature
(C) Humidity
(D) Partial oxygen pressure
(E) Partial CO_2 pressure
(F) Pressure of connected breathing gas bottles
(G) Pressure of pressure reducing outlets
(H) Oxygen content in supply lines to chamber & compartment and to breathing masks
(I) Battery charge and discharge, voltmeter, ammeter and a capacity indicator
(J) Power supply distributions, voltmeter, ammeter and frequency meter if alternating current is used.
(K) Electric leakage indicator for all chambers and compartments
(L) Fire alarm display panels
(M) Safety and signaling system monitors
(N) Display and control for breathing mixtures
(O) Environmental systems controls indicating heating and cooling system controls

5. Communications

(1) Direct communication is to be provided among the following positions :
(A) Dive control station
(B) Dive control console on the support vessel
(C) Winch and crane local operation stand
(D) All compartments associated with saturation diving
(E) Master of the diving support vessel
(F) Underwater vehicle
(G) Diver in the water

(2) Automatic recording of communication between the submersible and the control station is to be possible.

605. Environmental conditions [See Rule]

1. Sea condition which is required to apply rule **605. 4**, is what calculation of **Annex 9-5** is applied to.

606. Arrangement [See Rule]

1. In application to **606. 1** of the Rules, "the discretion of the Society." are those defined in **Pt 1 Ch 1. 104. and 105.**

607. Tests

1. In application to **607. 1** (2), "they are recognized as equivalent by the Society" means the relevant requirements of the **Guidance for Approval of Manufacturing Process and Type Approval, Etc.** recognized national and international standards or the equivalents when it is deemed appropriate by the Society. 【See Rule】

2. In application to **607.** of the Rules, for dive Control Stations the followings are to be added : 【See Rule】

   (1) Testing of all equipments, apparatus, wiring and piping is to be conducted in accordance with the these Rules in the presence and to the satisfaction of the Surveyor.
   (2) Before certification, all control systems are to be tested for proper function and operation.

5. **Compressors** 【See Rule】

   (2) Performance tests described in Rule **607. 5** (2) mean that charging rate is comprehended according to the type of compressed gas and the components of supplied air shall be complied with **Tables 9.7.1 ~ 9.7.4.**

Table 9.7.1 Purity requirements of compressed breathing air for divers

Components	Specification
Oxygen(Percentage per volume)	20-22 %
Carbon dioxide(per volume)	1,000 ppm(max)
Carbon monoxide(per volume)	20 ppm(max)
Total Hydrocarbon(CH_4 per volume)	25 ppm(max)
Odor and taste	None
Oil, mist, particles	5 mg/m^3(max)

Table 9.7.2 Purity requirements of compressed breathing air for divers

Components	Specification
Oxygen(Percentage per volume)	99.5 %
Carbon dioxide(per volume)	5 ppm(max)
Methane(per volume)	25 ppm(max)
Acetylene(C_2H_4)	0.05 ppm(max)
Ethylene(C_2H_6)	0.2 ppm(max)
Ethane(C_2H_6 and Hydrocarbon)	3.0 ppm(max)
Nitrogen dioxide(N_2O per volume)	2.0 ppm(max)
Halon compounds(per volume)	
Refrigerants	1.0 ppm(max)
Solvents	0.10 ppm(max)
Humidity(ppm or measured vapour by the dew point)	7 ppm(max) < -82 °F
Odor	None

Table 9.7.3 Purity requirements of compressed breathing Helium for divers

Components	Specification
Helium(percentage per volume)	99.997 %
Humidity(vapour)	9 ppm(max)
Dew point(not too high)	-78 °F
Hydrocarbon(Methane series)	1 ppm(max)
Oxygen	3 ppm(max)
Nitrogen + Argon	5 ppm(max)
Neon	23 ppm(max)
Hydrogen	1.0 ppm(max)

Table 9.7.4 Purity requirements of compressed breathing Helium for divers

Components	Specification / Rating	
Nitrogen	99.95 %	99.50 %
Oxygen	0.05 %	0.50 %
Humidity(vapour)	0.02 mg/L	0.02 mg/L
Total quantity of Hydrocarbon (Methane series per volume)	50 ppm(max)	50 ppm(max)
Odor	None	None

6. Piping system [See Rule]

(4) In application to **607. 6** (4) of the Rules, the cleaning test shall be complied with ASTM G93 ~96 Standard Practice for cleaning Methods and cleanliness levels for materials and Equipment used in Oxygen Enriched Environments, recognized national and international standards or the equivalents when it is deemed appropriate by the Society.

609. Sea trials [See Rule]

1. In application to **609.** of the Rules, "if deemed necessary by the Society" are those defined in **Pt 1 Ch 1. 104. and 105.**

Section 7 Gas Cylinders, Decompression Chambers and Diving Bells

705. Compression chamber and diving bells

1. In application to **705. 1** (2) (b) of the Rules, "the discretion of this Society" means the following requirements. **[See Rule]**

(1) Among a compartment of chambers, a chamber used for sanitary equipments is independently provided.

(2) Through the chamber closing device it is possible to enter with a stretcher.

2. In application to **705. 4** (2) of the Rules, "stringent requirements which are to be agreed with the Society" means **Annex 9-2** of this guidances, and if not specified in **Annex 9-2**, it shall be complied with the latest standards of ASME PVHO-2, recognized national and international standards or the equivalents when it is deemed appropriate by the Society. **[See Rule]**

3. In application to **Table 9.7.4** of **705. 11** of the Rules, "the discretion of the Society" means the latest standards of ASME PVHO-1 or the recognized International Standards in common.

[See Rule]

Section 8 Pipes, Valves, Fittings, Hoses and Umbilicals

802. Design principles

2. Pipe connections **[See Rule]**

(3) In application to **802. 2.** (3) of the Rules, "a recognized standard" are those defined in **Pt 1 Ch 1. 104. and 105.**

3. Valves and fittings **[See Rule]**

(1) In application to **802. 3.** (1) of the Rules, "a recognized standard" are those defined in **Pt 1 Ch 1. 104. and 105.**

803. Materials

2. Approved materials **[See Rule]**

(5) Other materials
In application to **803. 2.** (5) of the Rules, "in accordance with the discretion of this Society" are those defined in **Pt 1 Ch 1. 104. and 105.**

3. Material testing **[See Rule]**

(2) In application to **803. 3.** (2) of the Rules, "in accordance with the International Standards recognized by the Society" means the international Stardard(ISO), National Standard(KS) or equivalent standards.

(3) In application to **803. 3.** (3) of the Rules, "in accordance with the International Standards recognized by the Society" means the international Stardard(ISO), National Standard(KS) or equivalent standards.

804. Calculation of pipe wall thickness

1. Minimum wall thickness **[See Rule]**

(1) In application to **804. 1.** (1) of the Rules, "a recognized standard" means the American Society of Mechanical Engineers(ASME) code, European Standard(EN) code, American Petroleum Institute(API) code or equivalent standards.

Section 11 Automation, Communication and Locating Equipment *(2017)*

1103. Communication equipment **[See Rule]**

1. In application to **1103. 4** of the Rules, "the relevant requirements of the IMO Code of Safety for

Diving Systems, **IMO A.536(13)** and its revision **A.583(14).**" means the following requirements.

(1) A diving bell shall be have an emergency locating device, preferably with a frequency of 37.5 kHz, designed th assist personnel on the surface in establishing and maintaining contact with the submerged diving bell if the umbilical to the surface is severed. The device shall be complied with the following

(A) Transponder

It shall be an enclosed pressure type having a self-contained battery so as to operate at least 200m. And the battery shall be alkalic type to be supplied easily, and as far as possible, it can be used for the transponder between the diver and receiver on water. And then the transponder shall be complied with the **Table 9.7.5** of operating characteristics.

Table 9.7.5 **Operating characteristics**

Contents	Operating Characteristics
Common emergency reply frequency	37.5 kHz
Individual Interrogation frequencies	
- channel *A*	38.5 ± 0.05 kHz
- channel *B*	39.5 ± 0.05 kHz
Receiver sensitivity	+15 dB referred to 1μbar
Minimum interrogation pulse width	4 ms
Turnaround delay	125.7 ± 0.2 ms
Reply frequency	37.5 ± 0.05 kHz
Maximum Interrogation rates	
- more than 20% of battery life remaining	Once per second
- less than 20% of battery life remaining	Once per 2 seconds
Minimum transponder output power	85 dB referred to 1μbar at 1 m
Minimum transducer polar diagram	-6 dB at ± 135° solid angle, centred on the transponder vertical axis and transmitting towards the surface
Minimum listening life in water	10 weeks
Minimum battery life replying at 85 dB	5 days

(B) Diver's Calling / receiver

(a) the calling / receiver shall be provided with pistol grip and compass, and constructed with the enclosed pressure type for operating under water to Max. Diving depth, and at the end of the forward the underwater direction voice is to be taken and at the end of afterward 3-digit LED reading decoder with meter scales. The control device shall be provided with "on-off receiver" and "channel selection". The battery is to be of the alkaric type to be supplied easily. As far as possible, the battery can be used for both the callings and receivers.

(b) the calling/receiver shall be complied with the following requirements of **Table 9.7.6** operation characteristics.

Table 9.7.6 **Calling / Receiver 's operation characteristics**

Contents	Operation Characteristics
Common emergency reply frequency	37.5 kHz
Individual Interrogation frequencies	
A Channel	38.5 kHz
B Channel	39.5 kHz
Minimum transmitter output power	85 dB referred to 1μbar at 1 m
Transmit pulse	4 ms
Directivity	±15°
Capability to zero range on transponder	
Maximum detectable range	500 meter or more

(c) In addition to communication systems referred to above, a standard bell emergency communication typing Code should be adopted as given **table 9.7.7** for use between persons in the bell and rescue divers. The copies of the contents shall be attached to inside and outside the diving bell and also in the control room.

Table 9.7.7 **Bell Emergency Communication Typing Code**

Typing Code	Situation
3.3.3	Communication opening procedure (inside and outside)
1	Yes or affirmative of agreed
3	No or negative or disagreed
2.2	Repeat please
2	Stop
5	Have you got a Seal?
6	Stand by to be pulled up
1.2.1.2	Get ready for through water transfer (open your hatch)
2.3.2.3	You will NOT release your ballasts
4.4	Do release your ballast in 30 minutes from now
1.2.3	Do Increase your pressure
3.3.3	Communication closing procedure (inside and outside)

Section 12 Electrical Equipment *(2017)*

1202. Design principles [See Rule]

2. In application to **1202. 2.** (2) of the Rules, "international standards" means international electrotechnical committee or recognized national standards, Etc.

Section 15 Hyperbaric Evacuation System

1503. Mating and handling systems [See Rule]

1. In application to **1503. 2.** of the Rules, "in accordance with separately provided" are those defined in **Pt 1 Ch 1. 104. and 105.** ⚓

Annex 9-2 Design and Construction of Viewports

1. Approved materials

In applying to Design and Construction of viewports, "the requirements separatedly provided by the Society" means the following items and ASME PVHO-1, 2. And the acrylic plastic viewports(or windows) means windows made of castings, unlaminated polymechyl methacrylate.

1.1 General

(1) The design life of a window is a function of its geometry, conversion factor, ratio, and service environment. Windows that are expected to only compressive, or very low tensile stresses, have a longer design life than those that are exposed to high tensile stresses. The design life of windows in the first category shall be 20 years, while for the window in the latter category it shall be 10 years. The design life of windows under this standard shall be as follows,
   (A) The design life of flat disk windows shown in **Fig 9.1** shall be 10 years from the date of fabrication.
   (B) The design life of conical frustum windows shown in **Fig 9.2** and meeting the requirements of this Standard shall be 10 years from the date of fabrication for $t/D_i < 0.5$ and 20 years for. $t/D_i \geq 0.5$.
   (C) The design life of double beveled disk windows shown in **Fig 9.3** and meeting the requirements of this Standard shall be 10 years from the date of fabrication for $t/D_i < 0.5$ and 20 years for $t/D_i \geq 0.5$.
   (D) The design life of spherical sector with conical edge, hyperhemisphere with conical edge, and NEMO-type windows with conical edge penetrations shown in **Fig 9.4** and meeting the requirements of this Standard shall be 20 years from the date of fabrication.
   (E) The design life of spherical sector windows with square edge and hemispherical windows with equatorial flange, shown in **Fig 9.5** and meeting the requirements of this Standard, shall be 10 years from the date of fabrication.
   (F) The design life of cylinderical windows for internal pressure applications shown in **Fig 9.6** shall be 10 years from the date of fabrication.
   (G) The design life of cylinderical windows for external pressure applications shown in **Fig 9.6** shall be 20 years from the date of fabrication.
(2) The viewports(windows) other than **Table 9.2** and **9.3** shall be complied with the requirements of International Standards, ASME 2.2.7.1
(3) The permissible temperature range for acrylic plastic viewports(or windows) : -18 °C ~ 66 °C
(4) Maximum pressure ratio for acrylic plastic viewports(or windows) : 10 bar/sec
(5) Maximum pressure cycle : 10,000
(6) Maximum using hours under pressure of acrylic plastic viewports(or windows) : 40,000 hours
(7) Maximum working pressure for acrylic plastic viewports(or windows) : 1,380 bar

