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RULES FOR HIGH SPEED CRAFT

Part 1 GENERAL RULES

Chapter 1 GENERAL

1.1 General

1.1.1 Application*

1 The survey, construction, installation, material and equipment of the high speed craft (hereinafter referred to as "craft" in the Rules) to be registered in accordance with the **Regulations for the Classification and Registry of Ships** and to be defined in **2.1.2, Part 1** of the Rules are to be as prescribed in the Rules notwithstanding the requirements prescribed in the Rules for the Survey and Construction of Steel Ships unless otherwise specified elsewhere in each Parts of the Rules.

2 The survey, construction, installation, material and equipment of the craft which is excluded from the definition of the high speed craft in **2.1.2** of this Part are to be deemed appropriate by the Society.

3 Notwithstanding preceding **-1**, craft flying specified nationality are to comply with the requirements in other Rules of NIPPON KAIJI KYOKAI (hereinafter referred to as "the Society" in the Rules).

4 The Rules applies to the craft defined in **2.1.2** of this Part and engaged in the restricted voyages as follows:

(1) passenger craft which do not proceed in the course of their voyage more than 4 *hours* at 90% of the maximum speed from a place of refuge when fully laden; and

(2) cargo craft which do not proceed in the course of their voyage more than 8 *hours* at 90% of the maximum speed from a place of refuge when fully laden.

5 The high speed craft not engaged on international voyage and that comply with the requirements of *IMO Resolution MSC*.97(73) *THE INTERNATIONAL CODE OF SAFETY FOR HIGH SPEED CRAFT*, as may be amended, are to be deemed to be in compliance with the requirements stipulated in **Part 3** to **Part 13** of this Rules regardless of any of the requirements given in the Rules. However the matters not stipulated in the Code are to be according to the requirements of the Rules.

1.1.2 General Requirements

The application of the provisions of the Rules is subject to the following general requirements that:

(1) the Rule will be applied in its entirety;

(2) the craft will not operate in a rough sea condition;

(3) the craft will take a proper step, for example, refuge or deceleration when the craft runs into a sudden storm;

(4) the craft will at all times be in reasonable proximity to a place of refuge;

(5) adequate communications facilities, weather forecasts and maintenance facilities are available within the area of operation; and

(6) in the intended areas of operation, there will be suitable rescue facilities readily available.

1.1.3 Prohibition of Transportation of Dangerous Cargoes in Bulk by High Speed Craft

Notwithstanding preceding **1.1.1-4(2)**, the Rules is not to apply to tankers, craft carrying liquefied gases in bulk and craft carrying dangerous chemicals in bulk.

1.1.4 Stability

The requirements in the Rules are framed for craft having appropriate stability in all conceivable conditions. The Society emphasizes that the special attention is to be paid to the stability by the builders in design and construction stage and by the craft owners and craft masters while in service.

1.1.5 Craft of Unusual Form or Proportion*

In craft of unusual form or proportion, the requirements concerning hull construction, equipment, arrangement and scantlings

will be decided individually based upon the general principle of the Rules instead of the requirements in the Rules.

1.1.6 Equivalency

Alternative hull construction, equipment, arrangement and scantlings will be accepted by the Society, provided that the Society is satisfied that such construction, equipment, arrangement and scantlings are equivalent to those required in the Rules.

1.1.7 Ship Identification Number

For cargo craft not less than 300 *gross tonnage* and passenger craft not less than 100 *gross tonnage* engaged on international voyages, the ship's identification number is to be permanently marked as follows, in accordance with the material of the hull construction.

(1) Steel craft or aluminum alloy craft: Those specified in **14.2, Part 1, Part C of the Rules for the Survey and Construction of Steel Ships**

(2) Fibreglass reinforced plastics craft: Those specified in **1.3.8 of the Rules for the Survey and Construction of Ships of Fibreglass Reinforced Plastics**

1.1.8 Crafts Using Low-flashpoint Fuels*

Crafts using low-flashpoint fuels are to comply with **Part GF of the Rules for the Survey and Construction of Steel Ships**.

1.1.9 Work-Ships

Work-ships are to comply with **Part O of the Rules for the Survey and Construction of Steel Ships**.

1.2 Class Notations

1.2.1 General*

For craft complying with additional requirements and/or those exempted from any requirements related to the subjects specified in the following paragraphs in accordance with the provisions of this Rules, an appropriate notation is affixed to the Classification Characters in accordance with the provisions of **Chapter 2 of the Regulation for the Classification and Registry of Ships** as follows;

NS* (**(1)**) (**(2)**, **(3)**) (**(4)**) (**(5)**)

(1) Restricted services specified in **1.2.2**

(2) Structural materials for main hull specified in **1.2.3**

(3) Hull construction and equipment, etc. specified in **1.2.4**

(4) Compliance with the special requirements for international voyages specified in **1.2.5**

(5) Application of special survey scheme specified in **1.2.6**

1.2.2 Restricted Services

For craft classed subject to be engaged in restricted services, an appropriate notation is affixed to the Classification Characters as follows.

(1) For craft engaged in service restricted only to coastal areas within, in general, 20 *miles* from the nearest land or areas deemed equivalent by the Society (hereinafter, referred to as coasting service) :

Coasting Service (abbreviated to *CS*)

(2) For craft engaged in service restricted only to calm water areas, in general, sheltered from the open sea by land or areas deemed equivalent by the Society (hereinafter, referred to as smooth water service) :

Smooth Water Service (abbreviated to *SWS*)

(3) For craft other than specified in above **(1)** and **(2)** and applied to this Rules subject to be engaged in a restricted service deemed necessary by the Society, an appropriate notation may be affixed.

1.2.3 Structural Materials for Main Hull

For craft made of materials other than steel as a structural material for main hull in accordance with the provisions of **2.1.1, Part 3**, an appropriate notation is affixed to the Classification Characters as follows.

(1) For craft made of aluminium alloy:

Aluminium Alloy (abbreviated to *AL*)

(2) For craft made of fibre reinforced plastic:

FRP (abbreviated to *FRP*)

(3) For craft other than those specified in **(1)** or **(2)**, a notation deemed appropriate by the Society may be affixed.

1.2.4 Hull Construction and Equipment, etc.

1 For craft complying with the requirements of this Rules, the notation of "*High Speed*" (abbreviated to *HS*) is affixed to the Classification Characters.

2 For craft of catamaran or trimaran and complying with relevant requirements, the notation of "*Catamaran*" (abbreviated to *CAT*) or "*Trimaran*" (abbreviated to *TRI*) is affixed proceeding with notation relating to structural materials for main hull specified in **1.2.3.**

3 For craft intended for the carriage of passengers and complying with the relevant requirements of this Rules, the notation of "*Passenger*" (abbreviated to *P*) is affixed proceeding with notations as specified in **-1** and **-2** above.

4 For craft having cargo spaces not normally subdivided in any way and normally extending to either a substantial length or the entire length of the ship in which cargoes can be loaded and unloaded normally in a horizontal direction, and complying with the relevant requirements of this Rules, the notation of "*Roll on-Roll off*" (abbreviated to *RORO*) is affixed proceeding with notations as specified in **-1** and **-2** above.

5 For craft equipped for the carriage of dangerous goods (refer to **3.2.20**, **Part R of the Rules for the Survey and Construction of Steel Ships**) in accordance with the provisions of **4.2, Part 10** and **Chapter 19, Part R of the Rules for the Survey and Construction of Steel Ships**, the notation of "*Equipped for Carriage of Dangerous Goods*" (abbreviated to *EQ C DG*) is affixed to the Classification Characters.

6 For craft equipped for the carriage of motor vehicles with fuel in their tanks in accordance with the provisions of **4.1**, **Part 10** and **Chapter 5**, **Part 11**, the notation of "*Equipped for Carriage of Vehicles*" (abbreviated to *EQ C V*) is affixed to the Classification Characters.

7 Craft complying with the requirements of **Part GF of the Rules for the Survey and Construction of Steel Ships** applied in accordance with the requirements of **1.1.8** are to be in accordance with the requirements of **1.2.4-32, Part A of the Rules for the Survey and Construction of Steel Ships**.

8 For craft having a propeller shaft Kind 1*C* complying with the provisions of **5.1.9, Part 9**, the notation of "*1C*" is affixed to the Classification Characters.

9 For crafts complying with the provisions of **Chapter 4** and **5, Part X of the Rules for the Survey and Construction of Steel Ships**, the notation of "*Cyber Resilience*" (abbreviated to *CybR*) is affixed to the Classification Characters.

10 Otherwise specified in the above, for craft where deemed necessary by the Society, an appropriate notation may be affixed to the Classification Characters.

1.2.5 Compliance with the Special Requirements for International Voyages

For craft complying with the special requirements for those engaged in international voyage in accordance with the provisions of **Part 15**, the notation of "*High Speed Craft complied with International Code of Safety for High Speed Craft*" (abbreviated to *HSC*) is affixed to the Classification Characters.

Chapter 2 DEFINITIONS

2.1 General

2.1.1 Application

The definitions of terms which appear in this Rule are to be as specified in this Chapter and **Part A of the Rules for the Survey and Construction of Steel Ships**, unless otherwise specified elsewhere.

2.1.2 High Speed Craft

High speed craft is a craft capable of a maximum speed in knots equal to or exceeding:

$3.70\nabla^{0.1667}$ (m/sec), or

$7.1922\nabla^{0.1667}$ (kt)

where:

∇ : displacement corresponding to the designed maximum load line (m^3)

excluding craft the hull of which is supported completely clear above the water surface in non-displacement mode by aerodynamic forces generated by ground effect.

2.1.3 Length of Craft

Length of craft (L) is the overall length of underwater watertight envelope of the rigid hull, excluding appendages, at or below the designed maximum load line.

2.1.4 Length for Freeboard

Length of craft for freeboard (L_f) is 96% of the length in *metres* measured from the fore side of stem to the aft side of aft end shell plate on a waterline at 85% of the least moulded depth measured from the top of keel, or the length in *metres* measured from the fore side of stem to the axis of rudder stock on that waterline, whichever is the greater. The waterline on which this length is measured is to be parallel to a designed maximum load line.

2.1.5 Breath of Craft

Breath of craft (B) is the breath of the broadest part of the moulded watertight envelope of the rigid hull, excluding appendages, at or below the designed maximum load line.

2.1.6 Breadth of Freeboard

Breath of craft (B_f) is the overall length of underwater watertight envelope of the rigid hull, excluding appendages, at or below the designed maximum load line.

2.1.7 Depth of Craft

Depth of craft (D) is the vertical distance in *metres* from the top of keel to the top of freeboard deck beam at the side measured at the middle of L. In the case where watertight bulkheads extended to a deck above the freeboard deck and are recorded in the Register Book as effective up to that deck, the depth is to be measured to the bulkhead deck.

2.1.8 Maximum Speed

Maximum speed (V) is the designed speed in *knots* which the craft with clean bottom can attain at the maximum continuous output on calm sea in loaded condition corresponding to the designed maximum load line (hereinafter referred to as "the full load condition" in the Rule).

2.1.9 Maximum Astern Speed

Maximum astern speed is the designed backward speed in *knots* which the craft with clean bottom can attain at the maximum astern output on calm sea in the full load condition.

2.1.10 Midship Part of Craft

The midship part of craft is the part for $0.4L$ amidships unless otherwise specified.

2.1.11 End Parts of Craft

The end parts of craft are the parts for $0.1L$ from each end of the craft.

2.1.12 Load Line and Designed Maximum Load Line

1 Load line is the water line corresponding to each freeboard assigned in accordance with the provision of **Part 12** of this Rule.

2 Designed maximum load line is the water line corresponding to the designed maximum load draught.

2.1.13 Load Draught and Designed Maximum Load Draught

1 Load draught is the vertical distance in *metres* from the top of keel plate to the load line with no lift or propulsion machinery active.

2 Designed maximum load draught (d) is the vertical distance in *metres* from the top of keel plate to the designed maximum load line measured at the middle of L with no lift or propulsion machinery active.

2.1.14 Full Load Displacement

Full load displacement (W) is the moulded displacement in *tons* corresponding to the designed maximum load draught.

2.1.15 Freeboard Deck*

1 The freeboard deck is normally the uppermost continuous deck. However, in cases where openings without permanent closing appliances exist on the exposed part of the uppermost continuous deck or where openings without permanent watertight closing appliances exist on the side of the craft below that deck, the freeboard deck is the continuous deck below the deck.

2 In a craft having a discontinuous freeboard deck (e.g. a stepped freeboard deck), the freeboard deck is to be determined as follows.

(1) Where a recess in the freeboard deck extends to the sides of the ship and is in excess of 1 *m* in length, the lowest line of the exposed deck and the continuation of that line parallel to the upper part of the deck is taken as the freeboard deck.

(2) Where a recess in the freeboard deck does not extend to the sides of the ship or is not in excess of 1 *m* in length, the upper part of the deck is taken as the freeboard deck.

(3) Recesses not extending from side to side in the deck designated as the freeboard deck in accordance with the provisions of **-3** below the exposed deck may be disregarded, provided all openings in the exposed deck are fitted with weathertight closing appliances.

3 Where a craft has multidecks even one of which is recognized as freeboard deck defined above **-1** or **-2**, and the load line is marked corresponding to freeboard assigned in accordance with the requirements in **Part 12** of this Rule by assuming that the actual lower deck is taken as freeboard deck, freeboard deck may be the lower deck. In this case, the lower deck is to be continuous at least between the machinery space and peak bulkheads and continuous athwartships. Within cargo spaces, the deck is to be of suitably framed decks or stringers having adequate width and continuous in a fore and aft direction at the ship sides and transversely at each watertight bulkhead that extends to the upper deck. Where the lower deck is stepped, the lowest line of the deck and the continuation of that line parallel to upper part of the deck is taken as freeboard deck.

2.1.16 Bulkhead Deck

The bulkhead deck is the highest deck to which the watertight transverse bulkheads except both peak bulkheads extend and are made effective.

2.1.17 Strength Deck

The strength deck at part of craft's length is the uppermost deck at that part to which the shell plates extend. However, in way of superstructures, except sunken super structures, not exceeding $0.15L$ in length, the strength deck is the deck just below the superstructure deck. The deck just below the superstructure deck may be taken as the strength deck even in way of the superstructure exceeding $0.15L$ in length at the option of the designer.

2.1.18 Superstructure

The superstructure is the decked structure on the freeboard deck, extending from side to side of the craft or having its side walls at the position not farther than $0.04B_f$ from the side of the craft. Superstructures are classified as follows.

(1) A bridge is a superstructure which does not extend to either the forward or after perpendicular.

(2) A poop is a superstructure which extends from the after perpendicular forward to a point which is aft of the forward perpendicular. The poop may originate from a point aft of the after perpendicular.

(3) A forecastle is a superstructure which extends from the forward perpendicular aft to a point which is forward of the after perpendicular. The forecastle may originate from a point forward of the forward perpendicular.

(4) A full superstructure is a superstructure which, as a minimum, extends from the forward to the after perpendicular.

2.1.19 Enclosed Superstructure

The enclosed superstructure is the superstructure complying with the following conditions:

(1) Access openings in the end bulkheads of the superstructure are provided with doors complying with the requirements in **2.3.1-**

1, Part 7 of this Rule.

(2) All other openings in side or end bulkheads of the superstructure are provided with efficient weathertight means of closing.

(3) A means of access for the crew to reach machinery and other working spaces within a bridge or poop starting from any point on the uppermost complete exposed deck or higher is available at all times even when bulkhead openings are closed.

2.1.20 Approved Working Pressure of Boiler and Pressure Vessel

The approved working pressure of a boiler or a pressure vessel is the maximum pressure at its drum intended by the manufacturer or user, and is not to exceed the minimum value among the allowable pressures of various parts determined in accordance with the requirements in Chapter 9 and 10, Part D of Rules for the Survey and Construction of Steel Ships.

2.1.21 Nominal Pressure of Boiler with Superheater

The nominal pressure of a boiler with superheater is the maximum steam pressure at superheater outlet intended by the manufacturer or user, under which the safety valve of superheater is to be set.

2.1.22 Maximum Continuous Output of Engine

Maximum continuous output of engine is the maximum output at which the engine can run safely and continuously in the designed condition (which is of the full load running condition for main engines).

2.1.23 Number of Maximum Continuous Revolutions

The number of maximum continuous revolutions is the number of revolutions at the maximum continuous output.

2.1.24 Propeller Shaft Kind 1 and Propeller Shaft Kind 2

1 Propeller shaft Kind 1 is a propeller shaft which is effectively protected against corrosion by water (sea water, outboard freshwater and inboard freshwater) with a means approved by the Society or which is made of corrosion resistant materials approved by the Society. The shafts which comply with the following **(1)**, **(2)**, **(3)** or **(4)** are categorized respectively as propeller shaft Kind 1*A*, propeller shaft Kind 1*B*, propeller shaft Kind 1*C* or propeller shaft Kind 1*W*.

(1) Propeller shaft Kind 1*A* is a propeller shaft, at the after end, with a keyed propeller attachment (hereinafter referred to "keyed connection"), with a keyless propeller attachment (hereinafter referred to "keyless connection") or with a coupling flange (hereinafter referred to "flanged connection"); to which a seawater lubricated stern tube bearing (including shaft bracket bearing, hereinafter the same in this Chapter) or stern tube bearing, utilising outboard freshwater, is attached.

(2) Propeller shaft Kind 1*B* is a propeller shaft of keyed connection, keyless connection or flanged connection; to which an oil lubricated stern tube bearing is attached except for the shafts complying with **(3)**.

(3) Propeller shaft Kind 1*C* is a propeller shaft satisfying the conditions in **(2)** and the requirements in 6.2.11, Part D of Rules for the Survey and Construction of Steel Ships.

(4) Propeller shaft Kind 1*W* is a propeller shaft of keyed connection, keyless connection or flanged connection; to which a freshwater lubricated stern tube bearing, utilising inboard freshwater, is attached.

2 Propeller shaft Kind 2 is a propeller shaft other than those specified in **-1**.

2.1.25 Stern Tube Shaft

Stern tube shaft is an intermediate shaft which lies in a stern tube.

2.1.26 Stern Tube Shaft Kind 1 and Stern Tube Shaft Kind 2

1 Stern tube shaft Kind 1 is a stern tube shaft which is effectively protected against corrosion by sea water with a means approved by the Society or which is made of corrosion resistant materials approved by the Society. The shafts which are listed in the following **(1)**, **(2)** or **(3)** are categorized respectively as stern tube shaft Kind 1*A*, stern tube shaft Kind 1*B* or stern tube shaft Kind 1*W*:

(1) Stern tube shafts to which a seawater lubricated stern tube bearing or freshwater lubricated stern tube bearing, utilising outboard freshwater, is adopted;

(2) Stern tube shafts to which an oil lubricated stern tube bearing is adopted; or

(3) Stern tube shafts to which a freshwater lubricated stern tube bearing, utilising inboard freshwater, is adopted.

2 Stern tube shaft Kind 2 is a stern tube shaft other than those specified in **-1**.

2.1.27 Deadweight Tonnage

Deadweight tonnage (*DW*) is the difference in *tons* between full load displacement (*W*) and lightweight (*LW*).