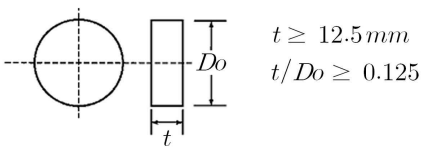


Fig 9.1 Flat Disk Viewports

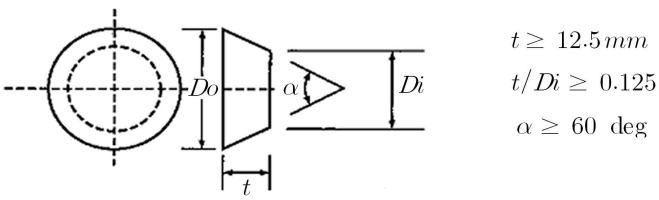


Fig 9.2 Conical Frustum Viewports

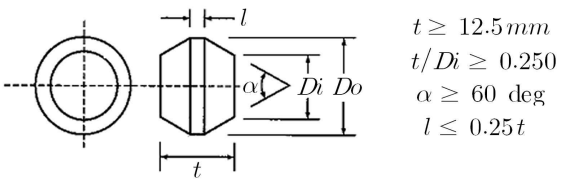
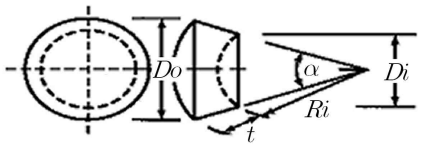
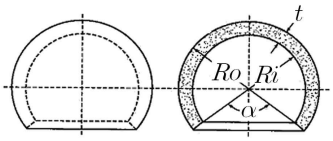


Fig 9.3 Double Beveled Disk Viewports



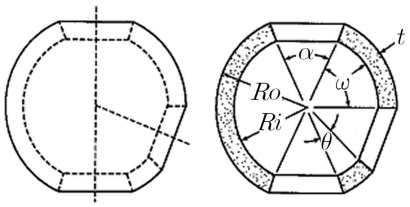
$t \geq 12.5\,mm$
$\alpha \geq 60$ deg
$t/Ri \geq 0.09$ for $\alpha \geq 60$ deg
$t/Ri \geq 0.06$ for $\alpha \geq 90$ deg
$t/Ri \geq 0.03$ for $\alpha = 180$ deg

Fig 9.4(a) Spherical Sector Viewports with Conical Edge



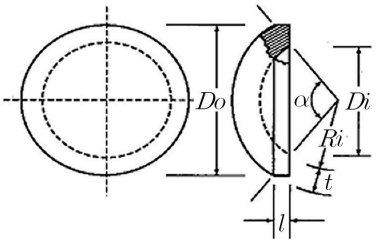
$t \geq 12.5\,mm$
$0.03 \leq t/Ro \leq 0.355$
$\alpha \leq 100$ deg

Fig 9.4(b) Hyperhemepherical Viewports



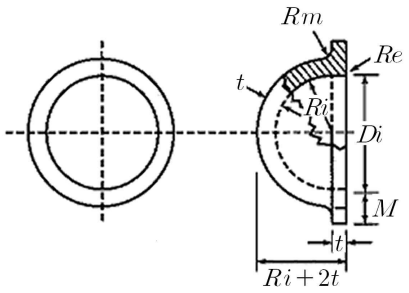
$t \geq 12.5\,mm$
$0.03 \leq t/Ro \leq 0.355$
$\alpha \leq 60$ deg
$\omega_i\theta =$
spacing between adjacent penetration shall exceed $\alpha/2$ of the larger penetrations

Fig 9.4(c) NEMO Viewports



$t \geq 12.5\,mm$
$30\,\text{deg} \leq \alpha \leq 150\,\text{deg}$
$t/Ri \geq 0.03$
$Di = 2Ri\sin\alpha/2$
$Do = 2Ro\sin\alpha/2$
$Ro = Ri + t$
$l = t\sin(90\,\text{deg} - \alpha/2)$

Fig 9.5(a) Spherical Sector Viewports with Square Edge



$t \geq 12.5\,mm$
$t/Ri > 0.03$
$Do = (Di + 4t)$
$Rm \geq 3.0\,mm$
$0.5\,mm \leq Re \leq 0.125t$
$0.5t \leq M \leq 2.0t$

Fig 9.5(b) Hemispherical Viewports with Equatorial Flange

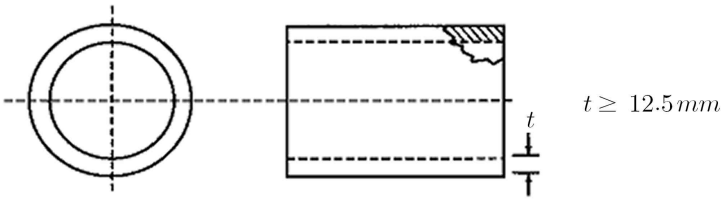


Fig 9.6 Cylinderical Viewports

1.2 Materials

(1) The materials used for acrylic plastic viewports(or windows) shall be complied with the **Table 9.1.**
(2) The manufacturer, when makes the acrylic plastic viewports(or windows) serially, shall issue the material certificates containing the following requirements.
(A) certificate number and dates issued
(B) maker's name and address
(C) type, design and application for casting
(D) a bundle number, quantity, shape and size for casting products
(E) marks of castings
(F) test results in **Table 9.1**
(G) endorse or signature
(3) If there is not the material certificate of acrylic plastic or it is unsatisfied, each test required by the Society shall be done.
(4) Each casting shall be made by marking at least on the position a manufacturing number, maker's name, dates constructed and a serial number.

1.3. Type and size for viewports(or windows)

(1) Type and size for viewports(or windows) shall be as same as **Table 9.2** and **9.3**, but for ones other than those viewports(or windows) the date shall be given independently to the Society, and then containing the purpose, the result of the function test and the manufacturing process.
(2) When constructing the viewports(or windows) the design temperature shall be ready to use the average of maximum inner temperature and outer one.
(3) When getting a pressure of viewports(or windows) inner and outer, the maximum of them shall be taken to design.
(4) In the case of the hemisphere type, the convex part shall be constructed to be pressurized.
(5) The thickness of the viewports(or windows) shall be equal to all the places, and are requested to comply with the **Table 9.2** and **9.3.**
(6) At the surface of viewports(or windows) with conical or convex type, the nominal external spherical radius shall be less than ± 0.5 % of the difference from ideal spherical sector.
(7) The surface roughness of viewports(or windows) shall be of 0.75 or less of the value.
(8) Windows for two-way pressurisation shall meet the requirements applicable to one-way windows in both directions. For double bevelled disc windows, not more than 50 % of the thickness shall be utilised in determination of short term critical pressure.
(9) O-ring grooves shall not be located in window bearing surfaces serving primarily as support or in the acrylic window itself.

2. Principles of Manufacture and Construction

2.1 Cutout sand viewports(or windows)

The seat dimensions for various standard windows shall be complied with the requirements of **Table 9.1** to **9.3.**

2.2 Construction of viewports(or windows)

(1) After all viewports(or windows) are constructed by machining required and manufacturer process-

ing, the heat treatment (tempering) shall be done in accordance with maker's specification.
(2) The viewport's surface shall be polished to be complied with the visual clarity required.
(3) The maker manufacturing viewports(or windows) shall get an appropriate certificate about all matters in the process of cutting, joining, polishing, molding and heat treatments, and the certificate shall contain the manufacturing date, performance test and the results.
(4) At those edge not to be put under the stress, the viewports(or windows) shall be permanently marked with the following items, but not use of punching.
(A) a design pressure (bar)
(B) a design temperature (°C)
(C) an approved stamp by the Society
(D) a serial number and a manufactured date
(E) name of manufacturer
(5) The included conical angle of the seating surface of a window shall be within +0.25/-0,00 degrees of the nominal value.
(6) The deviation of a spherical window from an ideal sphere shall be less than 0.5 % of the specified nominal external radius of the spherical section.
(7) Each window shall be annealed after all forming and polishing operations are completed. The annealing process shall be according to the annealing schedule in ASME PVHO-1.
(8) During the manufacturing process each window shall be equipped with identification and a manufacture process rider for recording of all pertinent data.
(9) Surface roughness of the frame is not exceeded 1.5 μm.
(10) The frame shall be provided with permanent protection against corrosion such as corrosion-proof buildup welding.
(11) Soft fillers may be used for primary sealing of standard windows and it shall be of enough viscosity to absorb adequate deformation without solidification.
(12) For flat surface windows with square frames, which are required for secondary sealing, the secondary sealing shall be fixed on the frame with a high-strength adhesive. In addition, the secondary sealing shall be also acted as supporters for the windows and less than 3 mm.
(13) All frames or metal flanges shall not be provided with filler grooves.
(14) The retainer ring shall provide adequate endurance against initial compression of the sealing arrangement due to the pressure.
(15) The seating surface and any grooves shall be ensured with complete cleanliness. Cleaner, grease for window seating and window sealing adherents shall be confirmed for this purpose before usage.
(16) Materials for acrylic plastic windows shall be manufactured and tested in accordance with the Society's requirements and ASME PVHO-1-1997 "Safety Standard for Pressure Vessels for Human Occupancy".

3. Inspection and tests *(2017)*

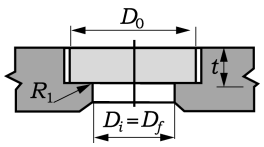
Inspection and tests shall be carried out in accordance with requirements of ASME PVHO-1, 2 in the presence of the surveyor.

Table 9.1 Mechanical, Optical Characteristics for acrylic plastic

Characteristics	Limitation	Test method
Ultimate tensile strength Elongation at break Elastic modulus	$\geq$ 62 N/mm^2 $\geq$ 2 % $\geq$ 2760 N/mm^2	ASTM *D* 638[1)]
Compression yield strength Elastic modulus	$\geq$ 103 N/mm^2 $\geq$ 2760 N/mm^2	ASTM *D* 695[1)]
Compressive deformation at 4000 psi(27.6MPa) and 50°C, 24 hours	$\leq$ 1 %	ASME PVHO-1, para 2-3.7 (c)
Ultraviolet transmittance(for 12.5mm thickness)	$\leq$ 5 %	ASME PVHO-1, para 2-3.7 (d)
Visual clarity	Clear print of size 7 lines per column inch(25mm) and 16 characters to the linear inch(25mm) shall be clearly visible when viewed from a distance of 20in.(500mm) through the thickness of the casting with the opposite faces polished.	ASME PVHO-1, para 2-3.7 (e)
Total residual monomer Methyl methacrylate Ethyl acrylate	$\leq$ 1.6 %	ASME PVHO-1, para 2-3.8
(Remarks) 1) The mechanical characteristics shall be proved by at least two(2) specimens.		

Table 9.2 Standard size for rectangular flat viewports(or windows)

Application
Minimum thickness : $t \geq 12.5$ mm
Thickness Ratio : $t/D_0 \geq 0.125$ mm
Edge radius : 1 mm $\leq R_1 \leq$ 2 mm
Ratio to viewport : $1.25 \leq D_0/D_f \leq 1.5$
Maximum operating pressure : $P \leq 170$ bar

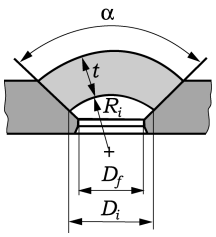


Design Pressure (P_c)(bar)	Minimum thickness / Inner diameter of seat (t/D_i)				
	10°C	24°C	38°C	52°C	66°C
5	0.134	0.146	0.154	0.164	0.188
10	0.154	0.173	0.188	0.201	0.226
15	0.173	0.195	0.210	0.223	0.253
20	0.188	0.210	0.226	0.240	0.281
25	0.201	0.223	0.240	0.257	0.305
30	0.210	0.233	0.253	0.274	0.324
35	0.219	0.243	0.267	0.292	0.344
40	0.226	0.253	0.281	0.305	0.363
45	0.233	0.264	0.295	0.317	0.383
50	0.240	0.274	0.305	0.329	0.402
60	0.253	0.295	0.324	0.354	0.441
70	0.267	0.310	0.344	0.378	0.480
80	0.281	0.324	0.363	0.402	0.520
90	0.295	0.339	0.383	0.427	0.559
100	0.305	0.354	0.402	0.451	0.598
110	0.315	0.368	0.422	0.476	0.637
120	0.324	0.383	0.441	0.500	0.676
130	0.334	0.398	0.461	0.524	0.715
140	0.344	0.412	0.480	0.549	0.754
150	0.354	0.427	0.500	0.573	0.793
160	0.363	0.441	0.520	0.598	0.832
170	0.373	0.456	0.539	0.622	0.871

Table 9.3 Standards for spherical shell type viewports(or windows) having conical type seat.

Application
Opening angle : $\alpha \geq 60^\circ$
Minimum thickness : $t \geq 12.5$ mm
Minimum ratio (t/D_0)
- when $\alpha \geq 60^\circ$, 0.09
- when $\alpha \geq 90^\circ$, 0.06

Ratio to viewport : $D_i/D_f \geq 1.02$
Maximum operating pressure : $P \leq 170$ bar



Design pressure P_c (bar)	Minimum thickness / inner diameter of seat (t/D_i)									
	when α = 60°					when α = 90°				
	10°C	24°C	38°C	52°C	66°C	10°C	24°C	38°C	52°C	66°C
5	0.090	0.090	0.090	0.090	0.090	0.042	0.042	0.042	0.042	0.049
10	0.090	0.090	0.090	0.090	0.112	0.042	0.043	0.049	0.054	0.070
15	0.090	0.090	0.097	0.108	0.140	0.043	0.052	0.060	0.067	0.089
20	0.090	0.097	0.112	0.126	0.166	0.049	0.060	0.070	0.080	0.107
25	0.090	0.108	0.126	0.143	0.191	0.054	0.067	0.080	0.091	0.124
30	0.097	0.119	0.140	0.160	0.215	0.060	0.075	0.089	0.102	0.142
35	0.104	0.129	0.153	0.176	0.238	0.065	0.082	0.098	0.113	0.160
40	0.112	0.140	0.166	0.191	0.259	0.070	0.089	0.107	0.124	0.177
45	0.119	0.150	0.179	0.206	0.279	0.075	0.095	0.116	0.135	0.194
50	0.126	0.160	0.191	0.221	0.298	0.080	0.102	0.124	0.146	0.210
60	0.140	0.179	0.215	0.248	0.332	0.089	0.116	0.142	0.168	0.242
70	0.153	0.197	0.238	0.274	0.363	0.098	0.128	0.160	0.190	0.272
80	0.166	0.215	0.259	0.298	0.391	0.107	0.142	0.177	0.210	0.300
90	0.179	0.232	0.279	0.320	0.416	0.116	0.155	0.194	0.230	0.327
100	0.191	0.248	0.298	0.340	0.439	0.124	0.168	0.210	0.250	0.351
110	0.203	0.264	0.315	0.359	0.460	0.133	0.181	0.226	0.269	0.373
120	0.215	0.279	0.332	0.377	0.480	0.142	0.194	0.242	0.287	0.393
130	0.227	0.293	0.348	0.394		0.151	0.206	0.257	0.304	0.411
140	0.238	0.307	0.363	0.410		0.160	0.218	0.272	0.320	
150	0.248	0.320	0.377	0.425		0.168	0.230	0.287	0.336	
160	0.259	0.332	0.391	0.439		0.177	0.242	0.300	0.651	
170	0.269	0.344	0.404	0.452		0.185	0.254	0.314	0.365	

Annex 9-3 Specific Survey Programs for Periodical Surveys

1. General

1.1 The requirements apply to periodical surveys for the equipment in **Ch 7, 601.**

1.2 Followings are to be examined during periodical surveys.

(1) emergency procedures for each work site to cover all foreseeable situations
(2) diving operations log
(3) valve shut-off checklists
(4) operational procedures
(5) emergency procedures
(6) dive log, duly signed off
(7) data sheet for diving system
(8) layout drawing for diving system
(9) PMS. records

1.3 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 Annex, 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.

1.4 Positioning systems (Dynamic Positioning, DP)

DP surveys are normally carried out on a two(2) yearly basis and should accompany the DSV survey when this is appropriate. However, when diving from a vessel on DP, a confirmation that the DP system is functioning satisfactorily should be carried out during the DSV survey on an annual basis.

1.5 Mooring systems

When diving from a vessel on mooring systems, periodical survey should accompany moorings.

1.6 Stability and floatability

Diving support vessels should be verified to maintain stability after periodical surveys and prior to starting diving operations.

2. Annual surveys

2.1 General

(1) Cleanliness of the system
  (A) An internal and external visual survey is required to assure cleanliness of the system. Particular attention should be paid to contamination by hydrocarbons such as grease, (other than silicone grease) oil, hydraulic oil etc. This is especially important in the oxygen compressor room and oxygen distribution room, but is also important in gas storage rooms and divers living areas.
  (B) Record the date when the diving system was last used and the extent of use since the last survey
  (C) Examine for, and record, any alterations that have been made since the last periodic survey.

2.2 Decompression chambers and diving bells

(1) Visual inspection on external damage and corrosion
(2) Examine the attachments, framework and supporting steelwork for chambers and system.
  (A) Ensure that bolts are secure and that steelwork supporting launch and recovery frame is in good order.
  (B) Tap gently the bolts on critical structures.
  (C) Certain attachments if moved or newly installed may require sea fastening calculations and a load test with NDT carried out.
(3) Examine to see that bunks are firmly supported.
(4) Examine if paintwork is clean, in good condition, and free from corrosion. Insulation should be clean, substantially free of damage and free from signs of corrosion underneath.
(5) Viewports are to be in accordance with **Ch 7, 705. 4** of the Rules or ASME PVHO-1/PVHO-2.
(6) Window and light port integrity is of utmost importance in diving systems, and they need to be examined closely. Windows should have a protective shield, clear plastic is suitable on the internally and externally.
(7) Windows exceeding 10 years of age should normally be replaced.
  (A) Windows should be clear, without discolouring, crazing, cracks or scratches. Provided the window thickness is sufficient according to the Rules, areas with scratches may be ground and polished before annealing and reinstallation. Maximum allowable depth of scratches on low pressure side: 0.3 mm and on high pressure side: 0.8 mm.
(8) Viewports at the top and bottom of diving bells should be equipped with internal protection against shock.
(9) If damage control plugs are provided to enable divers to quickly seal off windows in the event of serious leakage, one plug for each size of window is sufficient and should be examined for intact seals.
(10) Examine the hatch and medical lock sealing surfaces and o-rings. Particular attention should be paid to the Bell/TUP connecting flanges, the medical locks and equipment locks, and the bell bottom door flanges.
(11) Safety locking mechanisms shall be present on all hatches to prevent opening under pressure and these shall be function tested with the relevant chamber under pressure. Particular attention should be paid to medical / equipment locks with nut and bolt type doors. The locking mechanisms for these doors shall comply with the requirements given in the rules, both for preventing opening under pressure and preventing pressurisation when the locking arrangements are not in place.
(12) Examine the safety locking mechanism fitted between the bell and the transfer chamber preventing the mating clamp of the transfer chamber from being opened while there is pressure in the transfer trunk.
(13) Examine the structural integrity and corrosion status of chambers and bell with internal and external survey as applicable. Pay attention to bilges, equipment locks battery packs, maintenance, possible damage and serious corrosion. Examine with NDT if necessary.
(14) Corrosion status of Bilge pipes should be inspected including the lower section of the bell where the floor plating is in contact with the shell. Attachments to the bell(s), e.g. battery pack, gas containers, buoyancy blocks, should be examined.
(15) Examine the shell penetrations, especially the hot water penetrations on the bell where severe

corrosion is frequently found. This is especially found in un-sleeved penetrators. Oxygen and bilge penetrations in the chambers should also be inspected. Penetrators should be withdrawn if necessary. Threads should be examined. Examine areas around penetrators with regard to corrosion. Examine the bilge drains, supply and exhaust valves in bell(s) and chambers. Attention should be paid to the entry / equipment locks where there is a high level of moisture. At the discretion of the surveyor, penetrators should be withdrawn, if necessary. A thread gauge should be used to examine the threads.

(16) Ensure that the hollow penetrations are fitted with protection valves or other device to prevent catastrophic loss of pressure. Valves should be free of corrosion, should move freely through their full range of operations, and be clearly marked. The electrical penetrations should be certified and suitable for use on a pressure chamber. Open ended exhaust pipe work should be fitted with guards to protect fingers and avoid blockage. Open ended inlet pipe work should be fitted with some form of diffuser.

(17) The penetrations should be clearly marked to show their function.

(18) Function test pressure relied valves of the bell and chambers and alarm system.

(19) Function test supply valve silencers, non-return valves on exhaust lines and bilge discharge spring valves.

(20) Ensure that there are sufficient BIBS connections and masks for the designated number of occupants, plus one spare, in each chamber. Function test distribution panels.

(21) A method should be available whereby the stand-by diver can recover an unconscious diver into the bell singlehanded. This will normally consist of a self-locking hoist, used in conjunction with a pelvic lift type body harness worn by the diver. The diver can be lifted sufficiently for the bell doors to be closed. Make sure it runs smoothly.

(22) For the medical lock fitted on the bell, locking mechanisms and gauge should be tested. If external anodes are fitted, examine their general condition.

2.3 Gas storage cylinders and pressure vessels

(1) Visual inspection on external damage and corrosion

(2) Verify that cylinders have been examined, tested and marked according to requirements in the design code to which they were originally manufactured and certified. Ensure that gas containers are within their respective test dates. The last test date stamp on the cylinders should be painted over with a small patch of distinctive colour, to facilitate location.

(3) Verify that hazard warning signs are provided.

(4) Examine the attachments and the framework. Inspect supporting steelwork for racks including the bolts.

(5) Examine the structural integrity and corrosion status of gas containers. Examine externally and pay attention to maintenance, possible damage and serious corrosion. Examine by NDT if necessary.

(6) Where bulk gas is stored in an enclosed compartment function test gas leak detection system and audio/visual alarm system.

2.4 Pumps and compressors

(1) Pumps and compressors should be visually examined whilst running to ensure that there are no signs of leakage or excessive vibration.

(2) Leak test and further inspections should be carried out according to the manufacturer's manual.

(3) Examine the attachments and the framework. Inspect supporting steelwork for racks including the bolts.

(4) Verify that the compressors are fitted with solenoid switches, which will automatically stop the compressor if it begins to overheat.

(5) Except where oxygen-compatible oil is used, diaphragm type compressors should be fitted with cracked plate detectors, which will automatically stop the compressor in the event of diaphragm failure.

(6) Verify that where appropriate, there are warning signs on each compressor stating that it may be started up automatically and that care should be taken.

(7) Verify that there are audio/visual indications in dive control to warn of gas reclaim compressor malfunction.

(8) Verify that the equipment is maintained in accordance with the manufacturer's instructions. Particular attention should be paid to the regular changing of filters.

(9) Breathing air and gas delivered by compressors should be examined for purity.

2.5 Piping/ hoses/ valves/ fittings /filters/ driers/umbilicals

(1) Piping systems, including hoses and components, should be visually examined externally for damage, corrosion or leakage.
(2) Examine the cleanliness of the system by visual examination as required. Pay attention to contamination by hydrocarbons like grease, oil, hydraulic fluids.
(3) Pressure and leak test should be carried out for connections and distribution control panels
(4) Function and leak test should be carried out for O2 make up lines.
(5) Function and leak test should be carried out for ECU gas flow-lines, flow fuse and non-return valve
(6) Examine the leads of the umbilical and connecting tails to ensure they are arranged so as to avoid chafing and kinking.

2.6 Gas supply control

(1) Function test controls and instrumentation for gas supply.
(2) Examine the cleanliness of the system by visual examination as required. Pay attention to contamination by hydrocarbons like grease, oil, hydraulic fluids.
(3) Verify that the bulk storage of oxygen is in the open and well clear of fire hazard areas. Oxygen systems are pure oxygen or gas mixes with an oxygen content of 25 % or more.

2.7 Gas distribution system

(1) Examine the connections of the piping system to the surrounding structure. The system should be clean. Permanent marking of equipment is very important.
(2) Function tests the life support systems including the following:
  (A) heating and cooling arrangements
  (B) compressors; boosters
  (C) panels and piping systems, inclusive of flexible hoses for gas management
  (D) regeneration units
  (E) depth/pressure control.
(3) Examine with respect to modifications to approved system and arrangement for preventing damage of unattached flexible hoses. Function test O2 system valves including leak and cleanliness.
(4) Examine the oxygen make-up system. Visually examine and function test the system. Oxygen should normally be regulated at the storage quad down to 40 bars, with the exception of the on-board charging connection to the bell.
(5) Verify that oxygen lines are fitted with needle valves. The high pressure oxygen control system should not be fitted with quarter turn valves except where permitted. Pipe work should be examined to ensure segregation of the gas reclaim and the O2 System from the remaining system.
(6) Verify that where O2 levels are controlled manually there is a flow indicator situated in life support control, on the downstream side of the chamber O2 make-up line, to indicate when O2 is flowing into the chamber. Where automatic O2 injection systems are used there should be a control mechanism in place to ensure that the system cannot fail in the "on" position. The indicators should be function tested.
(7) Ensure that the oxygen make-up systems are arranged so that the oxygen is dispersed around the chamber. Where scrubber or internal environmental control units are used to disperse oxygen, the oxygen pipe outlet should be placed at the outlet point of the unit. The oxygen make-up system should not be capable of significantly exceeding the rate of metabolic consumption of the divers. Oxygen injection orifices should be fitted with a means, which will close in the event of a power failure and prevent potential harmful or explosive build up of oxygen levels within the reclamation unit.
(8) Examine if pressure is regulated at the storage quad down to a maximum of 50 bar (750 psi) for breathing gas supplies, or 60 bar (900 psi) for supplies to gas blenders.
(9) Verify that pipe work is hard plumbed wherever possible. Flexible hoses (oxygen compatible where required) should be kept to an absolute minimum. Visually inspect the piping to the chambers.
(10) Examine gas regeneration units and ECUs. Function test O2 solenoids if possible. Examine piping and valves.
(11) Examine if the Gas Reclaim panel is mounted within easy reach of the diving supervisor where the gauges can be clearly seen. An audio/visual alarm should be incorporated into the topside control panel to warn of reclaim compressor malfunction. The alarms shall be tested.
(12) Examine if a means of monitoring the gas bag is available. This may be by means of an au-

dio/visual over inflation alarm fitted to the gas bag. This alarm should operate in the gas bag area, the compressor room, dive control and chamber control.
(13) Verify that the gas bags are fitted with a relief valve or bursting disc, with overboard dump, to prevent rupture of the bags. Where system discharge exceeds gas bag capacity, such as in the case of exceptionally deep dives, suitable precautions should be in place. This may take the form of a solenoid-operated three-way valve which will discharge exhaust gases directly over the side instead of to the chamber gas reclaim system.
(14) Verify that there is sufficient room to allow for full expansion of the gas bag.
(15) Examine if there is a management system to monitor bacterial growth in the bag.
(16) Verify that reclaimed chamber gases is analysed for oxygen and carbon dioxide content prior to their re-use.
(17) Verify that indicator lights showing compressor cycling function, are installed in dive control room and chamber control room.
(18) Examine the arrangements made for preventing damage caused by discharging unattached flexible hoses. Hoses should be as short as possible.
(19) Test manual and automatic control valves and reduction valves by varying the set point of the control parameters, to ensure correct pressure/power delivery.
(20) Function test the gas reclaim water trap.
(21) Ensure that each diver's gas supply line is arranged so that if one line fails the failure does not interfere with another diver's supply.
(22) Examine the gas supplies to see they are so arranged that when blowing down or flushing the bell there is no interference with the diver's gas supply.
(23) Determine that the oxygen supply is fitted with a means whereby oxygen at a reduced pressure flows into the bell at a controlled rate or volume. HP oxygen should not be supplied into the bell.
(24) Verify that there is a means available, permitting the gas cylinder pressure to be read from both inside and outside the bell.
(25) Examine BIBS mask for each diver carried in the bell and see that they are functioning.