2.1.28 Lightweight*

The lightweight (*LW*) is the displacement in *tons* excluding cargoes, fuel oil, lubricating oil, ballast and fresh water in tanks, stored goods, and passengers and crew and their effects.

2.1.29 Dead Ship Condition

Dead ship condition is the condition under which the main propulsion plant, boilers and auxiliaries are not in operation due to the absence of power.

2.1.30 Displacement Mode

Displacement mode is the regime, whether at rest or in motion, where the weight of the craft is fully or predominantly supported by hydrostatic forces.

2.1.31 Non-displacement Mode

Non-displacement mode is the normal operational regime of a craft when nonhydrostatic forces substantially or predominantly supported the weight of the craft.

2.1.32 Transitional Mode

Transitional mode is the regime between displacement and non-displacement modes.

2.1.33 Machinery Space

Machinery spaces are spaces containing internal combustion engines either used for main propulsion or having an aggregate total power output of more than 110 *kW*, generators, oil fuel units, propulsion machinery, major electrical machinery and similar spaces and trunks to such spaces.

2.1.34 Auxiliary Machinery Spaces

Auxiliary machinery spaces are spaces containing internal combustion engines of power output up to and including 110 *kW* driving generators, sprinkler, drencher or fire pumps, bilge pumps, etc., oil filling stations, switchboards of aggregate capacity exceeding 800 *kW*, similar spaces and trunks to such spaces.

2.1.35 Auxiliary Machinery Spaces Having Little or No Fire Risk

Auxiliary machinery spaces having little or no fire risk are spaces such as refrigerating, stabilizing, ventilation and air conditioning machinery, switchboard of aggregate capacity 800 *kW* or less, similar spaces and trunks to such spaces.

2.1.36 Cargo Spaces

Cargo spaces are all spaces other than special category spaces, open vehicle spaces and spaces intended for the carriage of dangerous goods used for cargo (including cargo tanks) and trunks to such spaces.

2.1.37 Special Category Spaces

Special category spaces are those enclosed spaces intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion, into and from which such vehicles can be driven and to which passengers have access, including spaces intended for the carriage of cargo vehicles. Special category spaces may be accommodated on more than one deck provided that the total overall clear height for vehicles does not exceed 10*m*.

2.1.38 Open Vehicle Spaces

Open vehicle spaces are spaces:

(1) to which any passengers carried have access;

(2) intended for carriage of motor vehicles with fuel in their tanks for their own propulsion; and

(3) either open at both ends, or open at one end and provided with adequate natural ventilation effective over their entire length through permanent openings in the side plating or deckhead or from above.

2.1.39 Public Spaces

Public spaces are those spaces allocated for the passengers and include bars, kiosk, smoke rooms, main seating areas, lounges, dining rooms, recreation rooms, lobbies, lavatories and similar permanently enclosed spaces allocated for passengers.

2.1.40 Service Spaces

Service space are those spaces used for pantries containing food warming equipment but no cooking facilities with exposed heating surfaces, lockers, sales shops, store-rooms and enclosed baggage rooms. Such spaces containing no cooking appliances may contain the following.

(1) coffee automats, toasters, dish washers, microwave ovens, water boilers and similar appliances, each of them with a maximum power of 5 *kW*

(2) electrically heated cooking plates and hot plates for keeping food warm, each of them with a maximum power of 2 *kW* and a surface temperature not above 150°C

2.1.41 Control Stations

Control stations are those spaces in which the craft's radio or navigating equipment or the emergency source of power and emergency switchboard are located, or where the fire recording or fire control equipment is centralized, or where other function essential to the safe operation of the craft such as propulsion control, public address, stabilization systems, etc., are located.

2.1.42 Place of Refuge

Place of refuge is any naturally or artificially sheltered area which may be used as a shelter by a craft under conditions likely to endanger its safety.

2.1.43 Passenger Craft

A passenger craft is a craft which carries more than twelve passengers where a passenger is every person other than:

(1) the master and the members of the crew or other persons employed or engaged in any capacity on board a ship on the business of that craft; and

(2) a child under one year of age.

2.1.44 Cargo Craft

A cargo craft is any craft which is not a passenger craft.

2.1.45 Tanker

A tanker is a cargo craft constructed or adapted for the carriage in bulk of liquid cargoes of flammable nature except craft carrying liquefies gases in bulk and craft carrying dangerous chemicals in bulk.

2.1.46 Craft Carrying Liquefied Gases in Bulk

A craft carrying liquefied gases in bulk is a cargo craft constructed or adapted and used for carriage in bulk of liquefied gases specified in **Part N of the Rules for the Survey and Construction of Steel Ships**.

2.1.47 Craft Carrying Dangerous Chemicals in Bulk

A craft carrying dangerous chemicals in bulk is a cargo craft constructed or adapted and used for carriage in bulk of dangerous chemicals specified in **Part S of the Rules for the Survey and Construction of Steel Ships**.

2.1.48 Air-cushion Vehicle

Air-cushion vehicle (*ACV*) is craft such that the whole or a significant part of its weight can be supported, where at rest or in motion, by a continuously generated cushion of air dependent for its effectiveness on the proximity of the surface over which the craft operates.

2.1.49 Crafts Using Low-flashpoint Fuels

Crafts using low-flashpoint fuels mean crafts which use low-flashpoint fuels as defined in **2.2.1-28, Part GF of the Rules for the Survey and Construction of Steel Ships**.

2.1.50 IMO

IMO means the International Maritime Organization.

2.1.51 Anniversary Date

Anniversary date is the day and month of each year which will correspond to the date of expiry of the Classification Certificate, excluding the date of expiry of the Classification Certificate.

2.1.52 Craft at Beginning Stage of Construction

A craft at beginning stage of construction is a craft whose keel is laid or a craft at a similar stage of construction. For this purpose, the term "a similar stage of construction" means the stage at which:

(1) construction identifiable with a specific craft begins; and

(2) assembly of that craft has commenced comprising at least 50 *tonnes* or 3% of the estimated mass of all structural material, whichever is less.

2.1.53 Ro-ro Spaces

Ro-ro spaces are spaces not normally subdivided in any way and normally extending to either a substantial length or the entire length of the craft in which motor vehicles with fuel in their tanks for their own propulsion and/or goods (packaged or in bulk, in or on rail or road cars, vehicles (including road or rail tankers), trailers, containers, pallets, demountable tanks or in or on similar stowage units or other receptacles) can be loaded and unloaded, normally in a horizontal direction.

Part 2 CLASS SURVEYS

Chapter 1 GENERAL

1.1 Surveys

1.1.1 Classification Surveys*

1 All craft intended to be classed with the Society are to be subjected to Classification Surveys by the Surveyor in accordance with the requirements in **Chapter 2** of this Part.

2 Materials which contain asbestos are not to be used.

1.1.2 Periodical Surveys and Planned Machinery Surveys

1 Craft classed with this Society are to be subjected to Periodical Surveys and Planned Machinery Surveys by the Surveyor in accordance with the requirements of **Chapters 3** of this Part as appropriate.

2 The Society will be prepared to give consideration to the circumstances of any special case upon application by the owners.

1.1.3 Occasional Surveys*

All classed craft are to be subjected to Occasional Surveys when they fall under one of the conditions of **(1)** through **(6)** below not at the time of Annual, Intermediate or Special Surveys or Planned Machinery Surveys. At Occasional Surveys, investigations, examinations or tests are to be made to the satisfaction of the Surveyor with respect to the matters concerned. Where Annual, Intermediate or Special Survey is carried out together with the survey of specific matters for Occasional Survey at due date of the Occasional Survey, the Occasional Survey may be dispensed with.

(1) When main parts of hull, machinery or important equipment or fittings which have been surveyed by the Society, have been damages, or are to be repaired or altered. In addition, in cases where the modification of any ship registration details is needed, the ship is to comply with **2.5** in addition to the above requirements.

(2) When load lines are to be changed or to be newly marked

(3) When an alteration affecting her stability is made.

(4) When the Survey is requested by the craft owner.

(5) When the Survey is carried out to verify that the craft already constructed is in compliance with the retroactive requirements of the Rules.

(6) Whenever the survey is considered necessary by the Surveyor or by the craft owner.

1.1.4 Laid-up Craft*

1 Laid-up craft are not subject to Class Maintenance Surveys specified in **1.1.2** of this Part., unless an application for Occasional Survey is submitted.

2 When laid-up craft are about to be put into operation, the following surveys and the surveys for specific matters which have been postponed due to lay-up, if any, are to be carried out.

(1) When any Periodical Surveys or Planned Machinery Surveys designated before lay-up has not been due, surveys equivalent to the Annual Surveys specified in **3.3** and **3.6,** corresponding to the age of the craft, are to be carried out.

(2) When the Periodical Surveys or Planned Machinery Surveys designated before lay-up has already become due, these Periodical Surveys or Planned Machinery Surveys are, in general, to be carried out. However in case where two or more of the Periodical Surveys or Planned Machinery Surveys designated before lay-up have already become due, the superlative kind of Periodical Survey among them is to be carried out.

3 If the survey to be carried out under the requirements of **-2(2)** above is a Special Survey, either the overdue Special Survey or the next due Special Survey is to be carried out. In such cases, the validity of the Classification Certificate is to be in accordance with the requirements of **4.1.3-4, Guidance for the Classification and Registry of Ships** corresponding to the Special Survey to be carried out.

1.1.5 Machinery Verification Runs

1 At the time of a special survey, a dock trial in the presence of the attending surveyor is to be carried out to confirm the satisfactory operation of main and auxiliary machinery. If significant repairs have been carried out to main or auxiliary machinery or steering gear, the Surveyor may deem a sea trial necessary.

2 At the time of extended drydocking, a dock trial may be required at the discretion of the attending surveyor to confirm the satisfactory operation of main and auxiliary machinery. If significant repairs have been carried out to main or auxiliary machinery or steering gear, the Surveyor may deem a sea trial necessary.

3 For ships which rely solely on electric propulsion motors for propulsion (hereinafter referred to as "electric propulsion ships" in this part), at the time of the machinery verification runs specified in **-1** and **-2** above, the satisfactory operation of the following electrical installations related to propulsion (hereinafter refered to as "electric propulsion plants") is to be confirmed.

(1) Generating plants for propulsion

(2) Electric motors for propulsion

(3) Electrical installations that are necessary for the satisfactory operation of **(1)** and **(2)** (e.g. control gears for electric motors, semiconductor converters, and transformers)

1.1.6 Unscheduled Surveys

The classed ships may be subject to Unscheduled Surveys when the confirmation of the status of the ship by survey is deemed necessary in cases where the Society considers the ship to be subject to **1.4-3** of the **Conditions of Service for Classification of Ships and Registration of Installations**. At Unscheduled Surveys, investigations, examinations or tests are to be made to the satisfaction of the Surveyor with respect to the matters concerned.

1.2 Preparation for Surveys and Others

1.2.1 Notification

When a craft is to be surveyed in accordance with the Rules, it is the responsibility of the applicants of surveys to notify the Surveyor at the place where they wish to undergo the survey. The Surveyor is to be advised of the survey a reasonable time in advance so that the survey can be carried out at the proper time.

1.2.2 Preparation for Surveys*

1 Necessary preparations are to be made by the applicants of surveys at their responsibilities so that surveys specified in this Part as well as those which may be required as necessary by the Surveyor in accordance with the provisions in this Part may be carried out satisfactorily by the Surveyor. These preparations are to include provisions of an easy and safe access, necessary facilities and necessary records for the execution of the survey, open-up of installations, removal of any obstructions 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, 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 An applicant for surveys are to required to arrange for appropriate attendants at any survey who have a knowledge of the requirements for surveys and are able to supervise the preparation for surveys specified **-1** above.

3 Prior to the commencement of survey and measurement, a survey planning meeting is to be held by the surveyor(s), the owner's representative, the thickness measurement company representative, where involved, and the master of the ship or an appropriately qualified officer of the ship appointed by the master, ship owner or Company so as to ensure the safe and efficient conduct of the survey and measurement work to be carried out.

1.2.3 Suspension of Surveys

Surveys may be suspended where necessary preparations have not been made or any appropriate attendant are not present in accordance with **1.2.2** of this Part or the Surveyor considers that the safety for execution of the survey is not ensured.

1.2.4 Disposition when Repairs are Considered Necessary as a Result of Surveys

When repairs are considered to be necessary as a result of surveys, the Surveyor notifies his findings to the applicant of the

surveys. The applicant who receives such notification is to arrange the necessary repairs and to obtain the Surveyor's verification of the repairs.

1.2.5 Procedure for Tests, Wear and Tear, etc.

1 Speed Trial

Speed trial is to be carried out, where alterations or repairs which might affect craft's speed have been made on the occasion of Periodical Surveys or Planned Machinery Surveys. Trial of craft or machinery may be required where deemed necessary by the Surveyor at any survey.

2 Inclining Test

Where alterations or repairs which might greatly affect craft's stability have been made on the occasion of Periodical Surveys or Planned Machinery Survey and be where deemed necessary by the Surveyor at any survey, **2.3.1-5(1), Part B of the Rules for Survey and Construction of Steel Ships** is to be followed to determine the need for re-inclining tests, and the need for amending stability information.

3 Repairs for Wear and Tear

Where the thickness of materials of hull structure, scantlings of equipment, etc., become less than the stipulated wear and tear limits, these are to be replaced by new ones having either the original scantlings at the time of construction or the scantlings deemed appropriate by the Society. Where, however, the original scantlings were larger than the required ones, or where deemed appropriate by the Society, these requirements may be modified taking into account the location, extent, kind, etc. of the wear and tear.

4 Replacement of fittings, equipments and parts, etc.

In cases where it is necessary to replace any fittings, equipment or parts, etc. used onboard, replacements are to comply with the regulations to be applied during ship construction. However, in cases where new requirements are specified or where deemed necessary by the Society, the Society may require that such replacements comply with any new requirements in effect at the time the relevant replacement work is carried out. In addition, replacements are not to use any materials which contain asbestos.

1.2.6 Firms Engaged in Inspections, Measurements and Maintenance*

1 Unless otherwise specified, third parties engaged in thickness measurements, in-water surveys by divers or remote operated vehicles, or tightness testing of closing appliances such as hatches, doors, etc., with ultrasonic equipment are to be firms deemed appropriate by the Society.

2 Unless otherwise specified, third parties engaged in inspections and maintenance of fixed fire extinguishing systems, portable fire extinguishers, self-contained breathing apparatuses, emergency escape breathing devices or fire detection and alarm systems are to be firms deemed appropriate by the Society.

1.3 Others

1.3.1 Class Survey by Means of Remote Survey

Although the survey method for class maintenance survey is generally attendance on site by a Surveyor, the Society may approve survey methods different from the traditional ordinary survey with attendance by a Surveyor, provided that survey is carried out in accordance with the requirements specified in **Annex 1.5.3 "CLASS MAINTAINANCE SURVEY BY MEANS OF REMOTE SURVEY", Part B of the Rules for the Survey and Construction of Steel Ships**. However, in the case of matters stipulated in international conventions or instructions from Administrations, this may only be done with Administration acceptance.

Chapter 2 CLASSIFICATION SURVEYS

2.1 Classification Survey during Construction

2.1.1 General

In the Classification Survey during construction, the hull and equipment, machinery, fire protection and detection, means of escape, fire extinction, electrical installation, computer-based systems, stability and load lines are to be examined in detail in order to ascertain that they meet the relevant requirements in this Rule.

2.1.2 Submission of Plans and Documents*

1 When it is intended to build a craft to the classification with the Society, the plans and documents specified in **(1)** to **(3)** below are to be submitted for the approval by the Society before the work is commenced. Plans and documents may be subjected to examination by the Society prior to the submission of the application for the classification of the craft in accordance with the provision specified otherwise by the Society:

(1) Hull
- (a) General arrangement
- (b) Midship section (showing the characters of intended classification and the designed maximum load draught are to be indicated)
- (c) Stem, stern-frame, propeller post and rudder (including materials and the ship's speed)
- (d) Construction profile (showing arrangement of watertight bulkheads, the load draught, sizes of brackets and transverse sections of the craft at 0.1L and 0.2L from both ends of the craft)
- (e) Deck plans (indicating arrangement and construction of hatchways, hatch beams, etc.)
- (f) Single bottoms and double bottoms
- (g) Watertight and oiltight bulkheads (indicating the highest position of tank and positions of tops of overflow pipes)
- (h) Pillars and deck girders
- (i) Shell expansion (for craft having metal hull construction)
- (j) Laminating procedure and details of joints (for craft having FRP hull construction)
- (k) Shaft tunnels
- (l) Seatings of boilers, engines, thrust and plummer blocks, dynamos and other important auxiliary engines (indicating horse powers, heights and weights of main engines, and arrangements of holding down bolts)
- (m) Machinery casings
- (n) Long deckhouses, if fitted
- (o) Masts, mast houses and winch platforms
- (p) Piping diagram (with materials, sizes, kinds, design pressure and design temperature, etc., of piping and valves)
- (q) Pumping arrangements (indicating capacity of each tank, water or oil)
- (r) Construction for fire protection (including the details of the construction of fire protection)
- (s) Means of escape (indicating width, etc., of the escape route)
- (t) fire extinguishing arrangements
- (u) fittings for examination (indicating the arrangement, type, capacity, numbers, etc., of fire-extinguishing appliances, fire pumps, fire main hydrants, fire hoses and nozzles, fireman's outfits, fire alarms and fire detection systems, etc.)
- (v) Plans showing arrangement of ship's identification number specified in **1.1.7, Part 1 of the Rules**

(2) Machinery
- (a) Machinery arrangement of machinery space, diagram for internal communication systems (including diagram for engineers' alarm systems)
- (b) Main and auxiliary engines (including their accessories):
  - i) Reciprocating internal combustion engines

    Plans and data specified in **2.1.3-1(1), Part 9 of the Rules** as well as documents showing specifications of louvers

for emergency generator rooms and closing appliances of ventilators fitted to the rooms (if they are of power-operated type.)

ii) Gas turbines

Plans and data specified in **3.1.3(1), Part 9 of the Rules**

(c) Power transmission gears, shaftings and propellers:

Plans and data specified in **4.1.2(1)**, **5.1.2(1)**, **5.2.2**, **5.3.3(1)** and **5.4.2-1, Part 9 of the Rules**

(d) Boilers, thermal oil heaters, incinerators and pressure vessels:

Plans and data specified in **6.1.1**, **6.3.1(1)** and **6.4.1, Part 9 of the Rules**

(e) Auxiliary machinery and piping:

i) Piping diagrams in the engine room (with materials, sizes, kinds, design pressure and design temperature)

ii) Plans and data specified in **10.2.2(1), Part 9 of the Rules**

(f) Steering gear:

Plans and data specified in **9.1.2(1), Part 9 of the Rules**

(g) Refrigerating equipment (with materials, construction, etc.):

Plans and data specified in **11.1.2, Part 9 of the Rules**

(h) Automatic and remote controls:

Plans and data specified in **12.1.3(1), Part 9 of the Rules**

(i) Selective catalytic reduction systems and associated equipment (if fitted):

Plans and data specified in **21.1.3(1), Part D of the Rules for the Survey and Construction of Steel Ships**

(j) Exhaust gas cleaning systems and associated equipment (if fitted):

Plans and data specified in **22.1.3(1), Part D of the Rules for the Survey and Construction of Steel Ships**

(k) Exhaust gas recirculation systems and associated equipment (if fitted):

Plans and data specified in **23.1.3(1), Part D of the Rules for the Survey and Construction of Steel Ships**

(l) List of spare parts

(m) Electrical installations

Plans and data specified in **1.1.5, Part 10** of the Rules

(n) Computer-based systems

Plans and data specified in **2.1.1(2), Part X of the Rules for the Survey and Construction of Steel Ships**

(3) For crafts using low-flashpoint fuels, the plans and documents specified in **2.1.3-1(5), Part B of the Rules for the Survey and Construction of Steel Ships**

(4) Other plans and documents

In addition to the plans and documents as listed in **(1)** to **(3)**, other plans and documents may be required where deemed necessary by the Society.

2 The plans mentioned in **-1** are to indicate in detail the quality of materials used, scantlings and arrangements of structural members, their attachments, clearance between the bottom of boilers and the top of floors, and other particulars necessary for examination of proposed construction.

3 A stability information booklet required in **1.7.2, Part 8 of the Rules** is to be submitted for approval of the Society, in addition to the plans and documents as listed in **-1**.

4 For craft to be provided with the loading manual in accordance with the requirements of **1.4.2, Part 6 of the Rules**, the loading manual including the conditions for loading and other necessary information is to be submitted for approval of the Society, in addition to the plans and documents as listed in **-1**.

5 For craft to be provided with a loading computer in accordance with the requirements of **1.4.3, Part 6 of the Rules**, lines (provided with offset table), light load hydrostatic curves, tank capacity plan (finished plan), and the results of inclining tests are to be submitted to the Society, in addition to the plans and the documents specified in **-1**. However, part or whole of these plans and documents may be omitted in cases where the requirements are separately provided by the Society.

6 For crafts using low-flashpoint fuels, the operational procedures and emergency procedures specified in **17.2.2-3** and **17.2.2-4, Part GF of the Rules for the Survey and Construction of Steel Ships** are to be submitted for Society approval.

2.1.3 Submission of Other Plans and Documents

1 When it is intended to build a craft to the classification with the Society, the following plans and documents are to be submitted in addition to those required in **2.1.2**:

(1) Specifications for hull and machinery

(2) Calculation sheets for the minimum athwartships section modulus in way of the midship part

(3) For FRP craft,

(a) List and data of raw materials.

(b) The result of FRP material tests and strength tests specified in **Chapter 4 of the Rules for the Survey and Construction of Ships of Fibreglass Reinforced Plastics**.

(4) Where provisions to be made for exceptional conditions of loading, plans showing the particulars of the cargo intended to be carried and its distribution

(5) For craft to be provided with stability information, the following plans and documents:

(a) General arrangement

(b) Midship section

(c) Longitudinal section at centre line (showing the arrangement and size of hull construction and cargoes on the deck which are counted to the projected area against wind and/or buoyancy)

(d) Construction profile

(e) Lines (including an offset table)

(f) Opening arrangement (showing the position, size and closing devices of openings)

(g) Stability calculation sheets (showing the details of calculation of projected area against winds, free surface effect and maximum permissible height of the centre of gravity)

(h) Plans showing the arrangement, size and projected lateral area of bilge keels, if fitted.

(6) For craft required to be marked with load lines corresponding to the assigned freeboard, the following plans:

(a) General arrangement

(b) Midship section

(c) Construction profile or structural arrangement

(d) Deck plans (showing the freeboard and superstructure decks)

Where the structural arrangement plans (with scantlings and arrangements in detail of members in hatchways) are submitted, the submission of the deck plans may be dispensed with.

(e) Superstructure end bulkheads

(f) Lines

(g) Hydrostatic curves (indicating the displacement and the change of displacement per cm immersion at each draught up to the freeboard deck)

(7) The following plans and documents related to machinery:

(a) Main and auxiliary engines (including their accessories):

i) Reciprocating internal combustion engines

Plans and data specified in **2.1.3-1, Part 9** of the Rules

ii) Gas turbines

Plans and data specified in **3.1.3(2), Part 9** of the Rules

(b) Power transmission gears, shaftings and propellers:

Plans and data specified in **4.1.2(2), 5.1.2(2)** and **5.3.3(2), Part 9** of the Rules

(c) Boilers, thermal oil heaters, incinerators and pressure vessels:

Plans and data specified in **6.3.1(2), Part 9** of the Rules

(d) Auxiliary machinery and piping:

Plans and data specified in **10.2.2(2), Part 9 of the Rules**

(e) Steering gear:

Plans and data specified in **9.1.2(2), Part 9** of the Rules

(f) Automatic and remote controls:

Plans and data specified in **12.1.3(2), Part 9** of the Rules

(g) Selective catalytic reduction systems and associated equipment (if fitted):
Plans and data specified in **21.1.3(2), Part D of the Rules for the Survey and Construction of Steel Ships**

(h) Exhaust gas cleaning systems and associated equipment (if fitted):
Plans and data specified in **22.1.3(2), Part D of the Rules for the Survey and Construction of Steel Ships**

(i) Exhaust gas recirculation systems and associated equipment (if fitted):
Plans and data specified in **23.1.3(2), Part D of the Rules for the Survey and Construction of Steel Ships**

(j) Computer-based systems
Plans and data specified in **2.1.1(2), Part X of the Rules for the Survey and Construction of Steel Ships.**

(8) For crafts using low-flashpoint fuels, the plans and documents specified in **2.1.3-1(5), Part B of the Rules for the Survey and Construction of Steel Ships**

(9) Asbestos-free declarations and supporting documents

(10) Other plans and documents may be required where deemed necessary by the Society.

2.1.4 Presence of Surveyor*

1 The presence of the Surveyor is required at the following stages of the work in relation to hull and equipment. To implement surveys of items specified otherwise by the Society, in lieu of traditional ordinary surveys where the Surveyor is in attendance, the Society may approve other survey methods which it considers to be appropriate in the following cases.

(1) When the material tests prescribed in **Part K** and **Part L of the Rules for the Survey and Construction of Steel Ships** are carried out.

(2) When the materials or parts manufactured away from the site are being applied to the craft concerned.

(3) When the tests of welding prescribed in **Part M of the Rules for the Survey and Construction of Steel Ships** are carried out.

(4) When designated by the Society during shop work or sub-assembly.

(5) When each block is assembled.

(6) When hydrostatic tests, watertight tests and non-destructive tests are carried out.

(7) When the hull is completed.

(8) When performance tests are carried out on closing appliances of openings, remote control devices, steering gears, anchoring and mooring arrangements, piping, etc.

(9) When installing of rudder, profiling of keel line, measurement of principal dimensions, measurement of deflection of hull, etc., are carried out.

(10) When a loading computer is installed on board in accordance with the requirements of **1.4.3, Part 6 of the Rules**.

(11) When the craft are marked with the load lines corresponding to the assigned freeboard.

(12) When sea trials are carried out.

(13) When stability experiments are carried out.

(14) When installing of fire extinguishing arrangements, and when the performance tests are carried out.

(15) For FRP craft,

(a) When material tests specified in **Chapter 4 of the Rules for the Survey and Construction of Ships of Fibreglass Reinforced Plastics** are carried out.

(b) When strength tests specified in **Chapter 4 of the Rules for the Survey and Construction of Ships of Fibreglass Reinforced Plastics**, are carried out.

(c) When designated by the Society during moulding work.

(d) When the mouldings are connected (*e.g.*, shell to deck).

(16) When the ship's identification number is marked.

(17) When deemed necessary by the Society.

2 The presence of the Surveyor is required at the following stages of the work in relation to machinery. To implement surveys of items specified otherwise by the Society, in lieu of traditional ordinary surveys where the Surveyor is in attendance, the Society may approve other survey methods which it considers to be appropriate in the following cases.

(1) When the tests of materials of main parts of machinery prescribed in **Part K of the Rules for the Survey and Construction of Steel Ships** are carried out.

(2) Main parts of machinery

(a) When the tests specified in **Part D**, **Part H** and **Part X of the Rules for the Survey and Construction of Steel Ships** depending upon the kind of machinery are carried out.

(b) When the materials are applied to the parts and the parts are installed on board.

(c) When machining of the main parts is finished and, if necessary, at a proper time during machining.

(d) In case of welded construction, before welding is commenced and when it is completed.

(e) When shop trials are carried out.

(3) When essential machinery is installed on board.

(4) When performance tests are carried out on measuring devices, remote control devices of closing appliances, remote control devices for machinery and gears, automatic control devices, steering gears, mooring arrangements, pipings, etc.

(5) When sea trials are carried out.

(6) When deemed necessary by the Society.

3 For crafts using low-flashpoint fuels, the presence of the Surveyor is required for tests specified in **Part GF of the Rules for the Survey and Construction of Steel Ships**, in addition to the tests specified in **-1** and **-2**. To implement surveys, in lieu of traditional ordinary surveys where the Surveyor is in attendance, the Society may approve other survey methods which it considers to be appropriate.

4 The requirements specified in **-1** to **-3** may be modified having regard to the actual status of facilities, technical abilities and quality control at the works, except the case of sea trials.

5 For the tests specified in **-1** to **-3** above, the applicant is to prepare test plans for review by the Society prior to testing. Test records and/or measurement records are to be submitted to the Society, as required.

2.1.5 Hydrostatic and Watertight Tests

In the Classification Survey during construction, hydrostatic tests, watertight tests, etc., are to be carried out in accordance with the following:

(1) Hull and equipment

Hydrostatic tests or watertight tests are to be carried out in accordance with **Annex 2.1.5** in **Part B of the Rules for the Survey and Construction of Steel Ships**.

(2) Machinery

Hydrostatic, leakage or airtight tests are to be carried out as specified in each Chapter of **Part 9** in relation to the kind of machinery.

2.1.6 Documents to be Maintained On Board*

1 At the completion of a classification survey, the Surveyor confirms that the following drawings, plans, manuals, lists, etc., as applicable, of finished version are on board.

(1) Documents approved by the Society or their copies

(a) Loading manuals (**1.4.2, Part 6**)

(b) Stability information booklets (**1.7.2, Part 8**)

(c) Operational procedures for crafts using low-flashpoint fuels (**17.2.2-3, Part GF of the Rules for the Survey and Construction of Steel Ships**)

(d) Emergency procedures for crafts using low-flashpoint fuels (**17.2.2-4, Part GF of the Rules for the Survey and Construction of Steel Ships**)

(e) Zones and conduit diagram (**2.2.3-3(4), Part X of the Rules for the Survey and Construction of Steel Ships**)

(f) Cyber security design description (**2.2.3-3(5), Part X of the Rules for the Survey and Construction of Steel Ships**)

(g) Vessel asset inventory (**2.2.3-3(6), Part X of the Rules for the Survey and Construction of Steel Ships**)

(h) Risk assessment for the exclusion of computer-based systems (**2.2.3-3(7), Part X of the Rules for the Survey and Construction of Steel Ships**)

(i) Description of compensating countermeasures (**2.2.3-3(8), Part X of the Rules for the Survey and Construction of Steel Ships**)

(j) Ship cyber resilience test procedure (**2.2.3-4(2), Part X of the Rules for the Survey and Construction of Steel Ships**)

(2) Other manuals, etc.

(a) Fire Control Plans (**3.5.1, Part 11**)

(b) A copy of the *IGF* Code or national regulations incorporating the provisions of the *IGF* Code (**17.2.2-1, Part GF of the Rules for the Survey and Construction of Steel Ships**)

(c) Total Harmonic Distortion (THD) calculation report (**1.1.6, Part H of the Rules for the Survey and Construction of Steel Ships**)

(d) Harmonic filter operation guide (**1.1.6, Part H of the Rules for the Survey and Construction of Steel Ships**)

(e) Instructions and operation manuals (including cautionary notes for the safety of the operators) for the following equipment when fitted on the ship: selective catalytic reduction systems and associated equipment; exhaust gas cleaning systems and associated equipment; or exhaust gas recirculation systems and associated equipment.

(3) Ship Construction File specified in **2.1.8**, for crafts of not less than 500 *gross tonnage* engaged on international voyages

2 Where deemed necessary by the Society considering the purpose, characteristics, etc. of the ship, the submission of additional documents may be required.

3 For crafts of not less than 500 *gross tonnage* engaged on international voyages, it is recommended that all documents listed in **-1** above are marked with the *IMO* ship identification number.

4 At the completion of classification surveys, Surveyors confirm that certificates showing that the following devices have passed all required examinations or tests are maintained on board.

(1) Fire pumps (including emergency fire pumps)

(2) Fire hoses and nozzles

(3) Fire extinguishers (including spare charges)

(4) Fire-fighter's outfits

(5) Emergency escape breathing devices

(6) Fixed fire-extinguishing systems

(7) Fire dampers and power-operated closing doors

(8) Fixed fire detection and fire alarm systems and automatic sprinkler systems

(9) Fire protection materials

(10) Additional equipments required for ships carrying dangerous goods (electrical equipment of an explosion-proof type, detection systems, full protective clothing, portable fire extinguishers and water spraying systems)

(11) Watertight doors below the freeboard deck

(12) Side scuttles

2.1.7 Finished Plans

At the completion of a classification survey, an applicant of the classification of the craft is to prepare finished plans regarding the following drawings, etc., and submit to the Society.

(1) General arrangement

(2) Midship section, scantling plans (construction profile), deck plans, shell expansion, transverse bulkheads, plans for rudder and rudder stock, and plans for cargo hatch covers

(3) Bilge, ballast and cargo piping diagrams

(4) Fire protection plans

(5) Fire extinguishing appliances arrangement

(6) Plans and data showing the navigation bridge visibilities

2.1.8 Ship Construction File*

For crafts of not less than 500 *gross tonnage* engaged on international voyages, Surveyors are to confirm that the Ship Construction File contains all of the necessary documents from the following drawings, plans, manuals and documents, and that the Ship Construction File is on board the ship. Duplicate documents as in **2.1.6** are not required.

(1) Finished plans of hull structural drawings specified in **2.1.7**

(2) The following manuals and documents:

(a) Operating and maintenance manuals for doors and inner doors

(b) Damage control plans

(c) Loading manuals (**1.4.2, Part 6**)

(d) Stability information booklets (**1.7.2, Part 8**)

(3) Ship structure access manuals

(4) Copies of certificates of forgings and castings welded into hull structures

(5) Plans showing the locations, sizes and details of equipment forming part of the watertight and weather-tight integrity of the ship, including piping

(6) Corrosion prevention schemes

(7) Plans and documents for in-water surveys

(8) Docking plans

(9) Plans and documents for Anti-Fouling Systems (**2.2.2, Rules for Anti-Fouling Systems on Ships**)

(10) Test plans, test records, measurement records, etc.

2.2 Classification Survey of Craft Not Built under Survey

2.2.1 General

1 In the Classification Survey of craft not built under the Society's survey, the actual scantlings of main parts of the craft are to be measured in addition to such examination of the hull and equipment, machinery, fire protection and detection, means of escape, fire extinction, electrical installations and stability as required for the special survey corresponding to the craft's age in order to ascertain that they meet the relevant requirements in the Rules. For craft required to be marked with load, the freeboards are to be assigned and load lines corresponding to the assigned freeboards are to be marked.

2 When it is intended to build a craft to the classification with the Society in accordance with the manner prescribed in **-1**, plans and documents as required in **2.1** of this Part are to be submitted for the approval of the Society.

3 In addition to the plans and documents as listed in **-2**, for craft to be provided with the loading manual and the loading computer in accordance with the requirements of **1.4.2** and **1.4.3, Part 6 of the Rules**, the loading manual including the specific loading conditions and relative plans and documents for the installation of the loading computer are to be submitted for approval of the Society.

4 For crafts using low-flashpoint fuels, the operational procedures and emergency procedures stipulated in **17.2.2-3** and **17.2.2-4, Part GF of the Rules for the Survey and Construction of Steel Ships** are to be submitted for Society approval.

2.2.2 Hydrostatic and Watertight Tests

In the Classification Survey prescribed in **2.2.1**, sea trials are to be carried out after hydrostatic tests and watertight tests carried out in accordance with the requirements in the following **(1)** and **(2)**, machinery to be made in good order, working pressure of boilers to be determined, safety valves to be adjusted and accumulation tests of boilers to be carried out. Except hydrostatic tests of boilers and pressure vessels of which important parts have been newly repaired, main steam pipes, and air tanks of which interior can not be inspected, and tests for gas leakage of refrigerating machinery on board, tests and trials may be dispensed with at the discretion of the Society.

(1) Double bottoms, both peaks, tanks, cofferdams and chain lockers located abaft the collision bulkhead, watertight bulkheads and shaft tunnels are to be tasted as specified in **2.1.5(1)**.

(2) Hydrostatic, leakage or airtight tests are to be carried out as specified in each chapter in relation to the kind of machinery.

2.2.3 Documents to be Maintained On Board

At the completion of a classification survey, the Surveyor confirms that documents specified in **2.1.6** are on board the craft.

2.3 Sea Trials and Stability Experiments

2.3.1 Sea Trials*

1 In the Classification Survey of all craft, sea trials specified in following **(1)** to **(11)** are to be carried out in a full load condition, at the calmest possible sea and weather conditions and in deep unrestricted water. However, where sea trials cannot be carried out in a full load condition, sea trials may be carried out in an appropriate loaded condition.

(1) Speed test

(2) Astern test

(3) Steering test and the change-over test from the main to auxiliary steering gears

(4) Turning test. The turning test of an individual craft may be dispensed with, provided that sufficient data are available from the turning test of a sister craft and subject to the special approval by the Society.

(5) Confirmation of no abnormality for the operating condition of machinery and behaviour of the craft during the trials

(6) Performance test of windlasses

(7) Performance test of automatic and remote control systems for main propulsion machinery or the controllable pitch propellers, boilers and electric generating sets. However, the control systems for controllable pitch propellers intended for main propulsion are to be in accordance with **Annex 2.3.1-3** "Testing Procedures for Control Systems for Controllable Pitch Propellers Intended for Main Propulsion", **Part B of the Rules for the Survey and Construction of Steel Ships**.

(8) The accumulation test of boilers

(9) Measurement of the torsional vibration for the shafting systems

(10) Verification of Total Harmonic Distortion (THD) calculation report and harmonic filter operation guide

(11) Other tests where deemed necessary by the Society

2 The results of the tests specified in **-1** are to be submitted to the Society as seatrial records.

3 In the case of classification survey of craft not built under the Society's survey, the above tests may be dispensed with, provided that sufficient data on the previous tests are available and no alteration affecting the tests specified in **-1** have been made after the previous tests.

2.3.2 Stability Experiments*

1 In the Classification Survey, stability experiments of a craft are to be carried out upon completion of the craft.

2 In the Classification Survey of craft not built under the Society's survey, stability experiments may be dispensed with, provided that sufficient information based on previous stability experiments is available and neither alternation nor repair affecting the stability has been made after the previous experiments.