2.8 Depth/pressure control

(1) Verify the calibration of essential gauges and clocks and accuracy.
(2) Inspect the gauges and indicators critical for the life support system.
(3) Examine the calibration of oxygen gauge and oxygen usage.
(4) Verify that pressure-limiting devices are functioning to prevent gauges, such as therapeutic depth gauges, being exposed to pressure beyond their range.
(5) Verify that gauges for recording pressure over 40 bar are fitted with a safety relief device or suitably protected.
(6) Verify that gauges used on oxygen lines are compatible with such application.
(7) Verify that internal indicating gauges are fitted in each compartment and bell, and that they are calibrated.

2.9 Temperature and humidity control

(1) Function test and visual inspection for temperature and humidity control.
(2) Function test heaters in chambers, bells and hyperbaric evacuation systems. The system should be function tested in normal and back-up modes. Some systems have a hot water buffer tank and a separate pump as a back-up to the machines and this should be tested. The machines should have adequate flow rates; typically ~ 30 ℓ/minute per diver is required. If a calorifier is fitted this should be surveyed as a pressure vessel and any electrical systems inspected.
(3) Examine that heating for the chambers is controlled and maintained by the Environmental Conditioning Units.
(4) Examine the hot water piping and delivery to the bell(s) and divers.
(5) Examine how power will be supplied to the heating/cooling system to maintain operations for the period of diver's recovery if the support vessel loses its main power supplies.
(6) Ensure that a display indicating the temperature of hot water being passed down to the divers is available to the diving supervisor at the dive control point. The display should be fitted with audio/visual alarms, which will indicate when the temperature has moved outside pre-set high and low limit. Alarms for high and low temperature and low pressure should be tested.
(7) Ensure that for diesel fired heaters it is not possible to overflow the diesel day tank, i.e. a high level shut-off, return pipe or alarm should be fitted. The fuel supply system to the ready use fuel tank on oil fired hot water machines should be fitted with an automatic shut off facility

that will operate when the ready use tank is full, or a dead-man's handle. Where possible the fuel supply should be hard plumbed.
(8) Verify that, where applicable, oil fired hot water machines are so placed as to minimise risk to the diving system should they malfunction and catch fire. They should be mounted in a suitable spill tray, and the spill tray should be fitted with a drain leading to a safe dump area.

2.10 O2 / CO2 / contamination analysis

(1) Function test and visual inspection for O2 / CO2 / contamination analysis.
(2) Verify that the atmosphere in the chambers are monitored for levels of O2, CO2, temperature and relative humidity, with both primary and secondary methods being provided to monitor O2 and CO2. There should be means by which the diving supervisor can monitor the bell atmosphere for O2 and CO2 levels independently.
(3) Verify that there is an oxygen analyser fitted with audio/visual hi/low alarm on the downstream gas supply to the divers. Where a diver gas reclaim system is used, a CO2 analyser with audio/visual hi/low alarm should be installed into the down-stream diver gas supply. The adjustment of gas sample flow rate should not affect the correct functioning of any other analyser fitted at the same point.
(4) Verify that gas analysers are calibrated.
(5) Verify that oxygen analysers with audio-visual high/low alarm are provided in enclosed diving control rooms to warn of changes in the atmosphere O2 levels caused by leakage in the diving gas supply systems.
(6) Determine the means by which divers in the bell can monitor O2 and CO2 levels independently of the surface. Proof should be available that analysers in the bell have been examined and tested.
(7) Function test the primary powered scrubber unit removing CO2 from the bell atmosphere.
(8) Examine the secondary means of CO2 scrubbing in the bell that is independent of any surface power supply and determine if it has a minimum endurance of 24 hours.

2.11 Sanitary

(1) Ensure that there are no signs of leakage and safety devices function. Visual inspection on external damage and corrosion
(2) Examine the toilet flush system and function test it with special attention to safe working under pressure. Verify that the safety locking mechanisms is still in operation. It is sometimes removed for convenience. The locking mechanism is to ensure that it is not possible to sit on the toilet and flush it at the same time. This is often done by means of a linkage between the seat cover and a 1/2 turn valve. Note also that the hyperbaric evacuation unit may have a toilet.
(3) The sewage tanks shall be internally inspected.
(4) Function test the bilge drains in chambers to ensure that no accumulation of water or corrosion is evident. For split lock bulkhead (dished end of the inner chamber), thickness measurements should be carried, if necessary.
(5) Examine hot and cold water supplies to chambers

2.12 Auxiliary services to life support equipment

(1) Visually examine the power systems supplying the life support systems to ensure that the consumers are supplied and not causing peak loads.
(2) Visual inspection for the equipment according to a written list included in the planned maintenance system.
(3) Examine/test main and emergency power supplies for the following:
(A) lighting of chambers and bell (external on bell in addition)
(B) monitoring devices
(C) control consoles - saturation/dive and local control stands i.e. medical-locks and handling area
(D) normal and emergency life support systems
(E) alarm systems including fire loops
(F) condition of the switchboards, breakers and cables including cleanliness
(G) megger test records
(H) dynamic positioning alarm.
(4) Ensure that the required level of lighting is available around the diving system, and there should be self-contained emergency lighting provided in dive and saturation control rooms.
(5) Test that the change over from main to emergency supplies operates correctly.

(6) Determine if the bell electrical supply is fitted with an earth leakage detection system and alarms.
(7) Verify that emergency supplies are available to maintain essential supplies to divers, including:
(A) lights
(B) power packs
(C) scrubbers
(D) monitors
(E) analysers
(F) heating systems
(G) communications.
(8) Diving bell is to be equipped with lighting illuminates 360 degrees to assist diver location/orientation.
(9) Verify that the battery terminals/leads on external bell battery packs are insulated to protect them against short circuits.
(10) Verify that the battery housing on the bell has a relief valve.
(11) Test the earth monitoring systems, if applicable
(12) Examine/test the following:
(A) main electrical power supplies
(B) lighting of chambers and bell (int. and ext.)
(C) monitoring devices
(D) control consoles (sat, dive, handling)
(E) normal and emergency life support systems
(F) alarm systems
(G) switchboards, breakers, cables
(H) megger test records.
(13) Examine if lighting is adequate, and positioned so as to clearly illuminate the gas control panel and depth gauges. Secondary lighting should be provided. There should be lighting adequate for illuminating the chambers for surveillance purposes, and for divers' convenience. Examine external lights/assemblies on the chambers to ensure no damage to either the light assembly or the windows has occurred.
(14) Test the correct operation of change over from main to emergency supplies. Verify and ensure maintenance and tests are being carried out regularly.

2.13 Communication

(1) Primary
(A) function test primary communication systems and it should be carried out according to a written procedure.
(B) Examine the communication systems between the control stand and the:
- divers in the water
- bell
- compartments
- bridge
- Various control stands.
(C) Test the two-way communications between the:
- control station and the chambers/bells
- saturation control room and the dive control room
- saturation control room and the food locks (medical locks)
- saturation control room and the HES lock-off position.
- Testing should include sound powered phones, headsets and other systems. Diver’s mask communications should be tested in the bell(s).
(D) Determine if the supervisor has two-way voice communications with the divers, and the stand by diver and function test two-way voice communications, tape recorder and through water communications.
(E) Verify that the diving stations, machinery areas and the diving supervisor have means of:
- communicating with the key diving machinery areas and the winch/crane operator (where practicable this should be hard wired with dedicated link to the winch driver)
- surveillance of working areas as appropriate
- diving station, winch/crane operator

- dedicated link to winch driver

(F) Examine if provision are made for the divers inside the chambers to be within sight of life support personnel outside. Where there is no clear access to the ports, or life support control is remote from the bell, a closed circuit TV system should be fitted.

(2) Secondary

(A) function test secondary communication systems and it should be carried out according to a written procedure.

(B) Examine the secondary communication between control stand and the:
- divers in water
- bell
- compartment
- bridge
- various other control stands.

(C) Test the sound powered telephone providing the supervisor secondary communications to the diving bell.

(3) Emergency

(A) function test emergency communication systems and it should be carried out according to a written procedure.

(B) Examine and test the emergency communications including direct voice communication between the control stand, and the:
- bell
- compartment
- control stands as applicable
- the bridge (operational command centre).

(C) Examine if the bell through-water communications has available connections into the recorder.

(D) Examine if the surface transducer can be arranged so that interference by noise from the vessel's machinery or thrusters is minimised. This may involve deployment below the lowest point of the vessel.

(E) Test the communications in the breathing apparatus sets provided for the moon-pool team, with communication facility to the dive control.

(F) Test the bell emergency locating device for the bell. Determine if it has an operating frequency of 37.5 kHz. The validity date of the batteries on the transponder and strobe on the bell should be examined. A transponder should be fitted to the bell to aid relocation should it become separated from the support vessel. Transponder fitted, 37.5 kHz rated to 200 meters should be tested.

(G) Test the strobe light on the bell, and determine if it has a minimum of 24 hours duration to aid visual relocation.

(H) Verify the presence of a standard bell emergency communication tapping code.

(4) Alarms

(A) Function test the alarms. Tests should be carried out according to a written procedure.

(B) Test an audio/visual alarm, which is activated by the Dynamic Positioning System.

(C) Examine if the vessel or installation general alarm system is linked into the dive control room, or sited close by so that it can be heard and seen (where appropriate) at the dive control point.

(D) Examine if oxygen analysers with audio/visual hi/low alarms are provided in enclosed diving control rooms to warn of changes in the atmospheric O2 level caused by leakage in the diving gas supply systems. A repeater of the gas storage compartment O2 high/ low alarm should be located either in saturation control, or external to the compartment.

2.14 Launch and Recovery System

(1) Visually examine primary, secondary and emergency submergence launch and recovery systems for functionality.

(2) Electrical and pressure control functions

(A) Visually examine electrical and pressure control functions of submergence launch and recovery systems for functionality.

(3) Examine the bell main lifting arrangements closely, with particular attention given to the load bearing components. NDT should be performed at the surveyor's discretion.

(4) Determine the working weight of the bell(s) and enter the weight(s) into the records. The current result should be compared with the previous result. Ensure a calibrated load cell is used.
(5) Perform a dynamic load test of the launch and recovery system. Test Load factors are 1.25 × working weight of bell with independent brake test:
  (A) The bell should be loaded with 150 kg per diver plus the weight of his excluding equipment and tools, times the number of divers the bell is rated for.
  (B) The function test should be demonstrated by raising and lowering the bell on primary and secondary means. Normal and emergency electrical power should be tested. The bell should stop gently without excessive creep.
  (C) Independent brakes should be demonstrated by locking off one of the brakes, i.e. locking off the band brake (if applicable) and examining for creep on the counter balance valve and vice versa. Creep should not be excessive.
  (D) The hydraulic power system should be observed during running and examined for unusually high vibration levels, oil leakage, pressure peaks and jerking during bell launch and recovery. Oil analysis should be taken as necessary.
  (E) Ensure that winch-operating levers returns to a central neutral position upon being released by the operator and that the "raise" "lower" and "neutral" position of the operating levers are clearly marked.
  (F) Ensure that the automatic brakes come into operation whenever the operating lever returns to the neutral position, or when there is a loss of operating power to the winches. Verify also that the secondary brakes operate in case of failure of the primary brakes.
  (G) The alignment between the bell and the chamber trunk should be verified. The bell should be mated to the chamber trunk and the closing devices function tested.
  (H) Verify that alarms and safety functions are in order.
(6) Verify that the man-riding winch systems used for bell/basket deployment incorporate secondary motors and sources of operating power. If clutches are fitted to the winch drive shafts, they should be prevented from becoming disengaged while the winches are in operation.
(7) Verify that emergency supplies are available to recover the bell including:
  (A) lights
  (B) power packs
  (C) winch controls
  (D) monitors
  (E) bell/power/lights
  (F) communications.
(8) Examine the winch drum capacities that should be sufficient to accommodate the full length of the wire used except where special guards are fitted to prevent overspill. The distance between the top layer of rope, when evenly wound onto the drums, and the outer edge of the drum flanges, should be at least 2.5 times the diameter of the rope used. Where they are open to normal access, winch drums should be guarded to prevent anything being drawn into the machinery.
(9) Examine the wire certificates and verify that the wires are non-rotating when that is required.