3 The stability experiments of an individual craft may be dispensed with, provided that available stability data are obtained from the stability experiments of a sister craft or other adequate means and a special approval is given by the Society.

2.4 Docking

2.4.1 Docking

Every craft is recommended to be dry docked within six months after launching.

2.5 Alterations

2.5.1 Requirements of Surveys*

In cases where ships classified by the Society undergo repairs, alternations, modifications and outfitting related thereto (hereinafter referred to as "modifications, etc."), such ships are to continue to at least comply with any previously applicable requirements. Moreover, such ships, if constructed before the date on which any relevant amendments enter into force, are, as a rule, to comply with the requirements for ships constructed on or after that date to at least the same extent as they did before undergoing such modifications, etc. The modification, etc. of any main particular is to satisfy the requirements for ships constructed on or after the date on which any relevant amendments enter into force. In cases where ships undergo any modification, etc. which affects any main particulars, unless otherwise permitted by the Society, the concerned ship is to comply with requirements in force at the time of such modifications, etc.

Chapter 3 PERIODICAL SURVEYS AND PLANNED MACHINERY SURVEYS

3.1 General

3.1.1 General

1 All craft classed with the Society are to be subjected to the following Periodical Surveys:

(1) Annual Surveys

(2) Intermediate Surveys

(3) Special Surveys

(4) Propeller Shaft and Stern Tube Shaft Surveys

2 All craft classed with the Society are to be subjected to Planned Machinery Surveys.

3 All examinations and tests in accordance with the requirements in this Chapter are to be carried out to the satisfaction of the Surveyor.

3.1.2 Docking*

For Periodical Surveys, Annual, Intermediate or Special Surveys, the craft is to be dry docked or placed on slipways and to be placed on blocks of sufficient height and proper staging, except where in-water survey is requested by the owner and approved by the Society as substitution for surveys in dry docks or on slipways. Any consecutive in-water survey is not accepted.

3.1.3 Omission of Part of Surveys

At Special Surveys, close examinations of such items that were examined at the last Annual Survey or subsequent Surveys in accordance with the requirements for Special Surveys, may be omitted at the discretion of the Surveyor.

3.1.4 Omission of Pressure Tests

At Special Surveys of craft provided with a number of water or oil tanks, pressure tests of some of the tanks may be omitted at the discretion of the Surveyor, having regard to the condition and age of the craft as well as the time elapsed since the previous pressure test.

3.1.5 Modification of Requirements of Surveys*

1 With respect to Special Surveys in cases where considered appropriate by the Society, the Surveyor may modify the requirements for Special Surveys prescribed in **3.3** to **3.10** based on the size, purpose, service engaged, age, construction, results of the last survey and actual condition of the craft or the machinery.

2 At Special Surveys, for tanks where effective coatings are found to be in a good condition, internal examinations may be omitted and/or the extent of gauging requirements specified in this Chapter may be specially considered at the discretion of the Surveyor.

3.2 Intervals of Periodical Surveys and Planned Machinery Surveys

3.2.1 General*

1 A Periodical Survey is to be considered as completed when the relevant Periodical Surveys both for hull and for machinery have been completed, unless the special arrangement is made with the Society.

2 Expect as amended at the discretion of the Society, the intervals of Periodical Surveys are specified in **3.2.2** to **3.2.6**.

3 At the request of the owner, Periodical Surveys may be carried out before their due date.

4 Intermediate and Annual Surveys may be carried out at the request of the owner before the due date. In this case, one or more additional Periodical Surveys are to be carried out as specified otherwise.

3.2.2 Annual Surveys

1 Annual Surveys, except for passenger craft, are to be carried out within 3 *months* before or after each anniversary date of the date crediting a Classification Survey or the previous Special Survey.

2 Where both the Annual Survey and Intermediate Survey or Special Survey are due at the same time, only the Intermediate Survey or Special Survey is to be carried out.

3.2.3 Intermediate Surveys

1 Intermediate Surveys are to be carried out:

(1) within 3 *months* before or after each anniversary date of the date crediting a Classification Survey or the previous Special Survey for passenger craft.

(2) within 3 *months* before or after the second anniversary date or within 3 *months* before or after the third anniversary date of the date crediting a Classification Survey or the previous Special Survey for cargo craft. Annual Surveys are not required when an Intermediate Survey is carried out.

2 Where both the Intermediate Survey and Special Survey are due at the same time, only the Special Survey may be carried out.

3.2.4 Special Surveys

Special Surveys are to be carried out within 3 *months* before the date of expiry of the Classification Certificate.

3.2.5 Propeller Shaft and Stern Tube Shaft Surveys

Propeller Shaft and Stern Tube Shaft Surveys are to be carried out at intervals specified in **3.9**.

3.2.6 Planned Machinery Surveys

Planned Machinery Surveys are to be carried out at intervals specified in **1.1.2-2.(2), Part B of the Rules for the Survey and Construction of Steel Ships**.

3.2.7 Extension of Periodical Surveys

The extension of Special Surveys and Propeller Shaft and Stern Tube Shaft Surveys for Propeller Shafts Kind 2 to be carried out concurrently with the Special Survey may be granted, subject to the approval by the Society, according to the following:

(1) 3 *months* from the date of expiry of the Classification Certificate where a craft is abroad and navigating to a port of another country whose flag she is flying or to a port of another country in which the survey is intended to be carried out.

(2) 1 *month* from the date of expiry of the Classification Certificate where a craft is being engaged on short voyages.

3.3 Annual Surveys for Hull

3.3.1 Requirements for Annual Surveys

1 At each Annual Survey, the general condition of the hull and equipment is to be examined and tested as far as practicable and placed in good order with special attention being paid to the following:

(1) Upon outside of the hull being cleaned, keel plating, shell plating, stems, stern frames and foils, etc., are to be examined. Attention is to be given to parts of the structure particularly liable to excessive corrosion, discontinuous parts of the structure and openings in the shell. Grillage covers of openings in the shell are to be removed for the inspections, where considered necessary by the Surveyor.

(2) Rudders and shaft brackets are to be examined. In this case, rudders are to be lifted or removed and pintles and gudgeons, etc., are to be examined. This may be dispensed with provided the Surveyor is satisfied with bearing condition of the rudder by a measurement of the clearances.

(3) The scuppers, inlets and discharges including their valves are to be examined.

(4) The following items **(a)** to **(c)** are to be examined, and are to be tested, where considered necessary by the Surveyor, in accordance with the provisions specified in **Table 2.2.1** of this Part.

(a) The watertight integrity of the closures to any openings in the ship's side below the freeboard deck

(b) The means of securing the weathertightness of cargo hatchways, other hatchways and other openings on the freeboard and superstructure decks

(c) Side scuttles and deadlights

(5) Exposed engine casings and their openings, fiddley openings, engine room skylights and their closing appliances are to be examined.

(6) Ventilators including their coamings and closing appliances are to be examined.

(7) Air pipes including their coamings and closing appliances are to be examined.

(8) Watertight doors, penetrations and stop valves on watertight bulkheads, and superstructure end bulkheads and the closing appliances for the openings therein are to be examined. The operation tests of watertight doors on watertight bulkheads and closing appliances in superstructure end bulkheads are to be carried out.

(9) Bulwarks, shutters of freeing ports in bulwarks or guard rails are to be examined.

(10) Watertight bulkhead penetration.

(11) The guardrails, gangways, walkways and other means provided for the protection of the crew and means for safe passage of crew are to be examined.

(12) For craft required to be marked with load lines corresponding to the assigned freeboard, load line marks are to be verified.

(13) The stability information booklet approved by the Society is to be confirmed to be kept board.

(14) For craft required to be provided with the loading manual in accordance with the requirement of **1.4.2, Part 6** of this Rule, filing of the loading manual on board the craft for ready use is to be checked.

(15) For craft required to be provided with the loading computer in accordance with the requirement of **1.4.3, Part 6** of this Rule, it is to be confirmed that a loading computer having the performance and functions as deemed appropriate by the Society is installed on board.

(16) For craft required to be marked with the ship's identification number, general condition of the marking is to be examined.

(17) For craft of not less than 500 *gross tonnage* engaged on international voyages, general conditions of portable atmosphere testing instruments for enclosed spaces specified in **1.2.1, Part 15** are to be examined. (This includes the confirmation of calibration records.)

2 Drainage, mooring and anchoring arrangements and their accessories are to be examined. The means provided to minimize water ingress through the spurling pipes and chain lockers are also to be examined.

3 In addition to the general examinations for arrangements for fire protection, fire extinction and means of escape, general examinations and operation tests of the following **(1)** to **(17)** are to be carried out.

(1) Fire control plans kept on board are to be examined.

(2) As far as possible, general examinations and operation tests of fixed fire detection and fire alarm systems (including manually operated call points) and sample extraction smoke detection system are to be carried out.

(3) Fire pumps (including emergency fire pumps), fire main, hydrants, hoses, nozzles and the international shore connection are to be examined. Regarding fire pumps (including emergency fire pumps), it is to be confirmed that two jets of water are produced simultaneously from different hydrants at any part of the ship whilst the required pressure is maintained in the fire main are to be carried out.

(4) The fixed firefighting system for the machinery, cargo, vehicle, special category and ro-ro spaces are to be examined, as appropriate, and it is to be confirmed that its means of operation is clearly marked. It is also to be confirmed that fixed carbon dioxide fire-extinguishing systems are provided with two separate controls, one for opening of the gas piping and one for discharging the gas from the storage container, each of them located in a release box clearly identified for the particular space.

(5) Provision of the portable and non-portable fire extinguishers is to be checked, and the condition of these is to be randomly examined.

(6) Operation tests of ventilation systems for the release of smoke are to be carried out.

(7) For the firefighters' outfits, general examinations of the following **(a)** and **(b)** are to be carried out.

(a) It is to be confirmed that the firefighters' outfits including its self-contained compressed air breathing apparatus are complete and in good condition.

(b) It is to be confirmed that the cylinders, including the spare cylinders, of any required self-contained breathing apparatus are suitably charged.

(8) Fire-extinguishing and special arrangements in the machinery spaces are to be examined. As far as practicable and as appropriate, operation of the remote means of control provided for the opening and closing of the skylights, the release of smoke, the closure of the funnel and ventilation openings, the closure of power operated and other doors, the stopping of ventilation and boiler forced and induced draft fans and the stopping of oil fuel and other pumps that discharge flammable liquids are to be examined.

(9) Fire-extinguishing systems for spaces containing paint and/or flammable liquids and deep-fat cooking equipment in accommodation and service spaces are to be examined.

(10) General emergency alarm system is to be examined and tested.

(11) Fire protection arrangements (closing appliance, ventilation system, portable fire extinguisher, etc.) in cargo, vehicle and ro-ro spaces are to be examined. The operation of the means of control provided for closing the various openings are to be

confirmed, as far as practicable and as appropriate.

(12) The special arrangements for carrying dangerous goods are to be examined, when appropriate. This includes the check of the electrical equipment and wiring, the ventilation, the provision of protective clothing and portable appliances, and operation tests of the water supply, bilge pumping and any water spray system.

(13) It is to be confirmed, as far as practicable, that no changes have been made in the structural fire protection.

(14) As far as practicable, any manual and automatic fire doors are to be examined, and their operation is to be proved.

(15) Proper operation of the fire dampers of ventilation ducts as well as the means of closing the main inlets and outlets of all ventilation systems is to be confirmed, as far as practicable.

(16) Proper operation of the means of stopping power ventilation systems from outside the space served is to be confirmed, as far as practicable.

(17) It is to be confirmed that the means of escape from accommodation, machinery and other spaces are satisfactory.

4 The operation tests prescribed in **-1(8)**, however, may be dispensed with at the discretion of the Surveyor.

3.4 Intermediate Surveys for Hull

3.4.1 Requirements for Intermediate Surveys

1 At each Intermediate Surveys, the following are to be complied with and the general condition of hull and equipment is to be ascertained requirements in good order:

(1) All the requirements specified in **3.3.1-1** of this Part are to be complied with.

(2) Anchors, chain cables and ropes are to be ranged and examined. Hawse pipes, chain lockers and cable holdfasts are to be examined.

2 Drainage, mooring and anchoring arrangements and their accessories are to be examined. And, performance tests are to be carried out where deemed necessary by the Surveyor.

3 Fire extinguishing arrangements are to be examined and tested and placed in good order, paying attention to the following as well as general condition of the fire extinguishing arrangements:

(1) All the requirements specified in **3.3.1-3** of this Part are to be complied with.

(2) Measurement of the quantity of carbon dioxide extinguishing medium of the fixed gas fire-extinguishing system and its starting gas is to be carried out.

(3) Performance tests on the following **(a)** to **(e)** are to be carried out:

(a) Fixed carbon dioxide gas fire-extinguishing systems

(b) Fixed low-expansion form fire-extinguishing systems

(c) Fixed high-expansion form fire-extinguishing systems

(d) Fixed pressure water-spraying fire-extinguishing systems

(e) Automatic sprinkler systems

(4) Spare parts are to be examined.

3.5 Special Surveys for Hull

3.5.1 Kinds of Special Survey*

1 The first Special Survey of the craft after the Classification Survey during construction is designated as “No.1” and subsequent Special Surveys “No.2”, “No.3”, “No.4” and so on.

2 The kind of Special Survey of the craft classed with the Society after construction is to be determined in the similar sequence as specified in **-1** basing upon what kind of Special Survey was corresponding to her Classification Survey.

3 At Special Surveys, paying due attention to **(1)** through **(7)** below, examinations of structures and fittings such as piping, etc. in tanks and spaces are to be carried out carefully after the preparations specified in **1.2.2-1** of this Part have been done.

(1) Structural members, piping, hatch covers, etc. which are sensitive to corrosion in cargo holds where high-corrosive cargoes to steel such as logs, salt, coal, sulfide ore, etc. have been loaded

(2) Portions sensitive to wearing down by heat such as plating under boilers

(3) Structurally discontinuous portions such as corners of hatchway openings on deck, openings including side scuttles, cargo port, etc. on shell

(4) Condition of coating and corrosion prevention system if applied

(5) Condition of striking plates under sounding pipes

(6) Condition of cement or deck composition, if fitted

(7) Locations on which defects such as cracking, buckling, corrosion, etc. have been found in similar ships or similar structures

3.5.2 Requirements for Special Survey No.1 (For craft up to 5 *years* old)

1 At the Special Survey No.1, the followings are to be complied with:

(1) All items specified in **3.4.1-1** of this Part are to be thoroughly examined and tested.

(2) All compartments and following tanks are to be examined internally.

(a) Ballast tanks

(b) Peak tanks

(c) Cargo tanks

(3) Where compartments are to be fitted with insulation or close ceilings, compartments including their structural members, piping systems, etc., are to be examined after removing a sufficient amount of insulation or close ceiling as required by the Surveyor.

(4) For drainage, mooring and anchoring arrangements and their accessories, the items specified in **3.4.1-2** of this Part are to be thoroughly examined and tested.

2 For fire extinguishing arrangements, all items specified in **3.4.1-3** of this Part are to be thoroughly examined and tested.

3.5.3 Requirements for Special Survey No.2 (For craft between 5 and 10 *years* old)

At the Special Survey No.2, all the requirements specified in **3.5.2** of this Part and the following requirements are to be complied with:

(1) Fuel oil tanks within the cargo length areas and fresh water tanks are to be examined internally. However, fuel oil tanks and fresh water tanks need not all be examined internally, provided, after an external examination and from an internal examination of each one selected tank, the Surveyor is satisfied with the condition of the tanks. Notwithstanding the above, peak tanks are to be examined internally.

(2) Hydrostatic tests for shell plating, watertight bulkheads, shaft tunnels and watertight doors are to be carried out where considered necessary by the Surveyor.

3.5.4 Requirements for Special Survey No.3 (For craft between 10 and 15 *years* old)

At the Special Survey No.3, all the requirements specified in **3.5.3** of this Part are to be complied with. Furthermore, fuel oil tanks are to be examined internally. However, fuel oil tanks need not all be examined internally, provided, after an external examination and from an internal examination of two selected tanks within the cargo length areas (including one or more deep tank if present) and one selected tank within the engine rooms, the Surveyor is satisfied with the condition of the tanks. Notwithstanding the above, peak tanks are to be examined internally.

3.5.5 Requirements for Special Survey No.4 and after (For craft over 15 *years* old)

At the Special Survey No.4, all the requirements specified in **3.5.4** of this Part are to be complied with. Furthermore, fuel oil and lubricating oil tanks are to be examined internally. However, fuel oil tanks need not all be examined internally provided that, after external examinations and the internal examinations of half of the tanks (in no cases less than two tanks) selected from those within the cargo length areas and one selected tank within engine rooms, the Surveyor is satisfied with the condition of such tanks. Not all lubricating oil tanks need to be examined internally provided that, after external examinations and the internal examinations of one selected tank, the Surveyor is satisfied with the condition of such tanks. Notwithstanding the above, peak tanks are to be examined internally.

3.5.6 Thickness Measurements for the Craft Having Metal Hull Construction

1 For craft constructed in metal, at each Special Survey, thickness measurements are to be carried out in accordance with the requirements specified in this paragraph.

2 When thickness measurements are carried out, following are to be observed.

(1) Thickness measurements are to be carried out using an appropriate ultra-sonic gauging machines or other approved means. The accuracy of the equipment is to be proven to the surveyor as required.

(2) Thickness measurements are to be carried out within twelve months prior to completion of the survey in question under the

supervision of the surveyor, except where approved by the Society. The surveyor may re-check the measurements as deemed necessary to ensure acceptable accuracy.

(3) A thickness measurement record is to be prepared and submitted to the Society.

3 The Surveyor may extend thickness measurements as deemed necessary by the result of thickness measurements.

4 For craft constructed in steel, the following requirements of thickness measurements for each Special Survey are to be complied with.

(1) Special Survey No.1 (for craft up to 5 *years* old)

(a) In cargo holds where high-corrosive cargoes to steel have been loaded, lower parts of webs (most thin parts of web in case of built-up type frame) and tank side brackets of 3 hold frames at least at forward, middle and aft part of each cargo hold on both sides and 1 lowest strake plates at least of each transverse watertight bulkhead.

(b) Both ends and middle part (including face plate) of 1 transverse ring or corresponding main structural members in one each tank selected arbitrary from the deep tanks used as the permanent ballast tanks.

(c) Other parts as deemed necessary by the Surveyor.

(2) Special Survey No.2 (for craft between 5 and 10 *years* old)

(a) Following portions of structural members within 0.5*L* amidships;

i) Each plate in 1 section of the strength deck plating for the full beam of the craft.

ii) Each strength deck plate in way of water ballast tanks, if any.

(b) In cargo holds where high-corrosive cargoes to steel have been loaded, lower and upper parts of web (most thin parts of web in case of built-up type frame) of appropriate number (total to be of 1/3 at least of whole number frames in each cargo hold) of hold frames and their end brackets at forward, middle and aft parts of each cargo hold on both sides and all lowest plates of each transverse watertight bulkhead.

(c) In cargo holds other than **(b)** above, structural members specified in **(1)(a)** above.

(d) Both ends and middle part of each hatch side and end coaming.

(e) Both ends and middle part (including face plate) of approximately half the number of transverse rings or corresponding main structural members and at least 1 plate of upper and lower ends of each bulkhead in one each tank selected arbitrary from the deep tanks used as the permanent ballast tank.

(f) Both ends and middle part of 1 transverse ring or corresponding main structural members (including face plate) in all remaining deep tanks used as the permanent ballast tanks except those specified on **(e)** above.

(g) Other parts as deemed necessary by the Surveyor.

(3) Special Survey No.3 (for craft between 10 and 15 *years* old)

(a) Following portions of structural members;

i) Each strength deck plate within 0.5*L* amidships.

ii) Each plate and member in 1 transverse section within 0.5*L* amidships.

iii) Each plate in 1 selected strake of side shell plating in way of cargo spaces outside 0.5*L* amidships on each side above the ballast water line.

(b) In all cargo holds, lower and upper parts of web (most thin parts of web in case of built-up type frame) of appropriate number (total to be of 1/3 at least of whole number frames in each cargo hold) of hold frames and their end brackets at forward, middle and aft parts of each cargo hold on both sides and all lowest plates of each transverse watertight bulkhead.

(c) Both ends and middle part of each hatch side and end coaming.

(d) Both ends and middle part (including face plate) of about a half the number of transverse rings or corresponding main structural members and each plate at upper and lower parts of each bulkhead in all deep tanks used as the permanent ballast tank.

(e) Other parts as deemed necessary by the Surveyor.

(4) Special Survey No.4 (for craft between 15 and 20 *years* old)

(a) Following portions of structural members;

i) Each strength deck plate within 0.5*L* amidships.

ii) Each plate and member in two transverse sections within 0.5*L* amidships.

iii) Each plate in 1 selected strake of side shell plating in way of cargo spaces outside 0.5*L* amidships and each plate in

another selected strake of side shell plating outside 0.5*L* amidships from stem to stern, on each side above the ballast water line.

(b) Structural members specified in **(3)(b)** to **(d)** above.

(c) Other parts as deemed necessary by the Surveyor.

(5) Special Survey No.5 and after (for craft over 20 years old)

(a) Following portions of structural members;

i) Each strength deck plate within 0.5*L* amidships.

ii) Each plate and member in 3 transverse sections within 0.5*L* amidships.

iii) Each plate in two selected strakes of side shell plating outside 0.5*L* amidships from stem to stern on each side above the ballast water line.

(b) Structural members specified in **(4)(b)** above.

(c) Other parts as deemed necessary by the Surveyor.

5 For craft constructed of metal other than steel, thickness measurement is to be carried out where deemed necessary by the Surveyor.

3.5.7 Pressure Tests

1 At each Special Survey, pressure tests of tanks are to be carried out in accordance with the requirements specified in this paragraph.

2 Pressure tests of tanks are to be carried out under the pressure corresponding to the maximum head that can be experienced in service.

3 The surveyor may extend pressure tests of tanks as deemed necessary.

4 Pressure tests of tanks may be carried out when the craft is afloat, provided that an internal examination of the bottom is also carried out afloat.

5 The following requirements of pressure tests of tanks for each Special Survey are to be complied with. The testing of double bottom tanks and other watertight compartments not designed to carry liquids may be omitted, provided that satisfactory internal and/or external examinations are carried out.

(1) Cargo tanks and water tanks

(Pressure tests of fresh water tanks may be dispensed with, in cases where deemed appropriate by the Society.)

(2) Fuel oil tanks

(Pressure tests of these tanks may be dispensed with, in cases where deemed appropriate by the Society.)

(3) Lubrication oil tanks

(Pressure tests of these tanks may be dispensed with, in cases where deemed appropriate by the Society.)

3.6 Annual Surveys for Machinery

3.6.1 Requirements for Annual Surveys*

1 At each Annual Survey for Machinery, a general examination of the whole machinery in the engine room and the following inspections **(1)** to **(8)** are to be carried out;

(1) It is to be ascertained that the main propulsion machinery, power transmission machinery, prime movers other than main propulsion machinery, boilers, thermal oil heaters, incinerators, pressure vessels, auxiliary machinery, piping systems, control systems, electrical installations and switchboards are placed in good order.

(2) It is to be ascertained that the engine room, boiler spaces and means of escape are placed in good order with respect to dangers of fire and explosion.

(3) The clearance between the bush of stern tube bearing or shaft bracket bearing and propeller shaft or stern tube shaft, or the bearing weardown is to be measured.

(4) The stern tube sealing devices or the shaft bracket sealing device, if any, are to be examined.

(5) The propellers are to be examined. In the case where a controllable pitch propeller is fitted, it is to be ascertained that the pitch control device is in good working order.

(6) Valves and cocks fitted to the ship's hull, sea chest or distance piece mounted on the hull together with their fastenings to the

hull are to be opened up and examined. The open-up examinations may be dispensed with at the discretion of the Surveyor.

(7) For ships with oil lubricated or freshwater lubricated bearings, it is to be checked as to whether lubricating oil analysis or fresh water sample tests are regularly carried out. In cases where lubricating oil analysis or water sample tests are carried out, it is to be checked as to whether the reference standards deemed appropriate by the Society are complied with based upon the lubricating oil analysis or fresh water sample test reports, in addition to a general examination.

(8) Arrangements for remote closing of valves for fuel oil tanks, lubricating oil tanks and other flammable oil tanks are to be examined.

2 At Annual Surveys for electric propulsion ships, it is to be ascertained as far as practical for electric propulsion systems that forced cooling apparatuses (including filters), supports and coverings of cables, capacitor elements of propulsion semiconductor converters for propulsion, windings of generating plants and motors for propulsion , slip rings, commutators and brushes, etc. are in good condition.

3.6.2 Performance Tests*

At each Annual Survey for Machinery, performance tests for the following items in **(1)** to **(7)** are to be carried out in order to ascertain that they are placed in good order.

(1) Arrangements for remote closing of valves for fuel oil tanks, lubricating oil tanks and other flammable oil tanks, as far as practicable and as appropriate

(2) Emergency stopping devices for fuel oil pumps, ventilating fans and boiler draught fans

(3) Emergency sources of electrical powers

(4) All the means of communication between the navigation bridge and the machinery control position, as well as between the bridge and the steering gear compartment

(5) Main and auxiliary steering gears together with their associated equipment and control systems are to be subjected to the performance tests.

(6) Bilge systems

Operation tests for the valves (including ones for emergency use), cocks, strainers, pumps, reachrods and level alarms of the bilge systems

(7) Operation tests for the safety devices, etc. specified in the following **(a)** to **(e)** are to be carried out. However, the tests may be omitted at the Surveyor's discretion based on the general examination, and hearing of the working conditions at sea and inspection records taken by the ship's crew.

(a) Main propulsion machinery and auxiliary machinery

Operation tests of the following safety devices and alarm devices for main propulsion machinery and prime movers for driving generators, auxiliary machinery essential for main propulsion and auxiliary machinery for the manoeuvring and the safety are to be carried out.

i) Overspeed protective devices

ii) Automatic shut-off devices and alarm devices in case of loss or low pressure of the lubricating oil

(b) Boilers, thermal oil heaters and incinerators

Operation tests for the safety devices, alarm devices and pressure indicators specified in **Chapter 9, Part D of the Rules for the Survey and Construction of Steel Ships** are to be carried out. Calibration records for the pressure indicators of boilers are to be ascertained. Where deemed necessary by the Surveyor, the control records of the boiler water and thermal heater oil are required to be presented for review.

(c) Monitoring devices

Operation tests for pressure indicators, thermometers, ammeters, voltmeters and revolution meters are to be carried out.

(d) Automatic control devices and remote control devices

Operation tests for automatic control devices and remote control devices used for auxiliary machinery essential for main propulsion and auxiliary machinery for the manoeuvring and the safety as well as the means of remotely controlling the propulsion machinery (including electric propulsion plants for electric propulsion ships) from the navigating bridge (including the control, monitoring, reporting, alert and safety actions) are to be carried out.

(e) Engineer's Alarm

It is to be confirmed that the engineer's alarm is clearly audible in the engineers' accommodation.

3.6.3 Surveys of Selective Catalytic Reduction (SCR) Systems, etc.

At each Annual Survey for ships fitted with selective catalytic reduction (SCR) systems, exhaust gas cleaning systems or exhaust gas recirculation systems, in addition to the surveys specified in **3.3** and **3.6**, the surveys specified in **3.3.5-1**, **-2** and **-3, Part B of the Rules for the Survey and Construction of Steel Ships** respectively are to be carried out.

3.7 Intermediate Surveys for Machinery

3.7.1 General Examinations

At each Intermediate Survey for Machinery, the general examinations and inspections specified in **3.6.1** are to be carried out.

3.7.2 Performance Tests

At each Intermediate Survey for Machinery, performance tests specified in **3.6.2** are to be carried out.

3.7.3 Open-up Examinations

Boilers and thermal oil heaters are to be examined as follows;

(1) Pressure parts of boilers are to be internally examined with the manholes, cleaning holes and inspection holes dismantled. Where considered to be necessary for external examination by the Surveyor, the parts are to be examined to the Surveyor's satisfaction with the insulation around the parts removed.

(2) Superheaters, economizers and exhaust gas economizers are to be examined internally and externally.

(3) Combustion parts of boilers and thermal oil heaters are to be internally examined with the doors of the furnaces and combustion chambers opened.

(4) Valves and cocks mounted on boilers and their fastening bolts or studs are to be opened up and examined.

(5) Thickness of plates and tubes and size of stays is to be measured where deemed necessary by the Surveyor.

(6) The safety valves are to be adjusted under steam to a pressure not more than 103 % the approved working pressure after examination. The pressure gauge used for adjustment of safety valves is to be calibrated properly. The general conditions of relief pipes for thermal oil heaters are to be examined. The popping pressure of safety valves fitted on thermal oil heaters is to be ascertained.

(7) Steam generators and other pressure vessels with steam accumulated in them are to be handled in accordance with the requirements for boilers.

(8) The safety devices, alarm devices and automatic combustion control devices are to be tested in accordance with the requirements in **Chapter 9, Part D of the Rules for the Survey and Construction of Steel Ships** in order to ascertain that they are to in good working conditions after the examinations specified in **(1)** to **(7)** above.

(9) When direct visual internal inspection at the examinations specified in **(1)** to **(3)** above is not feasible due to the limited size of the internal spaces, such as for small boilers and/or narrow internal spaces, this may be replaced by a hydrostatic pressure test or by alternative verifications as deemed appropriate by the Society.

3.7.4 Surveys of Selective Catalytic Reduction (SCR) Systems, etc.

At each Intermediate Survey for ships fitted with selective catalytic reduction (SCR) systems, exhaust gas cleaning systems or exhaust gas recirculation systems, in addition to the surveys specified in **3.4** and **3.7**, the surveys specified in **4.3.5, Part B of the Rules for the Survey and Construction of Steel Ships** are to be carried out.

3.8 Special Surveys for Machinery

3.8.1 General Examinations

1 At each Special Surveys for Machinery, the general examinations and inspections specified in **3.7.1** are to be carried out.

2 In addition to -1, general examinations for the following items in **(1)** to **(3)** are to be carried out.

(1) Main propulsion machinery

Reciprocating internal combustion engines are to be examined in accordance with the following requirements in **(a)** to **(c)**;

(a) The essential part of the crankcase and cylinder jacket, the foundation bolts, the chock liners and the tie rod bolts are to be generally examined.

(b) The doors of the crankcase and the explosion relief devices of the crankcase and scavenge space are to be generally

examined.

(c) The anti-vibration dampers, detuners, balancers, etc. are to be generally examined.

(2) Electrical installations

Insulation resistance of the generators and switchboards (the both including those for emergency use), the motors and the cables; the main circuits of control gears for electric propulsion motors and semiconductor converters for propulsion of electric propulsion ships are to be tested to ensure that they are placed in good order, and to be adjusted if it is found not to comply with the requirements **2.18.1, Part H of the Rules for the Survey and Construction of Steel Ships**. However, where a proper record of measurement is maintained and deemed appropriate by the Surveyor, consideration may be given to accepting recent readings.

(3) Spare parts and associated fittings

Spare parts and associated fittings for Machinery are to be examined.

3 At each Special Surveys for Machinery, the verification runs specified in **1.1.5-1** and **-3** are to be carried out.

3.8.2 Performance Tests and Pressure Tests

1 At each Special Survey for Machinery, performance tests specified in **3.7.2** are to be carried out.

2 In addition to **-1**, the following performance tests in **(1)** and **(2)** are to be carried out.

(1) The performance tests for the speed governors, generator circuit breakers and associated relays are to be carried out with all generators run under loaded condition, either separately or in parallel, as far as practicable.

(2) The performance tests for lighting systems, communication and signaling systems, ventilating systems, other electrical equipment, etc. are to be carried out in case where deemed necessary by the Surveyor.

3 The following pressure tests in **(1)** and **(2)** are to be carried out.

(1) For condensers, evaporators and receivers using NH3(R717) as refrigerant, the parts exposed to the primary refrigerant are to be tested at a pressure of 90% of the design pressure (the pressure may be reduced down to 90% of the setting pressure of the relief valves. However, the pressure test may be replaced by other means as deemed appropriate by the Society.

(2) For all other machinery and its parts than those specified in **(1)**, pressure test is to be handled in accordance with the requirements **2.1.5(2)**, in case where deemed necessary by the Surveyor.

3.8.3 Open-up Examinations

At each Special Survey for Machinery, open-up examinations specified in **3.7.3** are to be carried out.

3.8.4 Surveys of Selective Catalytic Reduction (SCR) Systems, etc.

At each Special Survey for ships fitted with selective catalytic reduction (SCR) systems, exhaust gas cleaning systems or exhaust gas recirculation systems, in addition to the surveys specified in **3.5** and **3.8**, the surveys specified in **5.3.5, Part B of the Rules for the Survey and Construction of Steel Ships** are to be carried out.

3.9 Propeller Shaft and Stern Tube Shaft Surveys

3.9.1 Definitions

The terms which appear in this chapter are defined as follows.

(1) "Shafts" mean propeller shafts and stern tube shafts as specified in the following **(2)** and **(3)** but does not include intermediate shafts which are considered part of the propulsion shafting inside the ship.

(2) "Propeller shaft" is the part of the propulsion shaft to which the propeller is fitted.

(3) "Stern tube shaft" is a shaft placed between the intermediate shaft and propeller shaft, normally arranged within a stern tube or running in open water.

(4) "Shaft Kind 1" is a propeller shaft which is effectively protected against corrosion by sea water, outboard fresh water and inboard fresh water with a means approved by the Society or which is made of corrosion resistant materials approved by the Society.

(5) "Shaft Kind 1*A*" is "Shaft Kind 1" with water lubricated stern tube bearing.

(6) "Shaft Kind 1*B*" is "Shaft Kind 1" with oil lubricated stern tube bearing.

(7) "Shaft Kind 1*C*" is "Shaft Kind 1*B*" satisfying the requirements in **6.2.11, Part D**.

(8) "Shaft Kind 1*W*" is "Shaft Kind 1" with fresh water lubricated stern tube bearing.

(9) "Shaft Kind 2" is a propeller shaft other than "Shaft Kind 1".

(10) "Stern tube shaft" is a shaft placed between the intermediate shaft and propeller shaft, normally arranged within a stern tube or running in open water.

(11) "Stern tube" is a tube or pipe fitted in the shell of a ship at the stern (or rear part of the ship), through which passes the stern tube shaft or aftermost section of the propeller shaft.

(12) "Stern tube sealing system" means the sealing system installed for the following **(a)** or **(b)**, depending on the kind of shaft. The sealing system for the inboard extremity of the stern tube prevents the possible leakage of the lubricant media into the ship internal. The sealing system for the outboard extremity of the stern tube prevents any the possible sea water ingress or leakage of the lubricant media.

(a) "Shaft Kind 1*A*" or "Shaft Kind 2": Inboard extremity of stern tube

(b) "Shaft Kind 1*B*", "Shaft Kind 1*C*" or "Shaft Kind 1*W*": Inboard and outboard extremity of stern tube

(13) "Oil lubricated" means closed loop oil lubricating systems which use oil to lubricate the bearings and are sealed against the environment by adequate sealing devices.

(14) "Water lubricated" means open water lubricating systems where bearings are lubricated by water (sea water or outboard fresh water) and cooled.

(15) "Fresh water lubricated" means closed loop water lubricating systems which use fresh water to lubricate the bearings and are sealed against the environment by adequate sealing devices.

(16) "Service records" are regularly recorded data showing in-service conditions of the shafts and stern tube include the following (as applicable): service conditions of lubricating water pumps (for "Shaft Kind 1*A*" or "Shaft Kind 2"), lubricating oil temperature, bearing temperature and oil consumption records (for "Shaft Kind 1*B*" or "Shaft Kind 1*C*") or water flow, water temperature, salinity, pH, make-up water and pressure of lubricating fresh water pumps (for "Shaft Kind 1*W*").

(17) "Oil sample examination" is a visual examination of the stern tube lubricating oil taken in the presence of a surveyor with a focus on water contamination.

(18) "Lubricating oil analysis" is the analysis to be carried out in accordance with the following **(a)** to **(c)**:

(a) The lubricating oil analysis is to be carried out at regular intervals not exceeding 6 *months*.

(b) The documentation on lubricating oil analysis is to be available on board.

(c) Oil samples to be submitted for the analysis are to be taken in accordance with following **i)** to **ii)**:

i) The sample is to be taken from the same identified position in the system under service conditions.

ii) The sample, unless supervised by a surveyor, is to be collected under the direct supervision of the chief engineer and to be identified.

(19) "Fresh water sample test" is the test to be carried out in accordance with the following **(a)** to **(d)**:

(a) The fresh water sample test is to be carried out at regular intervals not exceeding 6 *months*.

(b) Fresh water samples are to be taken in accordance with the following **i)** to **iv)**:

i) The sample is to be taken under service conditions (i.e. with a rotating shaft and the system at service temperature) and are to be representative of the water circulating within the stern tube.

ii) The sample is to be taken from the same agreed position in the system, before the filters, if any fitted in the fresh water lubrication system, which is to be positively identified.

iii) At time of survey the sample for the test is to be taken in the presence of a surveyor.

iv) The sample, unless supervised by a surveyor, is to be collected under the direct supervision of the chief engineer.

(c) Analysis results are to be retained on board and made available to the surveyor.

(d) The fresh water sample test is to include the following **i)** to **iii)** parameters:

i) chlorides content;

ii) pH value; and

iii) presence of bearing particles or other particles (only for laboratory analysis, and not required for tests carried out in the presence of a surveyor).

(20) "Keyless connection" is the forced coupling methodology between the shaft and the propeller without a key achieved through the interference fit of the propeller boss on the shaft tapered end.

(21) "Keyed connection" is the forced coupling methodology between the shaft and the propeller with a key and keyway achieved

through the interference fit of the propeller boss on the shaft tapered end.

(22) "Flanged connection" is the coupling methodology, between the shaft and the propeller, achieved by a flange, built in at the shaft aft end, bolted to the propeller boss

(23) "Alternative means" means shafting arrangements such as an approved condition monitoring scheme or other reliable approved means for assessing and monitoring the condition of the shafts, sealing devices and the stern tube lubricant system capable to assure the condition of the propeller shaft assembly with an equivalent level of safety as obtained by survey methods specified in this part.