2.15 Auxiliary services to launch and recovery system (umbilical handling, power supplies, etc.)

(1) Visually examine the power systems supplying the lifting appliances to ensure that the consumers are supplied and not causing peak loads.
(2) Visually examine for possible damage and corrosion.
(3) Examine the attachments and frameworks to ensure structural integrity and determine corrosion status of the launch and recovery system.
(4) Examine the wires and terminations, i.e. bell wire, guide wires, cursor wires. Visual examination may be carried out according to ISO standard 4309, "Wire rope for lifting appliances - code of practice for examination and discard." The minimum breaking load should not been reduced by 10 % or more of its strength compared to new. The factor of safety between rope strength and SWL should not fall below 8:1.
(5) Wire should be cut and re-terminated at the bell end every 12 months. This applies also for the guide wires and cursor wires, if required. The minimum length to be removed will be from the bell to 5 metres beyond the sheave nearest the bell, as it becomes fully submerged. Any lifting

wires that have been re-socketed should be load tested to the launch and recovery systems design load.

(6) Examine the sheaves and guide rollers that are in contact with the moving wire for signs of surface wear. The line out indicator should be examined for operation.

(7) Examine the attachment point on the bell for connection of the main lift wire. Where a main lift wire is connected to a deployment device with a shackle or socket, there should be a suitable and safe method of attaching the main lift wire, utilizing an appropriate locking device.

(8) Examine that the wire has been pressure lubricated from the winch drum to the bell as far as the depth of deployment.

(9) If a winching system is used to traverse the bell laterally while it is at working depth, and thereby supports the weight of the bell in water, this should be tested to give a design load based on the weight of the bell in water when it is fully equipped, manned and ballasted.

(10) Ensure that a dedicated means of attaching a secondary lift wire is fitted e.g. delta plate sling or other. The secondary lift wire need not be attached in normal operation but should be examined annually.

(11) Examine the secondary means of recovery that is independent of the primary launch and recovery system. Ensure that it enables the bell to be mated to the TUP chamber. It should have a certified design load that is equal to or greater than the primary system. Where the secondary system is only capable of lifting the weight of the bell in water there should be an alternative designed and tested method of hoisting the bell clear of the water which enables it to be mated to the TUP chamber.

(12) In certain circumstances reliance on buoyant ascent as a means of diver rescue might be utilised and should be examined to meet the criteria listed below:

(A) Drop weights should be capable of release from inside the bell and precautions should be taken to prevent accidental release.

(B) The ballast release system should work in two independent stages, so that one action cannot release the ballast.

(C) Examine that the drop-weights are secured to prevent accidental shedding.

(D) Examine the bell ballast release wires (if applicable). Wires should be well lubricated. Particular attention should be paid if bright, not galvanised, wire is being used.

(E) If operation of the primary and secondary release mechanisms relies on a common structural component, then an independent means should be provided to retain the ballast i.e. no single component failure should result in buoyant ascent of the bell.

(13) When one of the emergency systems for recovery of the bell is by buoyant ascent of the bell, the value of the positive buoyancy should be determined.

(A) The drop weights should be removed for the test and the bell loaded with 150 kg per diver, plus the weight of his equipment, times the number of divers that the bell is rated for.

(B) The minimum required positive buoyancy is 3 % of the total displacement including the external appendages, such as external lights and onboard gas, etc.

(C) The trunk is also to be filled with water. This can be accomplished by using a hose fitted in the trunk and led some distance up the side of the bell. Water pressure will then displace the air in the trunk.

(D) A comparison should be made with the results of the previousbuoyancy test to see if any differences have occurred.

(E) Examine for ‘unauthorised’ modification to the buoyancy.

(14) Test the following bell emergency release mechanisms on the bell:

(A) umbilical connection/umbilical cutters

(B) lifting wire connection

(C) guide wire release (if applicable)

(D) ballast weights.

(E) Ensure that the release is carried out with the ballast weight supported to avoid shock loading on the bell.

(15) Carry out load tests. The following tests should be carried out:

(A) function test the system at 1.25 × working weight: specified in kg

(B) carry out a brake test at 1.25 × working weight: specified in kg.

(16) Function tests should be carried out on normal and backup power. Brakes should be tested independently and dynamically.

(17) Examine bell transfer and mating flanges. Examine the alignment with TUP. Function test locking mechanisms and test on emergency power.

(18) Examine hydraulic power system and determine that the last oil analysis date was / is recorded.
(19) Examine the main electrical power supplies to:
  (A) monitoring devices
  (B) control consoles
  (C) alarm systems
  (D) switchboards, breakers, cables.
  (E) Examine the Megger test records.
(20) Determine that there are two independent power supplies to the launch and recovery system.
(21) Examine the breathing apparatus provided for the winch operator(s) in case of a fire related emergency requiring recovery of the bell. If an umbilical supplied breathing system is provided, communications should be fitted and the fixed air intakes for the compressor supplying the breathing apparatus umbilical should be located in pollution free area.
(22) Examine if there is a means available of indicating the amount of umbilical and bell wire that has been paid out.
(23) Determine if the umbilical winch is fitted with a mechanical brake to prevent the umbilical paying out under load when the winch drive motor is in use. This needs to be examined.

2.16 Safety Equipment

(1) Fire safety
  (A) Visually examine fire doors, alarms, fixed fire fighting systems and portable fire extinguishers.
  (B) Determine if a general arrangement diagram of the diving system layout and configuration is attached.
  (C) Examine the condition of the A-60 fire protection towards any enclosed spaces from the outer area of the diving system.
  (D) Examine the fire detection systems in unmanned machinery spaces. Verify that type is suitable and that there are sufficient appliances. The permanently installed fire detection / alarm in gas storage and chamber rooms / diving areas should be tested. Alarm and safety limits should be examined as well as failure conditions of the fire systems. The ventilation system should be function tested.
  (E) Proper provision should be made for fire fighting in the diving control rooms and machinery spaces. Verify that type is suitable and that there are sufficient appliances. Proof should be available of examination and test. Determine that the type is suitable and that there are sufficient appliances.
  (F) Examine the fixed fire extinguishing systems. Note that CO2 is not accepted as an extinguishing agent in a fixed fire extinguishing systems for the outer area around the diving system. In due course, Halon will also be prohibited as an agent. Determine if the deluge systems include the chambers and gas storage rooms.
  (G) Examine the portable fire extinguishers in the chambers. Some extinguishers need safety valves incorporating bursting discs or relief valves to prevent over-pressurisation of the low pressure container.
  (H) Examine the portable fire extinguishers outside chambers. The extinguishers should be stored where they can be easily and quickly used in an emergency. Different extinguishers should be available to tackle different types of fire. The safety plan should be examined to see if sufficient numbers of extinguishers have been posted.
  (I) Examine the breathing apparatus with communications to chambers provided in the control rooms to enable the occupants to carry out emergency and life support functions in a smoke-laden atmosphere.

2.17 Hyperbaric evacuation

Visually examine the evacuation system to ensure that there is no damage to the system.

2.18 Personal protective equipment (including personal diving equipment)

Visually examine portable breathing apparatus, fireman's outfit (if fitted) and personal diving equipment. Follow manufacturer's instructions.

3. INTERMEDIATE SURVEY

3.1 General

(1) Leak testing should be carried out at low and high pressures by stepwise increasing the pressure to the working pressure. Leak tests are normally carried out with a minimum of 10 % He, if the pressure vessel or piping is designed to hold Heliox mixtures or pure He.
(2) Note that there is a fire risk with use of air at high pressure. Most leak tests therefore incorporate Nitrogen where applicable.
(3) The scope for the annual survey is added to the following scope for the intermediate survey.

3.2 Pressure vessels for human occupancy (chambers and bells) *(2017)*

(1) Leak test the chambers and bells to the maximum allowable working pressure (MAWP) with min. 20 % He. The test duration should be minimum 6 hours. Safety precautions shall be stated in the procedure. The procedure shall include an examination for leaks at low pressure before increasing to MAWP. Record:
(A) pressure: _____bar
(B) duration:_____hrs.
(C) result:_____.
(2) The tests are required to comply with the provision of **Ch 7, 607. 2** (7) of the Rules.

3.3 Gas storage cylinder and pressure vessel

New piping shall be hydrostatically tested to the test pressure determined by the design code. Most design codes for seamless cylinders have the test pressure stamped on the neck of the cylinder. A number of safety valves on permanently installed gas bottles selected by the surveyor should be tested to ensure their setting and operation. A register should be kept detailing the serial number of the valve and its set point. Valves should be labelled. The selected valves should be tested individually on a test stand, if possible. If considered safe, they can be tested on the bottle by taking the pressure above set point. The pressure should not exceed the safe working pressure.

3.4 Pressure test of pressure containing vessels (including chambers and diving bells)

(1) Pressure testing should be carried out in accordance with an approved procedure on the relevant pressure vessels. When modifications to the pressure have been carried out, the test requirements apply as given for new pressure vessels.
(2) Pressure testing shall be carried out in accordance with the procedure, and to the test pressure, required by the design code of the pressure vessel. The maximum allowable working pressure (MAWP) is determined by dividing the test pressure by a safety factor. The minimum safety factors shall be not less than 1.3.
(3) All pressure tests should be witnessed by the Surveyor. Internal visual inspections may be undertaken by a competent company in accordance with a prior agreement
(4) Prior to hydro testing, a thorough visual inspection internally and externally shall be conducted.
(5) Acoustic emission testing in lieu of hydrostatic testing of gas storage tubes is normally not accepted.
(6) Pressure modification(downgrading)
(A) In lieu of hydraulic pressure testing, it may be acceptable to carry out a pneumatic pressure test to the maximum allowable working pressure (MAWP) and to downgrade the existing working pressure by the applicable safety factor (minimum 1.3).
(B) For downgrading of pressure vessels in KR-certified diving systems, refer to the design code of the pressure vessel when determining Test and Maximum Allowable Working Pressures (TP and MAWP). Determine the new shell thickness if there is corrosion and apply the new shell thickness to the original design so you arrive at the New TP and a New MAWP.
(7) Pressure modification(downgrading) procedure
(A) calculate the strength at the modified pressure with the design code for the PV
(B) measure thicknesses of the shell
(C) apply the thicknesses to the calculations in the code and calculate the New TP
(D) divide the New TP with the safety factor in the code to arrive at the New MAWP.
(E) submit test procedure for approval
(F) for hydrostatic testing, test to the New TP and use to the New MAWP
(G for pneumatic testing, test pneumatically to the New MAWP. Divide the New MAWP by the safety factor used in (D). to arrive at the Downgraded MAWP. Use at the Downgraded

MAWP.

(8) Downgrading of chambers may be requested either:
  (A) to carry out periodical pressure testing after ten years pneumatically at a reduced pressure, or
  (B) after installation of windows with a lower design pressure than the chamber, or
  (C) after any other causes which may or may not imply a reduction of strength of the pressure vessel.

(9) First year periodic survey of pressure containing vessels (including chambersm diving bells, etc.)
  (A) All pressure vessels and piping shall be visually examined externally on an annual basis. Chambers and diving bells shall be visually examined internally also.

(10) Second year periodic survey of pressure containing vessels (including chambersm diving bells, etc.)
  (A) All pressure vessels shall be visually examined internally as well as externally at two yearly intervals, excepting gas storage tubes and piping. The latter are examined externally only.
  (B) Gas cylinders used in or under water shall be hydrostatically tested at intervals of 4 years.

(11) Fifth year periodic survey of pressure containing vessels (including chambers and diving bells)
  (A) At five year intervals chambers and bells are hydrotested with an internal pressure equivalent to the test pressures given by the design code. If diving bells are to be used for observation diving (internal pressure at one atmosphere), they shall be hydrostatically tested to the external test pressure determined by the design code.
  (B) At five year intervals gas cylinders and gas storage tubes, shall be hydrostatically tested to the test pressure and procedure (permanent set evaluation) as determined by the design code. At the first complete periodical survey the interval for hydraulic pressure testing of gas containers may be extended to 10 years if the following principles are applied:
    - external and internal survey by intra-scope
    - if internal survey is not possible or if corrosion or other items of concern are found, hydraulic test shall be carried out to the test pressure determined by the design code.
  (C) At five year intervals air and gas volume tanks, and sewage tanks, shall be hydrostatically tested to the test pressure determined by the design code.

3.5 Pumps and Compressors

(1) Boosters and compressors may be tested in running condition by letting the pressure exceed the safety valve setting. It may be necessary to use a calibrated gauge to ensure the pressure does not reach a dangerous level in the event of a safety valve failing to operate.
(2) Examine and test safety valves on compressors and boosters according to the manufacturer's instructions.
(3) Ensure that there are no signs of leakage or excessive vibration whilst running test.

3.6 Piping, hoses, valves, filters, driers and umbilicals

(1) Leak test the gas containers to maximum allowable working pressure (MAWP) with min. 10 % He. The test duration should be minimum 6 hours. Safety precautions shall be stated in the procedure. The procedure shall include an examination for leaks at low pressure before increasing to MAWP. Leakage rates should normally be less than 1 % pressure drop in 24 hours.
(2) Examine manual / automatic control valves and reduction valves and test by varying set point of control parameters to ensure correct pressure / power delivery. Verify that valves are working within their pressure rating.
(3) A number of valves should be tested in the presence of the Surveyor.
(4) Functions test the Main Bell umbilical to the maximum working pressure of the umbilical gas hoses. A flow check should also be carried out. For the hot water hose, this may need to be done by blowing a ball through to check against crushing. Insulation tests of the electrical conductors as well as function test (loop test) measurements of signal cables to the specified properties should be carried out. During insulation resistance testing, the umbilical should be disconnected at the upper part (slip ring) and at bell connection to avoid damage to electrical components.
(5) Visually examine the umbilical(s) and function test to the maximum allowable working pressure of the hoses. Electrical lines should be Megger tested.

3.7 Gas supply control

Examine and test life support systems during the survey, including pipe work and reclaim units. Gas delivered by the compressors should be examined for contamination by a competent company.

3.8 Gas distribution system

For the scope of annual survey, examine and test gas distribution system.

3.9 Depth and pressure control system

For the scope of annual survey, examine and test depth and pressure control system.

3.10 Temperature and humidity control system

For the scope of annual survey, examine and test temperature and humidity control system.

3.11 O2, CO2 and contamination analyser

For the scope of annual survey, examine and test O2, CO2 and contamination analyser

3.12 Sanitary

For the scope of annual survey, examine and test sanitary equipment.

3.13 Auxiliary services to life support equipment

For the scope of annual survey, examine and test auxiliary services to life support equipment.

3.14 Communication

(1) Primary communications
For the scope of annual survey, examine and test primary communications.
(2) Secondary communications
For the scope of annual survey, examine and test secondary communications.
(3) Emergency communications
For the scope of annual survey, examine and test emergency communications.
(4) Alarms
(A) Function test the following alarms:
- high/low pressure alarm for chamber
- temperature alarm for chamber
- divers hot water temperature alarms
- divers hot water pressure alarms
- change over to standby heater alarm
- gas delivery compressor - high pressure alarm
- compressor cooling system - low pressure alarm
- compressor - low pressure lubrication oil alarm
- O2 analysers, high/low alarm
- high level alarm for gas reclaim bag
- low O2 atmosphere sensors in control rooms.

(B) For alarms and safety systems, occurred faults during operation are to be reviewed and function test in accordance with the manufacturer's instructions.

3.15 Launch and Recovery System

(1) Determine the working weight of the bell,

(A) the bell weight: (in kN or kg)
(B) the previous weight: (in kN or kg).

(2) Test the following hydraulic systems power failure alarms (including electrical alarm systems) for bell launch and recovery:
(A) low pressure alarm
(B) high temperature alarm
(C) low oil level in tank alarm.

3.16 Auxiliary services to launch and recovery system (umbilical handling, power supplies, etc.)

For the scope of annual survey, examine and test primary communications.

3.17 Safety Equipment

(1) Fire safety
(A) Function test fire detection and alarm system
(B) Function test portable and fixed type fire extinguishing system.
(C) Examine and test the permanently installed fire extinguishing systems by a competent company.

3.18 Hyperbaric Evacuation systems

When extra chamber is installed, examine and test as described above.

3.19 Personal protective equipment (including personal diving equipment)

Visually examine and pressure test portable breathing apparatus, fireman's outfit (if fitted) and personal diving equipment.

4. Special(Renewal) survey

4.1 General

(1) The scope for annual and intermediate survey is added to the following scope for the special survey.
(2) Special surveys are carried out before the anniversary date, set 5 years after the previous renewal survey.
(3) At special survey, overhaul and dismantle all the diving systems. However, it may be extended to 5 years after final overhaul inspection in the presence of the Surveyor if recommended overhaul period is not elapsed.

4.2 Pressure vessels for human occupancy (chambers and bells)

(1) Examine the bell insulation and determine if affected areas require removal because of damage or signs of corrosion. Parts of the bell insulation should be removed if evidence of cracking exists. Areas around windows and attachments are prone. NDT should be carried out as necessary.
(2) Pressure testing of chambers shall be carried out according to a procedure based on the design code
(3) Bells are hydro-tested with an internal pressure equivalent to the test pressures given by the design code. If diving bells are to be used for observation diving (internal pressure at one atmosphere), they shall be hydrostatically tested to the external test pressure determined by the design code.
(4) It is to be inspected in accordance with **Ch 7, 607. 2** of the Rules.

4.3 Gas storage cylinder and pressure vessel

A number of safety valves on permanently installed gas bottles selected by the surveyor should be tested to ensure their setting and operation. A register should be kept detailing the serial number of the valve and its set point. Valves should be labelled. The selected valves should be tested individually on a test stand, if possible. If considered safe, they can be tested on the bottle by taking the pressure above set point. The pressure should not exceed the safe working pressure.

4.4 Pressure test of pressure containing vessels (including chambersm diving bells, etc.)

(1) Verify that pressure vessels have been examined and tested according to either the scope of intermediate survey or **3.4**, whichever is appropriate for the period of renewal survey.
(2) Pressure testing of pressure vessels in supply and return lines shall be carried out according to a procedure based on the design code(s). Air and gas volume tanks, and sewage tanks, shall be hydrostatically tested to the test pressure determined by the design code.

4.5 Pumps and compressors

(1) Verify that the equipment is overhauled in accordance with the manufacturer's instructions.
(2) Immediate survey items are to be inspected and tested.

4.6 Piping, hoses, valves, filters, driers and umbilicals

(1) Clean the piping and examine the cleanliness of the system.
(2) Pressure testing of piping systems shall be carried out according to a procedure based on the design code(s). The safety factor (SF) for piping is normally 1.5 to determine the maximum allowable working pressure (MAWP)

4.7 Gas supply control

For the scope of intermediate survey, examine and test gas supply control.

4.8 Gas distribution system

For the scope of intermediate survey, examine and test gas distribution system.

4.9 Depth and pressure control system

For the scope of intermediate survey, examine and test depth and pressure control system.

4.10 Temperature and humidity control system

For the scope of intermediate survey, examine and test temperature and humidity control system.

4.11 O2, CO2 and contamination analyser

For the scope of intermediate survey, examine and test O2, CO2 and contamination analyser

4.12 Sanitary

For the scope of intermediate survey, examine and test sanitary equipment.

4.13 Auxiliary services to life support equipment

For the scope of intermediate survey, examine and test auxiliary services to life support equipment.

4.14 Communication

(1) Primary communications
For the scope of intermediate survey, examine and test primary communications.
(2) Secondary communications
For the scope of intermediate survey, examine and test secondary communications.
(3) Emergency communications
For the scope of intermediate survey, examine and test emergency communications.
(4) Alarms
For the scope of intermediate survey, examine and test alarms.

4.15 Launch and Recovery System

(1) For the scope of intermediate survey, examine and test launch and Recovery System
(2) Load bearing parts are closely examined by NDT and Static load test the bell launch and recovery system to the design load.
(3) Load test the bell ballast weight release to 1.5 × the weight of the ballast in air. NDT should be performed after the test on load bearing members.
(4) Load test the various systems according to a written procedure based on the manufacturer's instructions, to the design loads of the system. NDT should be carried out on the load affected areas, prior to and, after the test.

4.16 Auxiliary services to launch and recovery system (umbilical handling, power supplies, etc.)

For the scope of intermediate survey, examine and test Auxiliary services to launch and recovery system.

4.17 Safety Equipment

(1) Fire safety
(A) For the scope of intermediate survey, examine and test fire safety.

4.18 Hyperbaric Evacuation systems

(1) Lifesaving appliances, including lifeboats, are to be examined in accordance with the Rules.
(2) Examine and test Hyperbaric Evacuation Systems, are connected to the main diving system, in accordance with relevant rules.
(3) The hyperbaric chamber, other pressure vessels and life support systems, if connected to the main diving system, should be considered as a mobile diving system integrated with the main diving system.
(4) The following should be checked:
(A) sufficient BIBS fitted and functional
(B) BIBS overboard dump fitted and functional
(C) lighting fitted and functional
(D) toilet provided
(E) locking mechanism fitted and functional
(F) periodic pressure and leakage tests
(G) doors can be opened from both sides
(H) doors can be secured "open"
(I) equalisation can be done if appropriate
(J) seat belts for the maximum complement of divers provided
(K) protective headgear provided
(L) recovery system available
(M) falls of sufficient length, where applicable.
(5) Examine and test in accordance with IMO Resolution A.692(17)
(6) Determine if there is sufficient oxygen available for metabolic make-up for the maximum complement of divers at a rate of 0.5 litres (0.018 cu. ft.) per minute per diver, for a minimum duration of 24 hours.

4.19 Personal protective equipment (including personal diving equipment)

For the scope of intermediate survey, examine and test personal protective equipment

Annex 9-4 Diving Simulators

1. General

1.1 Application

(1) The following Chapter apply to diving simulators which are permanently installed in a building or similar structure and which are built under the survey and in accordance with the Rules of this Society and at the request of Owner the diving simulator may be classed in this Society.
(2) Buildings, power generating plants, fuel storage and gas storage facilities etc. are required to comply with the relevant national regulations of the country in which the facilities are established.
(3) Designs other than those stated in this Rule may be approved provided their suitability has been verified by this Society and they have been recognized as equivalent.
(4) The Society reserves the right to impose requirements additional to those contained in the Rules in respect of all types of facility should this become necessary in the light of new knowledge or practical experience.

1.2 Definitions

For the purpose of this Rule the terms used therein are to be as followings in addition to **Ch 7, 602.** in this Rule:

(1) Diving simulator
A diving simulator means that compression chamber system in which both manned and unmanned tests can be carried out in a wet or dry environment under conditions simulating those at sea.
(2) Test chamber
A test chamber means that compression chamber in which manned tests can be carried out under the conditions prevailing in the sea.

1.3 Components of diving simulators

Where present, the following components form part of the diving simulator system and are to be designed, manufactured and tested in accordance with this Rule:

(1) Compression chambers
(2) Bottles
(3) Pressure vessels
(4) Pipes, valves, fittings and hoses
(5) Breathing gas systems
(6) Life support systems
(7) Welding gas absorbers
(8) Diver heating system
(9) Sanitary systems
(10) Communication systems
(11) Surveillance, automation and control equipment
(12) Gas analyzing systems
(13) Electrical systems and equipment
(14) Fire prevention, detection and extinguishing equipment
(15) Compressors
(16) Gas mixers
(17) Helium reclaim system
(18) Handling, transfer and mating system
(19) Hyperbaric evacuation system.

1.4 Documents for approval

The documents and drawings for the approval is to be specified in **Ch 7. 604.**

1.5 Test

Tests for the diving system are specified in **Ch 7. 605.**

1.6 Marking

Marking for the diving system are specified in **Ch 7. 606.**

1.7 Trials

Trials for the diving system are specified in **Ch 7. 607.**

2. Diving simulators

2.1 General

(1) Wherever appropriate and practicable, diving simulators are to be designed and built in such a way that the failure of any single component cannot cause a dangerous situation.
(2) Diving simulators and their components are to be designed for the conditions of service described in the equipment specification.
(3) Diving simulators are to be so designed that the proposed tests can be performed with maximum safety for the simulator crew.
(4) Diving simulators for technical experiments are to be equipped with suitable test chambers which are to be separable from the remaining chamber system in respect of operating services, pressure and atmospheric conditions. The living compartment of the simulator is to be so arranged that its occupants are not endangered or inconvenienced by the experiments.
(5) Diving simulators which can be operated with simultaneously differing chamber pressures are to be provided with effective means of preventing any unintentional pressure drift within the chamber system.
(6) Diving simulators are to be designed in such a way that injured divers can be carried on a stretcher inside the compression chamber system.
(7) It is recommended that diving simulators be equipped with a hyperbaric evacuation system.
(8) Diving simulators are to be designed and built to facilitate safe operation, adequate maintenance and necessary surveys.
(9) All parts of a diving simulator are to be designed, constructed and mounted in a way which facilitates cleaning and disinfection.

2.2 Environmental conditions

Diving simulators, including their accessories and ancillary equipment, are to be designed for the environmental conditions likely to be encountered at the operating site or under the planned test conditions.

2.3 Chamber conditions

(1) Diving simulators are to be equipped in such a way that a breathable atmosphere can be maintained in the compression chambers throughout the period of operation.
(2) Means are to be provided for keeping the partial pressure of CO2 below 0.005 bar at all times and for this purpose a CO2 production of 22 ℓ/h per diver at 20 °C and 1 bar shall be assumed.
(3) Under steady conditions, diving simulators are to be capable of keeping the temperature in the compression chamber constant to ± 1°C in the range from 27 ~ 36 °C while maintaining a relative atmospheric humidity of at least 50 %.
(4) Compression chambers are to be so arranged and equipped that a uniform chamber atmosphere can be maintained (CO2 and O2 levels, temperature and humidity).

(5) Under steady conditions, the permanent noise level (over 8 hours) in the living and compression chambers shall not exceed 65 dB(A).
(6) Deviations from the aforementioned chamber conditions are permitted where this is essential to the performance of the tests and where additional measures are taken to ensure the divers' safety.

2.4 Arrangement

(1) Diving simulators may only be installed and operated in areas not subjected to an explosion hazard.
(2) As far as possible, the area of installation of diving simulators is to be kept free of fire loads.
(3) Diving simulators and breathing gas storage facilities are to be located in areas which can be adequately ventilated and provided with suitable electric lighting.
(4) The area of installation of diving simulators is to be separated from other operational facilities. The partition is to, as a minimum requirement, possess Class A-30 fire resistance.

2.5 Chamber equipment and facilities

(1) Compression chamber equipment and facilities are to be suitable for operation in hyperbaric atmospheres. Under these conditions they shall not liberate any toxic or strongly irritant gases. This also applies to protective coatings and paints used inside chambers.
(2) Only incombustible, or at least flame retardant, materials should be used in the chambers.
(3) Permanently installed chamber facilities are to be so designed that they suffer no damage when the chamber is subjected to hydraulic pressure tests.
(4) Equipment items in experimental chambers are to be designed and installed in such a way as to minimize the danger of injury to the divers and leave sufficient room for movement. In addition, chamber equipment and experimental apparatus shall not prevent or limit unduly the possibility of observing the divers from outside the test chamber, where necessary with the aid of TV equipment.
(5) Ancillary systems and equipment needed to perform tests or create experimental boundary conditions are to be designed and constructed so that they are able to perform their functions safely without danger to the divers.