3.9.2 Surveys of Water Lubricated Shafts

1 Surveys of Shafts Kind 1*A*

(1) Surveys of shafts kind 1*A* are to be the Ordinary Survey specified in **Table 3.9.2** and are to be carried out within 5 years from the date of completion (survey due date) of the Classification Survey or the previous Ordinary Survey.

(2) In addition to **(1)** above, surveys for shafts Kind 1*A* which are used corrosion resistant materials specified in **6.2.7-1.(3), Part D of the Rules** are to be the Partial Surveys specified in **Table 3.9.2** and are to be carried out within 36 *months* from the date of completion (survey due date) of the Classification Survey or the previous Ordinary Survey specified in **(1)** above. In cases where the results of the Partial Survey are not satisfactory, the Ordinary Survey specified in **Table 3.9.2** is to be carried out.

(3) For the surveys referred to **(1)** and **(2)** above completed with 3 *months* prior to the survey due date, the next period is to start from the survey due date.

(4) The survey due date may be extended in cases where a survey is carried out in accordance with following **(a)** to **(d)** and the shafts condition is confirmed to be satisfactory. The interval of the Ordinary Survey specified in **Table 3.9.2** is not to exceed 6 *years*.

(a) The survey due date may be extended for up to 1 *year* in cases where the 1Year Extension Survey specified in **Table 3.9.2** is carried out. No further extension survey may be carried out.

(b) The survey due date may be extended for up to 3 *months* in cases where the 3Month Extension Survey specified in **Table 3.9.2** is carried out. No further 3Month Extension Surveys may be carried out. In the event an additional extension is requested, the survey due date, prior to the previous extension, may be extended for up to 1 *year* in cases where the 1Year Extension Survey specified in **Table 3.9.2** is carried out.

(c) The period of extension counts from the survey due date in cases where the extension survey is carried out within 1 *month* within the survey due date.

(d) The period of extension counts from the date on which the extension survey in cases where the extension survey is carried out more than 1 *month* prior to the survey due date.

2 Surveys of Shafts Kind 2

(1) Surveys of shafts Kind 2 are to be the Ordinary Surveys specified in **Table 3.9.2** and are to be carried out in accordance with the following **(1)** and **(2)** periods (survey due dates).

(a) Concurrently with Special Surveys; and

(b) Within 36 *months* from the date of completion of the Classification Survey or the previous Ordinary Survey

(2) For the surveys referred to **(1)** above completed with 3 *months* prior to the survey due date, the next period is to start from the survey due date.

Table 3.9.2 Surveys of Water Lubricated Shafts – Shafts Kind 1*A* and Kind 2

Items	Examinations	Ordinary Survey	Partial Survey	Extension Survey	
				1 year	3 months
1 Drawing out of the shafts -1 Entirely drawing out	(1) Drawing the propeller shaft and the stern tube shaft and examining the entire shaft (including liners, corrosion protection system and stress reducing features, where provided), inboard seal system and bearings.	○			
-2 Partially drawing out	(1) Drawing the propeller shaft to confirm the contacting parts to stern tube bearing. The propeller shaft may be withdrawn with the condition fitting propeller to propeller shaft.		○		
2 Propeller connections -1 Keyed connections	(1) Removing the propeller to expose the forward end of the taper. (2) Performing a non-destructive examination (*NDE*) to all around the shaft in way of the forward portion of the taper section, including the keyway with the method deemed appropriate by a surveyor. (When shafts are provided with liners, the *NDE* is to be extended to the after edge of the liner.)	○			
-2 Keyless connections	(1) Removing the propeller to expose the forward end of the taper. (2) Performing a non-destructive examination (*NDE*) to all around the shaft in way of the forward portion of the taper section with the method deemed appropriate by a surveyor. For shafts provided with liners, the *NDE* is to be extended to the after edge of the liner. (3) Notwithstanding **(2)** above, with the interval not to exceed 15 *years*, performing a non-destructive examination (*NDE*) to whole corn parts of shaft including the forward portion of the taper section with the method deemed appropriate by a surveyor.	○			
-3 Flanged connections	(1) Whenever the coupling bolts of any type of flange-connected shaft are removed or the flange radius is made accessible in connection with overhaul, repairs or when deemed necessary by a surveyor, performing a non-destructive examination (*NDE*) to the coupling bolts and flange radius with the method deemed appropriate by the surveyor.	○			
3 Clearance between bush of the stern tube bearing and propeller shaft	(1) Checking and recording the clearance between bush of the stern tube and propeller shaft. (2) Confirm the clearance dose not exceed the following value. (a) Shaft diameter no more than 230*mm*: 6 *mm* (b) Shaft diameter more than 230*mm* but no more than 305*mm*: 8 *mm* (c) Shaft diameter more than 305*mm*: 9.5 *mm*	○	○	○	
4 Propeller	(1) Verification that the propeller is free of damages which may cause the propeller to be out of balance. (For extension survey, the information is confirmed by the record etc.) (2) For ordinary surveys, checking propeller fitting condition to shaft. When the propeller shaft with keyless connection is force fitted to the shaft, it is to be ascertained that the pull-up length is within the upper and lower limits given in **7.3.1-1, Part D**.	○	○	○	○

5 Sealing device for stern tube	(1) Verification of the satisfactory conditions of inboard seals during the re-installation of the shaft and propeller. (For ordinary surveys, the verification is carried out during the re-installation of the shaft and propeller.)	○	○	○	○
6 Shaft and coupling bolts	(1) Examination of shaft and coupling bolts (For extension survey, visual inspection of accessible parts of shaft and coupling bolts.). However, performing a non-destructive examination (*NDE*) to coupling bolts with the method deemed appropriate by a surveyor in cases where the surveyor, based on the results of external examinations, deems such addition examination to be necessary. In addition, anti-corrosion covers are to be removed for shafts Kind 2.	○		○	○
7 Stern tube bearing	(1) Examination of the stern tube bearings.	○			
8 Propeller boss surfaces in contact with the propeller shaft taper	(1) Examination of the propeller boss surface.	○			
9 Controllable pitch propeller connections (Only applies to shafts with flanged connections)	(1) Open-up examination of the pitch control gear and working parts as well as performing a non-destructive examination (*NDE*) to the propeller blade fixing bolts with the method deemed appropriate by a surveyor.	○			
10 Water lubrication lines	(1) Examination of water lubrication lines.	○	○	○	○
11 Review of records etc.	(1) Review of following **(a)** to **(d)**. (a) Previous clearance recording (b) Service records (c) No report to repairs by grinding or welding of shafts or propellers (d) The information of the shafting arrangement is in good working condition by the chief engineer			○	○

3.9.3 Surveys of Oil Lubricated Shafts

Surveys of Shaft Kind 1*B* and 1*C*

(1) Surveys of Shaft kind 1*B* and Shaft kind 1*C* are to be the Ordinary Surveys specified in **Table 3.9.3** carried out within 5 years from the date of completion (survey due date) of the Classification Survey or the previous Ordinary Survey.

(2) Notwithstanding **(1)** above, for shafts which are subject to the lubricating oil analysis specified in **3.9.1(18)**, the Partial Survey specified in **Table 3.9.3** may be carried out instead of the Ordinary Survey. In cases where the results of the Partial Survey are not satisfactory, the Ordinary Survey specified in **Table 3.9.3** is to be carried out.

(3) Notwithstanding **(1)** and **(2)** above, for shafts with keyless or flanged connections and which are subject to the lubricating oil analysis specified in **3.9.1(18)**, Simplified Partial Survey specified in **Table 3.9.3** can be carried out instead of Ordinary Survey or Partial Survey. In cases where the results of the Simplified Partial Survey are not satisfactory, the Ordinary Survey specified in **Table 3.9.3** is to be carried out.

(4) Notwithstanding **(2)** and **(3)** above, for Shaft kind 1*B* and Shaft kind 1*C*, the interval of Ordinary Survey specified in **Table 3.9.3** above is not to exceed 15 *years*. This interval may be extended for up to 3 *months*. No further extension may be granted.

(5) For the surveys referred to **(1)** to **(4)** above completed with 3 *months* prior to the survey due date, the next period is to start from the survey due date.

(6) For shafts which are carried out lubricating oil analysis specified in **3.9.1(18)**, the survey due date may be extended in cases where a survey is carried out in accordance with following **(a)** to **(e)**.

(a) The survey due date may be extended for up to 2.5 *years* in cases where the 2.5Year Extension Survey specified in **Table 3.9.2** is carried out. No further extension survey may be carried out.

(b) The survey due date may be extended for up to 1 *year* in cases where the 1Year Extension Survey specified in **Table 3.9.2** is carried out. No further extension survey may be carried out.

(c) The survey due date may be extended for up to 3 *months* in cases where the 3Month Extension Survey specified in **Table 3.9.2** is carried out. No further 3Month Extension Surveys may be carried out. In the event an additional extension is requested, the survey due date, prior to the previous extension, may be extended for up to 1 *year* in cases where the 1Year Extension Survey specified in **Table 3.9.2** is carried out.

(d) The period of extension counts from the survey due date in cases where the extension survey is carried out within 1 *month* within the survey due date.

(e) The period of extension counts from the date on which the extension survey in cases where the extension survey is carried out more than 1 *month* prior to the survey due date.

Table 3.9.3 Surveys of Oil Lubricated Shafts – Shafts Kind 1*B* or 1*C*

Items	Examinations	Ordinary Survey	Partial Survey	Simplified Partial Survey	Extension Survey		
					2.5 years	1 year	3 months
1 Drawing out of the shafts	(1) Drawing the propeller shaft and the stern tube shaft and examining the entire shafts, seals system and bearings. (2) Checking and recording the bearing clearances between the bush and the shafts.	○					
2 Propeller connections -1 Keyed connections	(1) Removing the propeller to expose the forward end of the taper. (2) Performing a non-destructive examination (*NDE*) to all around the shaft in way of the forward portion of the taper section, including the keyway with the method deemed appropriate by a surveyor. (When shafts are provided with liners, the *NDE* is to be extended to the after edge of the liner.)	○	○				
-2 Keyless connections	(1) Removing the propeller to expose the forward end of the taper. (2) Performing a non-destructive examination (*NDE*) to all around the shaft in way of the forward portion of the taper section with the method deemed appropriate by a surveyor. (When shafts provided with liners, the *NDE* is to be extended to the after edge of the liner.)	○	○				
-3 Flanged connections	(1) Whenever the coupling bolts of any type of flange-connected shaft are removed or the flange radius is made accessible in connection with overhaul, repairs or when deemed necessary by a surveyor, performing a non-destructive examination (*NDE*) to the flange radius and coupling bolts with the method deemed appropriate by the surveyor.	○	○				
3 Weardown of shaft at the stern tube bearing	(1) Checking and recording the weardown (For extension surveys, the checking and recording are to be carried out as far as practicable.) (2) Confirm the weardown value does not exceed 0.3 *mm* (0.3 *mm* is standard value). In addition, factors such as the characteristics of the lubricating oil, the temperature fluctuation history of the lubricating oil or bearing material are to be taken into account.	○	○	○	○		
4 Propeller	(1) Verification that the propeller is free of damages which may cause the propeller to be out of balance. (For extension surveys, the information is to be confirmed by records etc.) (2) For ordinary surveys, checking propeller fitting condition to shaft. When the propeller shaft with keyless connection is force fitted to the shaft, it is to be ascertained that the pull-up length is within the upper and lower limits given in **7.3.1-1, Part D of the Rules for the Survey and Construction of Steel Ships**.	○	○	○	○	○	
5 Sealing device for stern tube	(1) Verification of the satisfactory conditions of inboard and outboard seals. (For ordinary surveys, the verification is carried out during the re-installation of the shaft and propeller.) For 3month extension surveys, verification of inboard seals may be accepted. (2) Confirmation that the seal liner is placed in a satisfactory condition. For extension, this examination is not applied.	○	○	○	○	○	○

Items	Examinations	Ordinary Survey	Partial Survey	Simplified Partial Survey	Extension Survey		
					2.5 years	1 year	3 months
6 Shaft and coupling bolts	(1) Examination of shaft and coupling bolts (For the surveys except Ordinary Survey, visual inspection of accessible parts of shaft and coupling bolts.). However, performing a non-destructive examination (*NDE*) to coupling bolts with the method deemed appropriate by a surveyor in cases where the surveyor, based on the results of external examinations, deems such addition examination to be necessary.	○	○	○	○	○	○
7 Stern tube bearing	(1) Examination of the stern tube bearings.	○					
8 Propeller boss surfaces in contact with the propeller shaft taper	(1) Examination of the propeller boss surface.	○					
9 Controllable pitch propeller connections (Only applies to shafts with flanged connections)	(1) Open-up examination of the pitch control gear and working parts as well as performing a non-destructive examination (*NDE*) to the propeller blade fixing bolts with the method deemed appropriate by a surveyor.	○	○				
10 Low oil level alarms of the lubricating oil tanks, lubricating oil temperature measuring devices, oil lubricating lines and lubricating oil circulating pumps, etc.	(1) Examination of the systems for verifying whether stern tube bearings are being maintained in good working condition.	○	○	○	○	○	○

Items	Examinations	Ordinary Survey	Partial Survey	Simplified Partial Survey	Extension Survey		
					2.5 years	1 year	3 months
11 Review of records etc.	(1) Examinations are to be carried out in accordance with the following **(a)** to **(g)**. (a) Service records are to be reviewed. (b) Review of test records of the lubricating oil analysis is to be carried out to confirm that the reference standards specified in following **i)** and **ii)** are complied with. i) Metal particles (upper limit) *1 : 1) Iron (Fe): 50 *ppm* 2) Tin (Sn): 20 *ppm* 3) Lead (Pb): 20 *ppm* 4) Sodium (Na): 80 *ppm* ii) IR oxidation and separated water*2: 1) IR oxidation @ 5.85*μm*: 10 (*Abs.unit/cm*) 2) Separated water: 1.0 *%* (c) Oil sample examination is to be carried out. (d) Verification of no reported repairs by grinding or welding of shafts or propellers is to be carried out. (e) Examination of the lubricating oil record book. (f) For 1year and 3month extension surveys, review of the previous clearance recordings is to be carried out. (g) Confirmation from the chief engineer that the shafting arrangement is in good working condition is to be obtained.		○	○	○	○	○

Notes

*1: If the test results of the oil analysis suggest that the sample oil does not represent the lubricating oil in the stern tube and is suspected to be invalid (e.g., when only iron (Fe) exceeds the upper limit of **(b)i)**, item **11**, it is suspected that rust in the lubricating oil tank is the cause.), the surveyor is to instruct the shipowner (or the ship management company) to promptly re-perform the oil analysis and to be verified the test results of the oil analysis by the time of the first periodical survey (excluding those specified in **1.1.3-1(5), Part B of the Rules for the Survey and Construction of Steel Ships**) on or after the day 3 *months* after the day of receiving the said instruction.

*2: Notwithstanding **(b)ii)**, item **11**, in the case of environmentally acceptable lubricants (EAL), observation of any trends (such as TAN (total acid number), viscosity and change in colour etc.) based on periodical oil analysis may be made. In such cases, observations of TAN trends are to be made based on sequential analyssis in conjunction with limits for continued use in service defined by oil makers.

3.9.4 Surveys of Fresh Water Lubricated Shafts

Surveys of Shafts Kind 1*W*

(1) Surveys for shafts Kind 1*W* are to be the Ordinary Surveys specified in **Table 3.9.4** and are to be carried out within 5 years from the date of completion (survey due date) of the Classification Survey or the previous Ordinary Survey (survey due date).

(2) Notwithstanding **(1)** above, for shafts which are subject to the lubricating oil analysis specified in **3.9.1(19)**, the Partial Survey specified in **Table 3.9.4** may be carried out instead of an Ordinary Survey. In cases where the results of the Partial Survey are not satisfactory, the Ordinary Survey specified in **Table 3.9.4** is to be carried out.

(3) Notwithstanding **(1)** and **(2)** above, for shafts with keyless or flanged connections and which are subject to the lubricating oil analysis specified in **3.9.1(19)**, the Simplified Partial Survey specified in **Table 3.9.4** may be carried out instead of an Ordinary Survey or Partial Survey. In cases where the results of the Simplified Partial Survey are not satisfactory, the Ordinary Survey specified in **Table 3.9.4** is to be carried out.

(4) Notwithstanding **(2)** and **(3)** above, the interval of Ordinary Survey specified in **Table 3.9.4** above is not to exceed 15 *years*. This interval may be extended for up to 3 *months*. No further extension may be granted.

(5) For the surveys referred to **(1)** to **(4)** above completed with 3 *months* prior to the survey due date, the next period is to start from the survey due date.

(6) For shafts which are carried out lubricating fresh water analysis specified in **3.9.1(19)**, the survey due date may be extended in cases where a survey is carried out in accordance with following **(a)** to **(e)**.

(a) The survey due date may be extended for up to 2.5 *years* in cases where the 2.5Year Extension Survey specified in **Table 3.9.4** is carried out. No further extension survey may be carried out.

(b) The survey due date may be extended for up to 1 *year* in cases where the 1Year Extension Survey specified in **Table 3.9.4** is carried out. No further extension survey may be carried out.

(c) The survey due date may be extended for up to 3 *months* in cases where the 3Month Extension Survey specified in **Table 3.9.4** is carried out. No further 3Month Extension Survey may be carried out. In the event an additional extension is requested, the survey due date, prior to the previous extension, may be extended for up to 1 *year* in cases where the 1Year Extension Survey specified in **Table 3.9.4** is carried out.

(d) The period of extension counts from the survey due date in cases where the extension survey is carried out within 1 *month* within the survey due date.

(e) The period of extension counts from the date on which the extension survey in cases where the extension survey is carried out more than 1 *month* prior to the survey due date.