2.6 Corrosion protection

(1) Diving simulators and all their ancillary components are to be effectively protected against corrosion. The corrosion protection is to be capable of being repaired or retouched at a later stage.
(2) Anti-corrosion coatings exposed to the chamber conditions are to meet the requirements stated in **Ch 7, 704.** In addition, they shall not tend to blister or flake off under hyperbaric conditions. In wet test chambers it may be necessary to make special provision for the effect of helium-saturated seawater.
(3) Wet test chambers are to be provided with an adequate anodic protection system.

3. Pressure Vessels and Apparatus

3.1 Compression chambers

(1) General
(A) The following Rules apply to pressure vessels used as compression chambers in diving simulators.
(B) The documents to be submitted to the Society for approval are listed in **1.4** and the necessary tests and markings are specified in **1.5** and **1.6.**
(2) Design principles
(A) Compression chambers
For the compression chamber, design principle is specified in **Ch 7, 705. 1.**
(B) Test chambers
(a) Test chambers are to be designed and built in such a way that the proposed tests can be performed safely and any danger to the rest of the chamber system is avoided.
(b) The dimensional design of test chamber walls is to allow for possible additional loads

due to test equipment.

(c) Test chambers are to be separated by double doors from the rest of the chamber system.

(d) Manned test chambers for technical experiments are to be provided with a lock for materials. Test chambers compartment are to be provided with sufficient mountings for experimental equipment. Adequate means are also to be provided for the transport and handling of experimental equipment.

(e) Each test chamber compartment is to be equipped with separate gas analysis connection. All open penetrations for gas, measurements and analysis are to be protected by replaceable filters mounted on the inside of the chamber.

(f) Each test chamber compartment is to be provided with separate connections for communications equipment. In addition, at least one blind flange each is to be fitted for power and data transmission.

(g) Test chambers are to be provided with drainage connections at their lowest points. Sumps and other drains are to be protected to prevent impurities being sucked in.

(h) Water circuits for test chambers are to be designed and constructed so that switching from high pressure to low pressure circuits cannot cause any inadmissible pressure drop in the test chamber. Furthermore, such switching operations shall not cause any unacceptable rise in pressure in low pressure circuit.

(i) Test chambers are to be provided with external insulation compatible with the test conditions and with the environmental conditions at the locations where the simulator is installed.

(C) Hatches and access openings

(a) Hatches and mating devices in diving simulators which are not sealed by pressure are to be equipped with a closing mechanism which precludes opening under pressure. The closing mechanism is to be so designed that the correct position of closure is clearly indicated before pressure is applied.

(b) Means are to be provided to enable hatches to be opened from both sides. Hatch trunks are to be provided with pressure equalizing valves. Devices are to be fitted which hold hatches in the open position. Hatches which open or close under their own weight are to be so designed that divers are not endangered when operating them.

(c) Hatches and access openings for persons should have a clear diameter of at least 500 mm, or at least 700 mm in the case of test chambers.

(d) The length of hatch trunks should not exceed the trunk diameter.

(e) For hatches in wet test chambers, the sealing groove and seal counterface should be made of non-corroding materials.

(f) Hydraulically operated hatches have to meet the following additional requirements:

(i) The hatches are to be capable of being opened manually if the hydraulic system fails.

(ii) Steps are to be taken to ensure that hatches which open under their own weight if the hydraulic system fails cannot endanger the divers.

(iii) Steps are to be taken to ensure that the opening action can only be initiated after the pressure has been equalized.

(iv) Operating elements fitted outside chambers are to be arranged so that the operations of opening and closing the hatch can be observed through the view ports provided in the chamber.

(v) The design and dimensions of the hydraulic system for internal hatches shall be compatible with the specified working pressures and with the boundary conditions of the compression chamber system.

(vi) The hydraulic fluid is to be suitable for use in the chambers and shall not under hyperbaric conditions release gas or vapours which are toxic or capable of supporting combustion.

(3) Materials

The materials used for diving simulators are required to comply with the provisions of **Ch 7, 701. 12 of the Rules.**

(4) Principles of manufacture and construction

Pressure vessels for diving simulators are to be in accordance with **Ch 7, 701. 13 of the Rules.**

(5) Calculations
Calculations relating to diving simulator pressure vessels are to be in accordance with **Ch 7, 701. 14 of the Rules.**

(6) Acrylic plastic windows
Acrylic plastic windows are to be designed and manufactured in accordance with **1.** of **Annex 9-2.**

3.2 Pressure vessels and apparatus and gas bottles

Pressure vessels and apparatus and gas bottles are to be manufactured in accordance with **Pt 5, Ch 6** of the Rules.

4. Pipes, Valves, Fittings and Hoses

4.1 General

Pipes, valves, fittings and hoses for diving simulators are to be designed and manufactured in accordance with **Ch 7, 801.** to **804. of the Rules.**

5. Compressors

5.1 General

Breathing gas compressors for diving simulators are to be designed and manufactured in accordance with **Ch 7, 901.** to **905. of the Rules.**

6. Life Support Systems

6.1 General

(1) The requirements of this Section apply to all parts and components of the system which are necessary to ensure the life support and safe environment of the occupants of a diving system.
(2) The documents to be submitted to the Society for approval are listed in **1.4** and the necessary tests and markings are specified in **1.5** and **1.6.**

6.2 Gas supply

(1) Gas storage facilities
(A) Each diving system is to be provided with a permanently installed gas storage facility or with a suitable location for the storage of mobile gas bottles.
(B) The capacity of the gas storage facility shall be such that a sufficient number and quantity of the appropriate gases can be supplied to all compression chambers and divers at all operating depths under both normal and emergency conditions.
(C) The emergency breathing gas supply is to be stored separately in bottles which shall not be opened for normal operation.
(D) Wherever possible, the gas storage facility is to be housed in a separate building. Rooms for the storage of oxygen are to be constructed of components having at least fire resistance.
(E) The gas storage facility is to be separated from adjoining rooms by fireproof partitioning, if these rooms are subject to a fire or explosion hazard.
(F) The roofing of the gas storage facility has to have adequate resistance to airborne incandescent particles and radiant heat. The floor covering is to be at least flame retardant.
(G) Gas store-rooms are to be adequately ventilated. The exits are to be so arranged that it is possible to quit the rooms quickly in case of danger.
(H) No combustible materials may be stored in the gas storage facility.
(I) Gas stores in the open are to be established in such a way that they are protected from mechanical damage and the action of outside fires. The containers are to be readily accessible from all sides. The valves are to be capable of being operated from a fixed control point.
(J) Gas storage facilities are to be safeguarded against unauthorized entry. In addition, warning

notices are to be mounted prohibiting the introduction of mobile fire loads as well as the use of open fires and smoking inside the gas store.

(2) Gas distribution
The gas supply system shall be so designed in accordance with **Ch 7, 1002. of the Rule.**

(3) Conditioning of chamber atmosphere
(A) Each compression chamber living compartment is to be equipped with an oxygen dosing device and a chamber gas circulating unit in which the CO2 can be absorbed and the air temperature and humidity can be regulated. The rate of circulation shall be such as to satisfy the conditions stated in **Ch 7, 702. of the Rule.**
(B) Each diving simulator is to be equipped with at least 2 chamber gas treatment units which are to be so arranged that they can be switched to adjoining chambers.
(C) Test chambers for the performance of manned experiments in which gases, vapours, dust or fumes injurious to health are generated are to be equipped with extraction systems capable of aspirating the harmful substances as close as possible to their point of origin. Such test chambers are also to be provided with purification systems (welding gas absorbers) for keeping the chamber atmosphere breathable, inert and within the permitted temperature limits, e.g. during welding operations. In addition to this, such test chambers are to be equipped with a personal breathing system and respirators independent of the chamber atmosphere. Additional equipment is to be provided to enable not only the chamber atmosphere but also the breathing gases supplied to the divers to be permanently monitored directly at the mask when work or tests are being carried out in a non-breathable atmosphere.

(4) Treatment and mixing of breathing gases
The use of closed breathing circuits, gas mixing systems for direct breathing gas supply and helium reclaim systems is subject to approval by the Society.

6.3 Control and instrumentation

(1) Central Control Position
Diving simulators are to be arranged and equipped in a manner which enables the entire simulator operation to be centrally monitored. The Central Control Position is to be equipped with all the necessary means for the surveillance, control and coordination of the various operating functions. Measures are necessary to ensure that:
(A) the Central Control Position is adequately shielded from other service rooms (protection against noise and visual interference, separate ventilation system, no access or thoroughfare to other service rooms);
(B) the Central Control Position is free from items of equipment and components which do not belong to, or are not needed in the Central Control Position;
(C) the Central Control Position is provided with effective all round fire protection;
(D) the atmosphere in the Central Control Position is reguated to provide optimum conditions for human beings and equipment;
(E) the Central Control Position is designed on ergonomic principles and the main units are laid out and arranged in a manner compatible with the test work to be performed (e.g. relative positioning of the chamber control consoles);
(F) the Central Control Position is provided with a sufficiently secure emergency power supply (electricity, compressed air);
(G) the Central Control Position is provided with a sufficiently bright emergency lighting system with a back up power supply;
(H) As far as possible, the pipes and cable runs in the Central Control Position are installed separately according to system so that faults in one system cannot lead to the failure of others;
(I) the Central Control Position has communication links not only with the compression chambers but also with the ancillary units and general operations rooms;
(J) the Central Control Position contains the central fire alarm station for the compression chamber fire detection system, where such a system is installed, as well as the release valves of the compression chamber water spray extinguishing system;
(K) the Central Control Position is itself provided with a fire detection system and with the means for combating effectively a fire in the Central Control Position without endangering the safe operation of the compression chamber system as a whole;
(L) effective stops are taken to prevent operations in the Central Control Position from being impaired by telephones, the activation of alarms and general noise.

(2) Instrumentation
(A) Indicating instruments
(a) The instruments for the surveillance, control and operation of the diving simulator are to be grouped and arranged in the Central Control Position in accordance with the principles of safety technology and ergonomics.
(b) In the Central Control Position a separate control console is to be provided for each independently operated compression chamber compartment. For test chambers, an additional independent control stand should be placed in the immediate vicinity of the test chambers.
(c) At least the following operating parameters are to be displayed at the Central Control Position for each manned compression chamber compartment:
(i) Pressure or depth
(ii) Temperature
(iii) Humidity
(iv) Partial oxygen pressure
(v) Partial CO2 pressure
(vi) Pressure of connected breathing gas containers/bottles
(vii) Oxygen content in supply lines to chamber compartment or breathing masks in chambers.
(d) The instrumentation of compression chambers used exclusively for unmanned tests shall be compatible with the test conditions.
(e) The pressure gauges of compression chambers are to give a reading accurate to 0.3 % of the full instrument scale subject to a maximum deviation of 30 cm water column. All other pressure readings may be accurate 1 % of the full instrument scale.
(f) Inadmissible deviations from reference values of the vital parameters shall actuate a visual and audible alarm at the Central Control Position. Automatically actuated switching operations in the gas supply system and similar functions shall also trip such alarms.
(g) Compression chamber compartments are to be equipped with pressure and temperature gauges which can be read from inside.
(h) Pressure gauges connected directly to the compression chamber system are to be fitted with a shutoff valve.
(B) Analyzers
(a) Each diving simulator is to be equipped with at least one oxygen and one CO2 analyzing system.
(b) Throughout the entire period of operation, the oxygen analyzer is to give a reading accurate to at least 0.015 bar partial oxygen pressure.
(c) Throughout the entire period of operation, the CO2 analyzer is to give a reading accurate to at least 0.001 bar partial CO2 pressure.
(d) Compression chamber living compartments are to be equipped in addition with independent instruments for monitoring the oxygen and CO2 levels.
(e) Where gas mixtures other than air or helium-oxygen are to be used for diving, suitable additional equipment is to be provided for analyzing the gases used.
(f) Test chambers in which welding operations are performed are to be equipped with analyzers for continuously monitoring the chamber atmosphere for impurities such as CO, NO, NOx, hydrocarbons and ozone. It is necessary to ensure that the analyzers are also able to monitor the chamber atmosphere of the other compression chambers. Apparatus is also to be provided for the analysis of the pure gases. The breathing gas mixtures and the purified helium gases.
(g) The accuracy of the analyzer readings shall be such that the discrepancy between the partial pressure in the gas and the partial pressure readings on the instrument does not exceed 10 %.
(h) For diving simulators where the chamber atmosphere is not subject to contamination as a result of technical experiments, test tubes may be recognized as a suitable means of monitoring the chamber atmosphere for contamination.
(3) Control equipment
(A) The Central Control Position is to be equipped with controls for at least the following functions:
(a) pressurisation and pressure control of each independently operated compression chamber compartment and each diving bell.

(b) Decompression of each independently operated compression chamber compartment and each diving bell.
(c) Pressure equalization between chamber compartments
(d) Oxygen supply to the chamber compartments
(e) Control of gas supply to breathing masks
(f) Control of temperature and humidity in the compression chambers.

(B) The control stand for the gas distribution system is to be provided with a mimic diagram showing the functions of the various valves and the different gas lines marked in colour.

7. Automation and Communication Equipment

7.1 General

(1) The requirements of this Section apply to the construction and application of equipment for the surveillance and control of diving simulators and their communication monitoring systems.
(2) The documents to be submitted to the Society are listed in **1.4.**
(3) The necessary tests and markings are specified in **1.5** and **1.6.** All components and units which have been approved by this society may be installed.

7.2 Automation equipment

Automation equipment for diving simulators is to be designed and constructed in accordance with the Rules for Diving system.

7.3 Communication equipment

(1) Voice communication systems
(A) Diving simulators are to be equiped with a suitable communications system allowing direct communication between the control stand and ;
(a) each compartment of compression chambers and test chambers
(b) test equipment control positions
(c) test chamber control stands
(d) sub component
(e) offices and service rooms (e.g. the operation manager's office and mechanical and electrical workshops)

(B) Where diving simulators are operated with helium gas mixtures, each compression chamber compartment is to be connected to a helium speech unscrambler. The speech unscramblers should be designed for maximum noise suppression and automation compensation of changes in signal level.

(C) It is recommended that the Central Control Position be equipped to record all communications with the divers.

(D) Voice communications between the compression chamber compartments and the Control Position is to be provided by a communication system with loudspeaker which is permanently switched to 'Receive' at the control console. Switches for reversing the direction of communication are to be of the self resetting type. In addition, each compression chamber compartment is to be provided with at least one head set.

(E) A mains-independent telephone link is to be provided in addition to the telephone system called for in (3).

(F) Electrically powered telephone systems are to be provided with a reliable power supply. This normally means that they are to be supplied from a storage battery with a parallel connected mains unit and battery charger supplied with energy.

(G) In wet rooms microphone and receiver systems are to be designed to prevent the penetration of water. Where this cannot be ensured by the design the penetration of water shall not render the equipment permanently unserviceable.

(H) The microphone and receiver in diver's masks and helmets are to be functionally separated from each other.

(2) Television surveillance equipment
(A) Diving simulators are to be equipped with a television surveillance system.
(B) The number of cameras and their angles of view shall be chosen to give, wherever possible,

a complete picture of the whole interior of the diving simulator. In test chambers, allowance is to be made for the fact that the chambers may be partially filled with water and adjustable test equipment may obstruct the view.

(C) A sufficient number of TV monitors are to be provided. Each TV monitor are to indicate clearly which compartment is being viewed at any time.

(D) The image reproduced on the monitors are to show up the necessary detail.

(E) It is recommended that a video recorder be installed.

(3) Other communication equipment

(A) All compression chamber compartments are to be provided with suitable alternative communications equipment (e.g. a 3-button signalling system).

(B) Diving simulators should be provided with equipment for the transmission of radio, television and video programmes which can, if necessary, carry operational telephone communications as priority traffic.

8. Electrical Equipment

8.1 General

Electrical installations and equipment for diving simulators are to be designed and constructed in accordance with **Ch 7, Sec 12. of the Rule.** The electrical components and equipment to be installed outside compression chambers are to, as a minimum requirement, conform to a recognized standard.

9. Fire Protection

9.1 General

(1) The requirements of this Section apply to the fire protection of diving simulators.

(2) The documents to be submitted to the Society for approval are listed in **1.4** and the necessary tests and marking are specified in **1.5** and **1.6.**

9.2 Structural fire protection

(1) Area of installation of diving system

(A) Buildings and their ancillary units are to be designed and constructed in accordance with the building regulations in force at the site where the diving simulator is to be installed.

(B) Diving simulator may be installed and operated in areas not subject to an explosion hazard.

(C) The rooms in which the diving simulator, the central control position and the gas storage facility are installed are to be separated from other service rooms by floors and walls with class F-30 fire protection.

(D) The rooms in which diving simulators and their ancillary units are installed are to be provided with forced ventilation systems capable of effecting at least 8 changes of air per hour. The air is to be aspirated from a area not subject to an explosion hazard. The room also to be equipped with an effective smoke extraction system.

(E) In the area of installation of the diving simulator, the gas storage facility and central control position, source of ignition and fire loads are to be reduced to a minimum. Wherever possible, materials which are at least fire retardant are to be used. Heat insulation is to be made of non-combustible materials.

(2) Interiors of compression chambers and diving bells

(A) As far as possible, all materials used in compression chambers or diving bells are to be at least flame retardant (for the purpose of this Rule, 'flame retardant' refers to materials which do not continue to burn spontaneously in a compressed air atmosphere of at least 6 bar).

(B) As far as possible, fire loads and sources of ignition are to be avoided. Electrical heating appliances and heaters are to be fitted with protection against overheating.

(C) Components and materials are to be selected with a view to minimizing the danger of static charges.

9.3 Fire surveillance

(1) Fire detection and alarm systems

(A) The rooms in which diving simulators and their ancillary units are to be protected by an

automatic fire detection system.
(B) The occurrence of fire is to be signalled visually and audibly in at least one permanently manned control room.
(C) The fire alarm may be actuated manually from the permanently manned control room or may be automatically activated by the fire detection system.

(2) Fire detection systems
(A) Fire detection systems including central fire detection stations, fire detectors and the wiring of the detection loops require the approval of this Society
(B) Fire detection systems are to be so constructed that any fault, e.g. supply failure, short-circuit or wire breakage in the detection loops, or the removal of a detector from its base triggers a visual and audible signal at the central fire detection station.
(C) The design and arrangement of fire detection and alarm systems are to conform to **Pt 6**.

9.4 Fire extinguishing systems

(1) Area of installation of diving simulator
(A) The area of installation of the diving simulator and its ancillary units is to be equipped with a general water fire extinguishing system as well as with portable and mobile fire extinguishers and extinguishing equipment in accordance with **Pt 8**.
(B) 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.
(C) The rooms in which diving simulators and their ancillary units are installed are to be equipped with approved hand extinguishers. In each case, one of the portable extinguishers is to be mounted close to the entrance to the room concerned.
(D) Where the room in which the diving simulator is installed is also used wholly or in part as a workshop, the room in question is to be additionally equipped with at least one mobile 50 kg dry extinguisher.

(2) In compression chambers
(A) Each compartment of inside a compression chamber is to be equipped with suitable means for extinguishing a fire in the interior by providing for the rapid and efficient distribution of the extinguishing agent to any part of the chamber.
(B) The fire extinguishing system is to be designed and constructed in such a way that it can safely deal with every conceivable outbreak of fire under all the environmental conditions for which the diving simulator is designed. Actuation of the fire extinguishing system may not cause any unacceptable pressure drop inside the chamber. The extinguishing system may be actuated by hand.
(C) Water is the preferred extinguishing agent. Extinguishing agents with a toxic or narcotic effect are not permitted.

9.5 Other fire protection equipment

The central control position of diving simulator is to be equipped with at least one independent compressed air respirator of approved design having an operating capability of at least 30 minutes and fitted with equipment for voice communication with the divers.

10. Hyperbaric Evacuation System

10.1 General

(1) Where a hyperbaric evacuation system permanently connected to the diving simulator is provided, the followings are to be applied.
(2) Where the evacuation chamber is also to be used as a compression chamber, the relevant sections of the **2.** of this Rule also to be applied.
(3) The documents to be submitted to the Society for approval are listed in **1.4.**
(4) The necessary tests are specified in **1.5.**

10.2 Design principles

(1) Evacuation chamber

(A) The hyperbaric evacuation chamber is to be designed for the simultaneously rescue of all the divers in the diving simulator at the maximum operating depth. At least one seat with safety harness is to be provided for each diver.

(B) The evacuation chamber is to be provided with a lock for supplies.

(C) The evacuation chamber is to be equipped with view ports enabling all the occupants to be observed from outside.

(D) The chamber connections for gas, water and electricity are to be designed for rapid coup1ing and uncoupling and also as light as possible.

(E) The evacuation chamber is to be equipped with an autonomous life support system enabling the pressure, temperature and gas composition in the compression chamber to be maintained for at least eight hours. The life support system or the evacuation chamber is to be provided with connections for external supply and surveillance.

(F) The evacuation chamber is to be equipped externally with regulating and control devices enabling a safe environment for the divers to be maintained.

(G) The evacuation chamber is to be equipped with a telephone system allowing communication with the divers.

(H) The evacuation chamber is to be provided with its own power supply enabling the electrical systems to be kept operational for at least eight hours.

(I) The evacuation chamber is to be so designed that it can be operated in the open air.

(J) The evacuation chamber is to be equipped with a mating and handling system enabling it to be quickly and safely connected and disconnected and conveyed to a position of safety without external power.

(K) The evacuation chamber is to be provided with attachment points enabling it to be hoisted by as standard crane. ⚓

Annex 9-5 Dynamic Load of Diving Bell Handling and Transfer System

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).

2. Definitions

2.1 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 ves-

sel 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)

2.2 Parameters applied for correction of units in empirical formulae:

h1 = 1 m^{-1}

L1 = 1 m^{-1}

u1 = 1 m/s

u2 = 1 m

3. Loads on Negative Buoyant Bell

3.1 Loads on bell clear of support vessel

(1) In a free flow field the maximum vertical hydrodynamic load Fn 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:

$$F_v = 0.5 \rho A C_d (f_v v_r)^2 \quad \text{(N)}$$

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:

$$F_w = 0.4(1 + C_m) f_w \rho V g \quad \text{(N)}$$

The parameters and principles applied for calculation of the forces are given in 3.1 (2) of the Rules.

(2) 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:

$$2\pi \sqrt{\frac{m + \rho V C_m'}{k}} < 3$$

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 az of the support vessel is given by the smaller of:

$$a_z = \frac{(5h_1h_s - 0.02h_1h_sL_1L + 1) \times g}{100} \quad (\mathrm{m/s^2})$$

or a_z as obtained from the Rules. The pitch acceleration a_p of the support vessel is given by:

$$a_p = \frac{3.5}{C_B} \times \frac{R_p}{L} \times a_z \quad (\mathrm{m/s^2})$$

The combined vertical acceleration from heave, pitch and roll is given by:

$$a = \sqrt{(ra_z)^2 + a_p^2} \quad (\mathrm{m/s^2})$$

r : coefficient of roll
: 1.0 at centreline of vessel
: 1.2 at sides of vessel

The relative acceleration ar between vessel and water particles at surface is given by:

$$a_r = \left(0.15q\sqrt{h_1 \times h_s}\right) \times g \quad (\mathrm{m/s^2})$$

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:

$$v = \left(14 - 4.5\frac{R_p}{L}\right)\frac{a \times u_1}{g} \quad (\mathrm{m/s^2})$$

The relative vertical velocity between vessel and water particles at surface is given by:

$$v_r = (0.04 \times L_1 \times L + 6)\frac{a_r \times u_1}{g} \quad (\mathrm{m/s^2})$$

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:

$$f_v = \frac{v + (v_r - v)f_w}{v_r}$$

3.2 Hydrodynamic Loads on bell in moon pool

(1) 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 **3**, 3.1, 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:

$$F_m = \pm As_r\rho \geq {}^{\left(-0.32\frac{d}{h_s}\right)} \quad \text{(N)}$$

For a moon pool at the centreline of the support vessel s_r may be taken as:

$$s_r = (0.064L+1.6u_2)\frac{a_r}{g}$$

3.3 Impulse Loads

(1) 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 :

$$F_i = v_i\sqrt{k(m+\rho VC_m)} \quad \text{(N)}$$

v_i : impulse velocity (m/s) obtained from Clause **3**, 3.3, (2) or Clause **3**, 3.3, (3)

(2) Impulse velocity
The impulse velocity v_i during start and stop may be taken as the maximum normal transportation velocity.

(3) Slack
Slack hoisting rope may be expected when

$$|F_n| = (m-\rho V)g7$$

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:

$$v_i = v_1+v_2C_i$$

v_i = free fall velocity (m/s) in calm water

$$v_1 = \sqrt{\frac{2(m-\rho V)g}{\rho AC_d}}$$

$v_2 = v_rf_v$ 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

4.1 Impulse loads

(1) 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:

$$F_i = v_i\sqrt{k(m+\rho V_e 0.6 C_m)} \quad \text{(M)}$$

V_e = volume of displaced water of the floating bell

v_i = impulse velocity obtained from Clause **4**, 4.1, (2)

(2) Impulse velocity is taken to be as follows:

$$V_i = V_r + V_{hoist}$$

V_r : from 3.1, (2) (m/s)

V_{hoist} : normal transportation speed.

5. Design loads

5.1 Maximum load

(1) 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 : $P = mg+\sqrt{(ma)^2+F_i^2}$

(2) 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

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 installed a part of high voltage shore connection systems in accordance with the requirements of **Ch 8** of the Rules may be assigned with the class notation HVSC-Partial. ⚓

CHAPTER 9 CARGO VAPOUR EMISSION CONTROL SYSTEMS

Section 3 Requirements for VEC2 Notation

302. Overfill Alarm [See Rule]

1. In applying **302. 1** (1) & (3) of the Rules, the sensor of cargo gauging system and the sensor of high level alarm can be used in common. *(2019)*
2. In applying **302. 1** (5) of the Rules, visible and audible alarms are to be provided where the operator readily recognizable from the cargo areas. *(2018)* ⚓

CHAPTER 10 BALLAST WATER MANAGEMENT

Section 3 Ballast Water Management Systems

303. Arrangement of BWMS *(2018)* [See Rule]

1. In applying **303. 1** (3) of the Rules, the area within 3 m around the open end of degas equipment venting dangerous gas is to be considered a hazardous area. ⚓

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

PART 9 ADDITIONAL INSTALLATIONS

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