Table 3.9.4 Surveys of Fresh Water Lubricated Shafts – Shafts Kind 1*W*

Items	Examinations	Ordinary Survey	Partial Survey	Simplified Partial Survey	Extension Survey		
					2.5 years	1 year	3 months
1 Drawing out of the shafts	(1) Drawing the propeller shaft and the stern tube shaft and examining the entire shafts, seals system and bearings. (2) Checking and recording the bearing clearances between the bush and the shafts.	○					
2 Propeller connections -1 Keyed connections	(1) Removing the propeller to expose the forward end of the taper. (2) Performing a non-destructive examination (*NDE*) to all around the shaft in way of the forward portion of the taper section, including the keyway with the method deemed appropriate by a surveyor. (When shafts are provided with liners, the *NDE* is to be extended to the after edge of the liner.)	○	○				
-2 Keyless connections	(1) Removing the propeller to expose the forward end of the taper. (2) Performing a non-destructive examination (*NDE*) to all around the shaft in way of the forward portion of the taper section with the method deemed appropriate by a surveyor. (When shafts are provided with liners, the *NDE* is to be extended to the after edge of the liner.)	○	○				
-3 Flanged connections	(1) Whenever the coupling bolts of any type of flange-connected shaft are removed or the flange radius is made accessible in connection with overhaul, repairs or when deemed necessary by a surveyor, performing a non-destructive examination (*NDE*) to the flange radius and coupling bolts with the method deemed appropriate by the surveyor.	○	○				
3 Weardown of shaft at the stern tube bearing	(1) Checking and recording the weardown (For extension surveys, the checking and recording are to be carried out as far as practicable.) (2) Confirm the weardown value is not exceed 0.3 *mm* (0.3 *mm* is standard value). In addition, factors such as the characteristics of the lubricating oil, the temperature fluctuation history of the lubricating oil or bearing material are to be taken into account.	○	○	○	○		
4 Propeller	(1) Verification that the propeller is free of damages which may cause the propeller to be out of balance. (For extension survey, the information is confirmed by the record etc.) (2) For ordinary surveys, checking propeller fitting condition to shaft. When the propeller shaft with keyless connection is force fitted to the shaft, it is to be ascertained that the pull-up length is within the upper and lower limits given in **7.3.1-1, Part D of the Rules for the Survey and Construction of Steel Ships**.	○	○	○	○	○	
5 Sealing device for stern tube	(1) Verification of the satisfactory conditions of inboard and outboard seals. (For ordinary surveys, the verification is carried out during the re-installation of the shaft and propeller.) For 3months extension surveys, verification of inboard seals may be accepted. (2) Confirmation that the seal liner is placed in a satisfactory condition. For extension, this examination is not applied.	○	○	○	○	○	○

Items	Examinations	Ordinary Survey	Partial Survey	Simplified Partial Survey	Extension Survey		
					2.5 years	1 year	3 months
6 Shaft and coupling bolts	(1) Examination of shaft and coupling bolts (For the surveys except Ordinary Survey, visual inspection of accessible parts of shaft and coupling bolts.). However, performing a non-destructive examination (*NDE*) to coupling bolts with the method deemed appropriate by a surveyor in cases where the surveyor, based on the results of external examinations, deems such addition examination to be necessary.	○	○	○	○	○	○
7 Stern tube bearing	(1) Examination of the stern tube bearings.	○					
8 Propeller boss surfaces in contact with the propeller shaft taper	(1) Examination of the propeller boss surface.	○					
9 Controllable pitch propeller connections (Only applies to shafts with flanged connections)	(1) Open-up examination of the pitch control gear and working parts as well as performing a non-destructive examination (*NDE*) to the propeller blade fixing bolts with the method deemed appropriate by a surveyor.	○	○				
10 Low level alarms of the lubricating fresh water tanks, lubricating fresh water temperature measuring devices, fresh water lubricating lines and lubricating fresh water circulating pumps, etc.	(1) Examination of the systems for verifying whether stern tube bearings are being maintained in good working condition.	○	○	○	○	○	○

Items	Examinations	Ordinary Survey	Partial Survey	Simplified Partial Survey	Extension Survey		
					2.5 years	1 year	3 months
11 Review of records etc.	(1) Examinations are to be carried out in accordance with the following **(a)** to **(g)**. (a) Service records are to be reviewed. (b) Review of test records of the fresh water analysis is to be carried out to confirm that the reference standards specified in following **i)** and **ii)** are complied with. i) Chloride content and sodium content (Upper limit) : 1) Chloride: 60 *ppm* 2) Sodium (Na): 70 *ppm* ii) pH : Lower limit values determined based upon characteristics of the correction inhibitors used, but not to be less than 11 iii) Metal particles (upper limit) : 1) Iron (Fe): 25 *ppm* 2) Chromium (Cr): 5 *ppm* 3) Nickel (Ni): 5 *ppm* 4) Copper (Cu): 40 *ppm* 5) Silicon (Si): 30 *ppm* iv) Bearing particles (non-metallic content): No polymer resins are to be found by micro-filter or microscopic testing (c) Fresh water sample test is to be carried out. (d) Verification of no reported repairs by grinding or welding of shafts or propellers is to be carried out. (e) Examination of the lubricating fresh water record book. (f) For 1year and 3month extension surveys, review of the previous clearance recordings is to be carried out. (g) Confirmation from the chief engineer that the shafting arrangement is in good working condition is to be obtained.		○	○	○	○	○

3.10 Planned Machinery Surveys

At Planned Machinery Surveys, the examinations specified in **Chapter 9, Part B of the Rules for the Survey and Construction of Steel Ships** are to be carried out.

3.11 Surveys for Crafts Using Low-flashpoint Fuels

3.11.1 Annual Surveys

At Annual Surveys for crafts using low-flashpoint fuels, the examinations specified in **3.6**, **Part B of the Rules for the Survey and Construction of Steel Ships** are to be carried out, in addition to the examinations specified in **3.3** and **3.6**.

3.11.2 Intermediate Surveys

At Intermediate Surveys for crafts using low-flashpoint fuels, the examinations specified in **4.6**, **Part B of the Rules for the Survey and Construction of Steel Ships** are to be carried out, in addition to the examinations specified in **3.4** and **3.7**.

3.11.3 Special Surveys

At Special Surveys for crafts using low-flashpoint fuels, the examinations specified in **5.6**, **Part B of the Rules for the Survey and Construction of Steel Ships** are to be carried out, in addition to the examinations specified in **3.5** and **3.8**.

3.12 Surveys of Water jet Propulsion Systems, etc.

3.12.1 Annual Surveys

For ships fitted with water jet propulsion systems, the annual surveys are to be carried out in accordance with the surveys specified in **3.3.4**, **Part B of the Rules for the Survey and Construction of Steel Ships**.

3.12.2 Intermediate Surveys

For ships fitted with water jet propulsion systems, the intermediate surveys are to be carried out in accordance with the surveys specified in **4.3.4**, **Part B of the Rules for the Survey and Construction of Steel Ships**.

3.12.3 Special Surveys

For ships fitted with water jet propulsion systems, the special surveys are to be carried out in accordance with the surveys specified in **5.3.4**, **Part B of the Rules for the Survey and Construction of Steel Ships**.

3.12.4 Docking Surveys

For ships fitted with water jet propulsion systems, the docking surveys are to be carried out in accordance with the surveys specified in **6.1.1-2**, **Part B of the Rules for the Survey and Construction of Steel Ships**.

3.13 Surveys of Crafts Affixed with the Notation "*CybR*"

3.13.1 Annual Surveys

At Annual Surveys for crafts affixed with the notation "*CybR*", the examinations specified in **3.9**, **Part B of the Rules for the Survey and Construction of Steel Ships** are to be carried out, in addition to the examinations specified in **3.3** and **3.6**.

3.13.2 Intermediate Surveys

At Intermediate Surveys for crafts affixed with the notation "*CybR*", the examinations specified in **4.9**, **Part B of the Rules for the Survey and Construction of Steel Ships** are to be carried out, in addition to the examinations specified in **3.4** and **3.7**.

3.13.3 Special Surveys

At Special Surveys for crafts affixed with the notation "*CybR*", the examinations specified in **5.9**, **Part B of the Rules for the Survey and Construction of Steel Ships** are to be carried out, in addition to the examinations specified in **3.5** and **3.8**.

Part 3 HULL STRUCTURAL MATERIALS AND THEIR WELDING OR MOULDING

Chapter 1 GENERAL

1.1 General

1.1.1 Application

1 The requirements in this Part apply to rolled steels, aluminium alloys and FRP which are intended to be used for hull structures, and their welding or moulding.

2 Rolled steels, aluminium alloys, FRP or other materials which are not specified in this Part may be used subject to the design approval with regard to the application of those materials.

3 Materials which are used for hull structures of craft registered under classification character, affixed with "*Smooth Water Service*" are to be at the discretion of the Society.

Chapter 2 HULL STRUCTURAL MATERIALS

2.1 Hull Structural Materials

2.1.1 General

In principle, rolled steels or aluminium alloys intended to be used for hull structure are to comply with the requirements in **Part K of the Rules for the Survey and Construction of Steel Ships**, and similarly, FRP is to comply with the requirements of the **Rules for the Survey and Construction of Ships of Fibreglass Reinforced Plastics**.

2.1.2 Rolled Steels

Rolled steels used for hull structure are to be "rolled steels for hull" specified in **3.1**, **Part K of the Rules for the Survey and Construction of Steel Ships**.

2.1.3 Aluminium Alloys

Aluminium alloys used for hull structure are to be "aluminum alloys" specified in **Chapter 8**, **Part K of the Rules for the Survey and Construction of Steel Ships**.

2.1.4 FRP

1 FRP and their raw materials are to be those specified in **Chapter 4 of the Rules for the Survey and Construction of Ships of Fibreglass Reinforced Plastics**.

2 Mechanical properties of FRP are to comply with the following **(1)** to **(4)**, but excluding gelcoats (*See* paragraph **1.3.4**, **Chapter 1 of the Rules for the Survey and Construction of Ships of Fibreglass Reinforced Plastics**);

(1) Tensile strength: 98 N/mm^2 min.

(2) Modulus of tensile elasticity: 6,867 N/mm^2 min.

(3) Bending strength: 147 N/mm^2 min.

(4) Modulas of bending elasticity: 6,867 N/mm^2 min.

3 Moulding of FRP is to comply with the requirements in **Chapter 5** of this Part.

Chapter 3 WELDING OF ROLLED STEELS FOR HULL STRUCTURE

3.1 General

3.1.1 Application

Welding of rolled steels for hull is to comply with the requirements in **Part M of the Rules for the Survey and Construction of Steel Ships**.

Chapter 4 WELDING OF ALUMINIUM ALLOYS FOR HULL STRUCTURE

4.1 General

4.1.1 Application*

Welding of aluminium alloys for hull structure is to be in accordance with the requirements in **Part M of the Rules for the Survey and Construction of Steel Ships**, otherwise specified in this Chapter.

4.2 Preparation of Welding

4.2.1 Groove and Groove Processing

1 The groove is to be determined by taking into consideration the shape of joint, thickness, welding process, welding position, number of layers, existence of backing and back chipping, restriction on work, quality to be required, etc.

2 When the difference between thickness of plates is not less than 4 *mm*, or when the thickness of thinner plate is less than 4 *mm* and the difference of thickness from the thicker plate is not less than 2 *mm*, the shape of groove of butt welding is to be tapered not more than one-third in principle at the end of the thicker plate.

3 The kind and size of fillet welds for tee joints and their application are to be in accordance with the requirements given in **Table 12.2.1-1** and **Table 12.2.1-2, Part 1, Part C of the Rules for the Survey and Construction of Steel Ships** respectively. However, the size of fillet "f_{a1}" is not to be less than that obtained from the following formula:

$$f_{a1} = (f - 1.5)\frac{\sigma_Y}{\sigma_d} \ (mm)$$

Where:

f : Size of fillet of continuous fillet weld or intermittent fillet weld according to the thickness of the plate as specified in **Table 12.2.1-1, Part 1, Part C of the Rules for the Survey and Construction of Steel Ships** (*mm*)

σ_Y : Proof stress as specified in **1.2.2, Part 6** (N/mm^2)

σ_d : The lower limit of the specified proof stress of the base material with suffix "*-O*" in the division or the grade concerned (N/mm^2)

Where **Table 12.2.1-1** and **Table 12.2.1-2, Part 1, Part C of the Rules for the Survey and Construction of Steel Ships** are correspondingly applied, kinds of fillet welds are to be three types of *F*1, *F*2 and *F*3, and taking *F*3 in lieu of *F*4 in **Table 12.2.1-2, Part 1, Part C of the Rules for the Survey and Construction of Steel Ships.** And, notwithstanding Note 5 of **Table 12.2.1-1**, the chain intermittent fillet weld may be applied as the intermittent fillet welds. However, the ends 1*w* is to be welded on both sides wherever the chain intermittent fillet weld is applied.

4 Notwithstanding preceding **-3**, kinds and sizes of fillet welds for Tee joints and their application may be in accordance with the other technical standard as deemed appropriate by the Society.

5 For lap joints, the breadth of overlap is not to be less than obtained from the following formula, but need not exceed 50 *mm*.

$2t + 25$ (*mm*)

Where:

t : thickness of the thinner plate (*mm*)

6 For joggled lap joints, the breadth of overlap is not to be less than obtained from the following formula, but need not exceed 40 *mm*.

$t + 25$ (*mm*)

Where:

t : thickness of the thinner plate (*mm*)

7 The groove is to be finished smoothly by a mechanical method.

4.2.2 Pretreatment of Base Material

The joint part of base material is to be mad sufficiently clean by using appropriate methods directly before welding as far as possible so that the oxide or other extraneous matter of surface does not become source of weld defects.

4.2.3 Welding Condition

The welding conditions are to be determined so that a sound weld can be obtained.

4.3 Execution of Welding

4.3.1 Jig, Fixing Device and Prevention of Welding Distortion

1 Jig, fixing device, etc., are to be used as far as possible in order to avoid the welding distortion since aluminium alloys have a larger solidifying shrinkage and a larger coefficient of expansion than steels, and therefore the welding distortion is easily generated in aluminium alloys.

2 Non-magnetic materials are to be used for the materials of jig and fixing device when there is a possibility of magnetic arc blow.

3 Welding is to be carried out in symmetrical order to avoid twisting and bending.

4 Care is to be taken to be free from ununiformity of restraint to a weld line. When the plates are different in thickness, restraint is to be strengthened and special consideration is to be given to prevention of welding distortion.

5 Restraint or preset distortion by an appropriate method is to be adopted to prevent angular deformation. Further, the allowance for shrinkage is to be considered preliminarily.

4.3.2 Backing Metal and Backing

1 The same material as the base material in quality is in principle to be used for backing metal to be left as it is after completion of welding.

2 Non-magnetic materials such as follower metal and copper, or stainless steel are recommended for backing. Further, they are to be clean and to have appropriate grooves as required.

4.3.3 Tack Welding

1 An appropriate root gap by the use of fixing device, spacer, etc., is to be kept to avoid stagger of plates at the time of regular welding.

2 Care is to be taken so that the length of bead and the thickness of throat do not become too little because of the tack welding is easy to produce weld defects. Further, tack welding is to be avoided at corners, end parts and other important places where stress concentrate.

3 The adhering matters such as black powder, oxide film, etc., which have been produced by the tack welding, are to be removed sufficiently before the regular welding. Harmful defects are to be completely removed when those have been produced in the tack welding.

4 The tack welding is to be as little as possible in principle, and it is preferable to make restraint by a fixing jig. When the tack welding is used, the tack welding is to be carried out with sufficient cares in line with the purpose.

4.3.4 Preheating and Interpass Temperature

1 In the case of aluminium alloys, preheating is not carried out as a rule. However, when it is necessary to execute welding of a thick plate with a relatively small current, preheating may be executed in order to facilitate the penetration and reduce the generation of weld cracks and blow holes by decreasing the cooling speed. In this case, the standard preheating is to be made below 200℃ for general cases, while below 100℃ to 150℃ in the case of the strain-hardened or heat-treated aluminium alloys.

2 The interpass temperature is to be kept lower as far as possible. If the interpass temperature is high in the multi-layer welding, the preceding bead is excessively heat-affected, often causing generation of minor cracks due to the local intergranular fusion or coarsening of the base material in the vicinity of the bead.

4.3.5 Treatment of Starts and Ends of Welding and Joints of Beads

1 It is recommendable that the end tabs having the same material as that of the base metal should be fitted at both ends of welding joints, and the starts and ends of welding beads should be placed on the tabs, since the blowholes, cracks or the like might be generated at both ends of the welding joints. The starts and ends of welding without end tabs, joint of beads, or the like are to be welded particularly with care by deliberating of the position of arc starts, or by the method of the crater filler or the like, or an appropriate countermeasure are to be taken such as continuing the welding beads by fully removing the craters, and the welding beads are to be examined as found necessary.

2 When the fillet welding is carried out on only one side, the end part is in principle to be welded with boxing. The length of boxing is to be about 20 *mm*.

4.3.6 Chipping and Cleaning of Interlayer

1 The back chipping is to be carried out until weld defects at the first layer are removed when the back chipping is necessary. Lubricant is not to be used in this case.

2 When foreign matter such as black powder, impurities, etc., exist, those are to be removed sufficiently by brushing, chipping and other appropriate methods.

4.3.7 Removal of Welding Distortion

1 The generated welding distortion is to be corrected by an appropriate mechanical method and a point or linear heating method.

2 At the time of removing distortion by a mechanical method, a method giving no damage on the surface of the base material is to be used. For example, in the case of press, rubber or a piece of lumber is to be put, and in the case of hammering, a wooden or metal hammer of which top covered with raw leather is to be used.

3 Attention is to be paid to maximum heating temperature when the removal of welding distortion by quenching or hot working after heating is carried out.

4.4 Inspection of Welds

4.4.1 Inspection and Quality

1 The welds are to be subjected to visual examination and non-destructive examination at the discretion of the Society.

2 The welds are to be sound and free from defects such as crack, excessive reinforcement or underfill, harmful undercut or overlap, lack of fusion, lack of penetration, porosity and so on.

3 The surfaces of welds are to be reasonably smooth. The flank angle at the toe of bead made by base material and bead surface is to be sufficiently large.

4 Welded joints are to be reasonably free from excessive mis-alignment and welding distortion.

5 The welding defects found in visual examination, non-destructive examination or other examination are to be removed, corrected and re-examined.

Chapter 5 MOULDING OF FRP FOR HULL STRUCTURE

5.1 General

5.1.1 Moulding

Moulding of FRP is to be in accordance with the requirements in **Chapter 5 of the Rules for the Survey and Construction of Ships of Fibreglass Reinforced Plastics**.

5.1.2 Workshops

Workshops intending to manufacture FRP craft and their facilities are to be in accordance with the requirements in **Chapter 3 of the Rules for the Survey and Construction of Ships of Fibreglass Reinforced Plastics**.

Part 4 REQUIREMENTS FOR GENERAL ARRANGEMENT

Chapter 1 GENERAL

1.1 General

1.1.1 Application

The requirements in this Part apply to the general arrangement of craft.

1.1.2 Carriage of Oil

Oils are not to be carried in a fore peak tank or a tank forward of the collision bulkhead.

Chapter 2 ARRANGEMENT OF WATERTIGHT BULKHEADS

2.1 Arrangement of Watertight Bulkheads

2.1.1 General

1 All craft are to have following watertight transverse bulkheads.

(1) Collision bulkheads

(2) Machinery space bulkheads

(3) Hold bulkheads

2 The watertight transverse bulkheads are to extend from side to side and from the bottom to the bulkhead deck of the craft in general.

2.1.2 Collision Bulkheads*

1 All craft are to have a collision bulkhead, at a position not less than $0.05L_f$, but not more than $0.08L_f$ except where larger distance may be accepted by the Society due to a special reason as to structure, from the forward terminal of the stem plate at the designed maximum load draught.

2 The bulkhead may have steps or recesses within the limits specified in the above **-1**.

3 Notwithstanding preceding **2.1.1-2**, in cases where a long forward superstructure is provided, the collision bulkhead is to extend up to the superstructure deck and to be made weathertight except where otherwise approved by the Society. However, where the extension is located within the limits specified in **2.1.2-1** and the part of the deck which forms the step is made effectively weathertight, it need not be fitted directly above the bulkhead thereunder.

4 Any access openings, doors, manholes or ducts for ventilation, etc., are not to be cut in the collision bulkhead below freeboard deck. The number of openings in collision bulkhead above the freeboard deck is to be kept to a necessary minimum and such openings are to be provided with weathertight means of closing.

5 Pipes piercing the collision bulkhead are to be fitted with suitable valves which are operable from above the freeboard deck and made of steel, bronze or approved other ductile materials.

6 Arrangement of the collision bulkhead in a craft provided with bow door is to be in accordance with preceding **-1** to **-5**. However, where a sloping ramp forms a part of the collision bulkhead above the freeboard deck, the part of the ramp which is more than 2.3 *m* above the freeboard deck may extend forward of the limit specified in the above **-1**. In this case, the ramp is to be weathertight over its complete length.

2.1.3 Machinery Space Bulkheads

1 A watertight bulkhead which extends up to the bulkhead deck is to be provided at each end of the machinery space.

2 Where accommodation spaces are located over machinery spaces, the decks consisting of the boundary between accommodation spaces and machinery spaces are to be gastight. In cases where any opening is arranged on these decks, closing appliances with gasket are to be fitted with these openings.

2.1.4 Hold Bulkheads*

1 All craft are to have hold bulkheads to ensure survival capabilities in compliance with **2.3.3** and **3.2.2, Part 8** of this Rules according to the kind of craft respectively.

2 Notwithstanding preceding **-1**, a cargo craft which is not engaged in international voyage and for restricted service (Refer to the provision of **Chapter 3, Part 8** of this Rule) may have hold bulkheads in accordance with **2.2.1.4, Part 1, Part C** or **13.1.4, Part CS of Rules for the Survey and Construction of Steel Ships**.

3 Where the length of a hold is especially long, suitable means are to be provided so as to maintain the transverse strength and stiffeness of the hull.

2.1.5 After Peak Bulkheads*

1 A cargo craft which is not engaged in international voyage and for restricted service (Refer to the provision of **Chapter 3, Part 8** of this Rule) is to have an after peak bulkhead situated at a suitable position. An aft bulkhead of machinery space bulkheads may be used as an after peak bulkhead subject to the approval of the Society.

2 Notwithstanding preceding **-1**, where it is impracticable and incompatible to arrange after peak bulkheads due to the design and proper working of the craft, after peak bulkheads may be omitted to arrange subject to the approval of the Society.

2.1.6 Protection of Stern Tubes

The stern tube is to be enclosed in a watertight compartment with suitable capacity.

2.1.7 Chain Lockers

1 Chain lockers located abaft the collision bulkhead or in the fore peak tank are to be watertight and to be provided with means for drainage by pump.

2 Chain lockers are to be subdivided by centre line screen walls.

2.2 Watertight Doors

2.2.1 General

Watertight doors are to be provided for all access openings in the watertight bulkheads in accordance with the requirements in following **2.2.2** to **2.2.6**.

2.2.2 Construction of Bulkheads in way of Watertight Doors

Where stiffeners are cut or the spacing of stiffeners is increased in order to provide the watertight door in the bulkhead, the opening is to be suitably framed and strengthened as to maintain the full strength of the bulkhead. In no case are the door frames to be considered as stiffeners.

2.2.3 Types of Watertight Doors

1 Watertight doors are to be of sliding type, except that other types, such as hinged or rolling type, may be accepted provided that the subject door is normally closed, and is not used at sea and an indicator showing whether such doors are opened or closed is fitted on the navigation bridge.

2 Doors which are closed by dropping or by the action of a dropping weight are not permitted to be used.

3 Watertight doors are to be operable from both sides at the position of the door.

2.2.4 Strength and Watertightness

1 Watertight doors are to be of ample strength and watertightness for water pressure to a head up to the bulkhead deck, and door frames are to be effectively secured to the bulkheads. Where deemed necessary by the Society, watertight doors are to be tested by water pressure before they are fitted up.

2 The frames of vertically sliding watertight doors are to have no groove at the bottom in which dirt might lodge and prevent the door from closing.

2.2.5 Remote Control Means of Watertight Doors

1 Watertight doors are to be capable of being operated from a readily accessible position above the bulkhead deck and means to indicate whether the door is opened or closed is to be provided at the remote operating position. This remote control means of door may be omitted provided that the subject door is normally closed, and is not used at sea and an indicator showing whether such doors are opened or closed is fitted on the navigation bridge.

2 Where the above control means is operated by rods, the lead of operating rods is to be as direct as possible and the screw is to work in a nut of gun-metal or other approved materials.

2.2.6 Hinged Doors and Rolling Doors

The hinge pins of these doors are to be of gun-metal or other approved materials.

Chapter 3 ARRANGEMENT OF DEEP TANKS

3.1 General

3.1.1 Terminology

The deep tank is a tank used for carriage of water, fuel oil and other liquids, forming a part of the hull in holds or tween decks. The deep tanks used for carriage of oils are designated as “deep oil tank”, if necessary.

3.1.2 Application

Where the bulkhead of deep tank partly serves as a watertight bulkhead, the part of the bulkhead is to be in accordance with the requirements in **Chapter 2** of this Part.

3.1.3 Divisions in Tanks

1 Deep tanks are to be of proper size and to be provided with such longitudinal watertight divisions as necessary to meet the requirements for stability in service conditions as well as while the tanks are being filled or discharged.

2 Tanks for fresh water, fuel oil or those which are not intended to be kept entirely filled in service conditions are to be have additional divisions or deep wash plates as necessary, to minimize the dynamic forces acting to the structure.

3 Where it is impracticable to comply with the requirements in the above **-2**, the scantlings are to be properly increased.

3.2 Fittings of Deep Tanks

3.2.1 Limbers and Air Holes

Limbers and air holes are to be cut suitably in the structural members to ensure that air or water does not remain stagnated in any part of the tank.

3.2.2 Cofferdams

1 Oiltight cofferdams are to be provided between the tanks for carrying oils and those for carrying fresh water such as that for living use, boiler feed water, etc., which may cause any trouble when oil mixes therein.

2 Water closets and sanitary spaces are not to be located directly above the tanks for carrying fresh water for living use. Where water closets and sanitary spaces are located above such tanks inevitably, these spaces are to be separated from such tanks by cofferdams of water-tight construction with a sufficient clearance.

Chapter 4 ARRANGEMENT OF DOUBLE BOTTOMS

4.1 Double Bottoms in Passenger Craft

4.1.1 General*

1 A double bottom is to be fitted in accordance with following extent as far as this is practicable and compatible with the design and proper working of the craft:

(1) In craft of 50 *m* and upwards but less than 61 *m* in length, a double bottom is to be fitted at least from the machinery space to the fore peak bulkhead, or as near thereto as practicable.

(2) In craft of 61 *m* and upwards but less than 76 *m* in length, a double bottom is to be fitted at least outside the machinery space, and is to be extend to the fore and aft peak bulkheads, or as near thereto as practicable.

(3) In craft of 76 *m* in length and upwards, a double bottom is to be fitted amidships, and is to extend to the fore and aft peak bulkheads, or as near thereto as practicable.

2 Where a double bottom is required to be fitted, its depth is to the satisfaction of the Society and the inner bottom is to be continued out to the craft's sides in such a manner as to protect the bottom to the turn of the bilge. Such protection will be deemed satisfactory if the line of intersection of the outer edge of the margin plate with the bilge plating is not lower at any part than a horizontal plane passing through the point of intersection with the frame line amidships of a transverse diagonal line inclined at 25 degrees to the base line and cutting it at a point one-half the craft's moulded breadth from the middle line.

3 Small wells constructed in double bottom in connection with drainage arrangements of watertight spaces are not to extend in depth more than necessary. The depth of the well is in no case to be more than the depth less than 460 *mm* of the double bottom at the centre line, nor is to the well extend below the horizontal plane referred to in preceding **-2**. A well extending to the outer bottom may, however, be permitted at the after end of the shaft tunnel of the craft subject to the approval of the Society.

4 A double bottom need not be fitted in way of watertight compartments of moderate size used exclusively for the carriage of liquids, provided the safety of the craft, in the event of bottom or side damage, is not, in the opinion of the Society, thereby impaired.

5 Notwithstanding the requirements in **-1** to **-4**, with respect to craft which have sufficient survival capability accepted by the Society in the case where a double bottom is omitted, or craft which are not engaged in international voyages and are for restricted service, a double bottom may be omitted.

4.2 Double Bottoms in Cargo Craft

4.2.1 General*

1 A double bottom is to be fitted extending from the collision bulkhead to the aft peak bulkhead, as far as this is practicable and compatible with the design and proper working of the craft.

2 Where a double bottom is required to be fitted, its depth is to be to the satisfaction of the Society and the inner bottom is to be continued out to the craft's side in such a manner as to protect the bottom to the turn of the bilge.

3 Small wells constructed in double bottom in connection with drainage arrangements of watertight spaces are not to extend in depth more than necessary. A well extending to the outer bottom may, however, be permitted at the aft end of the shaft tunnel of the craft subject to the approval of the Society.

4 A double bottom need not be fitted in way of watertight compartments of moderate size used exclusively for the carriage of liquids, provided the safety of the craft, in the event of bottom or side damage, is not, in the opinion of the Society, thereby impaired.

5 Notwithstanding the requirements in **-1** to **-4**, with respect to craft which have sufficient survival capability accepted by the Society in the case where a double bottom is omitted, or craft which are not engaged in international voyages and are for restricted service, a double bottom may be omitted.

Chapter 5 ARRANGEMENTS OF ACCOMMODATION SPACES

5.1 Arrangements of Accommodation Spaces

5.1.1 General

1 Crew accommodation spaces and passenger spaces are not to be arranged within the following areas:

(1) The area at any level more than 1.8 *m* below designed maximum load line.

(2) The area forward of the collision bulkhead.

2 Crew accommodation spaces and passenger spaces are not to be directly adjacent to the tanks for carriage of fuel oil. Such compartments are to be separated from the fuel oil tanks by cofferdams which are well ventilated and accessible. Where the top of fuel oil tanks has no opening and is coated with incombustible coverings of 38 *mm* and over in thickness, the cofferdam between such compartments and the top of fuel oil tanks may be omitted.

Part 5 DESIGN LOADS

Chapter 1 GENERAL

1.1 General

1.1.1 Application

The definitions and characters that appear in this Part are to be as specified in this Chapter, unless otherwise specified elsewhere.

1.2 Definitions

1.2.1 Vertical Acceleration at Forward End

The vertical acceleration at forward end is an approximation for the average of 1/3 highest accelerations in g (=9.81m/sec^2) at the forward end. In this case, the forward end is the perpendicular at the intersection of the fore side of the stem at centre line with the designed maximum load line defined in **2.1.12-2, Part 1** of this Rule.

1.2.2 Scantling Length of Craft

The scantling length of craft (L_S) is a horizontal distance in metres on the designed maximum load line defined in **2.1.12-2, Part 1** of this Rule.

1.2.3 Range of Strengthened Bottom Forward

The range of strengthened bottom forward is the bottom part from the forward end of *Ls* to the position obtained from the following formula abaft the forward end of *Ls*.

$$\frac{L_S}{10}\left(4+\frac{V}{10W^{1/6}}\right) \ (m)$$

where:

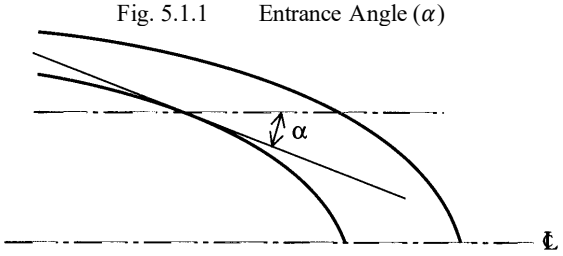
V : Maximum speed defined by **2.1.8, Part 1** of the Rules.

W : Full load displacement defined by **2.1.14, Part 1** of the Rules.

1.2.4 Entrance Angle

The entrance angle (α) is the angle in degrees at the point to be considered, defined as the angle between a longitudinal line parallel to the centreline of a craft and the tangential line to the shell plating in an assumed horizontal plane through the midpoint of the distance between the cross point of the base line and the centreline and the upper edge of the bottom shell plating at the transverse section to be considered (*See* **Fig. 5.1.1**).

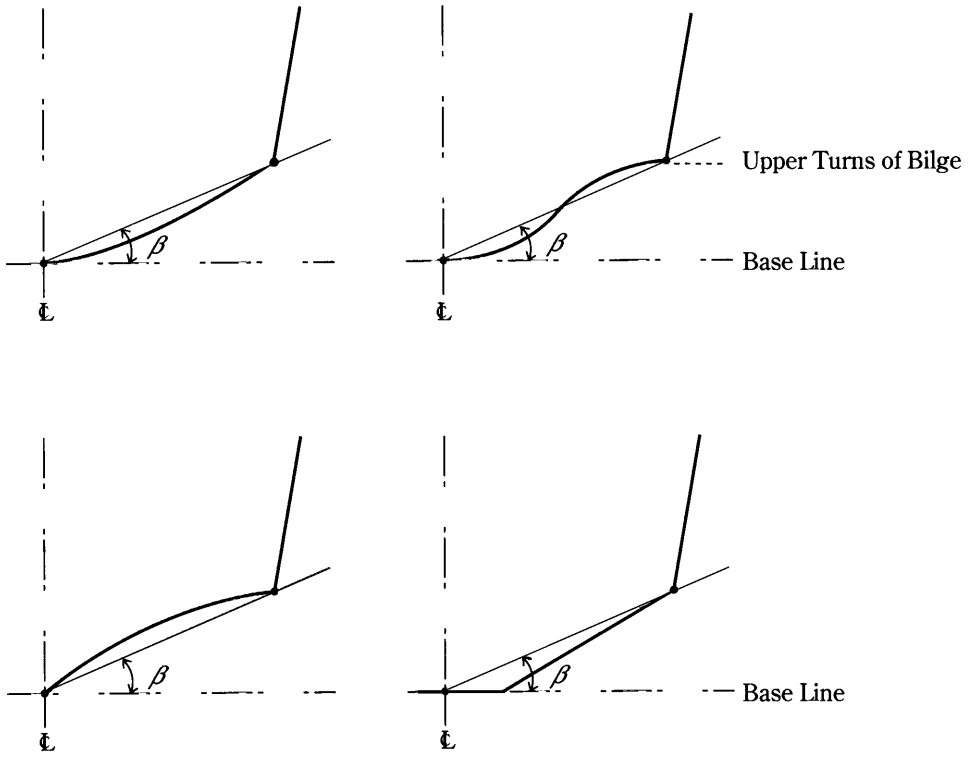
Fig. 5.1.1 Entrance Angle (α)



1.2.5 Deadrise Angle

The deadrise angel (β) is the angle in degrees at the point to be considered, defined as the angle between the base line and the line from the cross point of the base line and the centreline to the upper edge of the bottom shell plating at the transverse section to be considered. Where the deadrise angel is less than 10 degrees, the deadrise angel is to be taken as 10 degrees (*See* **Fig. 5.1.2**).

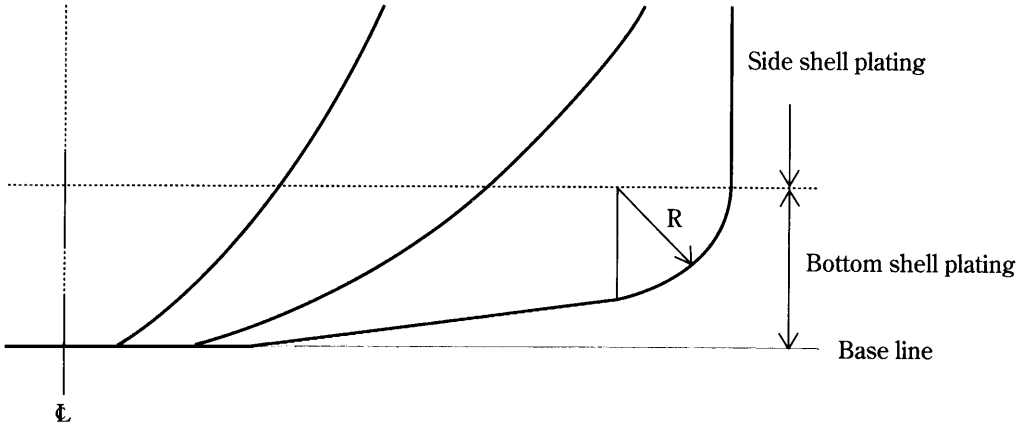
Fig. 5.1.2 Deadrise Angle (β)



1.2.6 Bottom Shell Plating

For the craft with chines, bottom shell plating is the shell plating located below the level of chines, and for the craft with no chine, bottom shell plating is the shell plating located below the assumed boundary line which is to run parallel to the base line and to run through the upper turn of bilge at midship section. (*See* **Fig. 5.1.3**).

Fig. 5.1.3 Range of Bottom Shell Plating



Chapter 2 DESIGN LOADS

2.1 Application

2.1.1 Application

The design loads detailed in 2.2 through 2.5 are to be applied to monohull craft of which length are less than 50 *m* and which are operated in the displacement mode.

2.1.2 Special Cases in Application*

In craft of which length is more than 50 *m* or in craft of unusual form, proportion or operating mode, the design loads will be considered in each case by the Society.

2.1.3 Simulation for Dynamics and Load of Crafts

1 Notwithstanding preceding 2.1.1 and 2.1.2, long term prediction of loads and stress acting on each part of the hull is carried out using the response amplitude operator in regular waves obtained by the strip method or an equivalent method, wave spectrum and long-term wave data on irregular sea surface.

2 In applying this procedure, approval is to be obtained beforehand from the Society on the calculation method of response amplitude operator in regular waves, wave spectra, long-term wave data.

2.2 Design Loads for Bottom Construction

2.2.1 Design Loads for Bottom Construction

The design load for bottom construction (P_B) is to be obtained in accordance with following requirements.

(1) Where the transverse section considered is positioned within the range of the strengthened bottom forward :

The design load for bottom construction (P_B) is not to be less than that obtained from the following formula.

$P_B = P_{IM} F \quad (kN/m^2)$

where:

P_{IM} : The peak value of the impact pressure acting on the bottom construction as obtained from the following formula.

$$P_{IM} = \frac{1}{2}\rho K_{PW} V i^2 \left(1 + \frac{\pi^2}{4\tan^2\xi}\right) \quad (kN/m^2)$$

ρ : The specific gravity of fresh or sea water of the service area where a craft is operated.

K_{PW} : Compensating factor for impact load and obtained from the following formula. However, if the calculated value of K_{PW} is larger than 1, it should be 1, or if negative, it should be 0.

$K_{PW} = 1.0245 - 3.8 \times 10^{-3}\xi - 1 \times 10^{-4}\xi^2$

ξ : The impact angle as obtained from the following formula.

$\xi = \tan^{-1}(\tan\beta/\cos\alpha) \quad (°)$

V_i : The velocity to determine the impact pressure acting on the bottom construction as obtained from the following formula.

$V_i = V_{hz} + V_{wz} + V_s\tan\theta \quad (m/sec)$

V_{hz} : The vertical velocity of a craft as obtained from the following formula.

$V_{hz} = 0.025\pi \cdot \omega_e \cdot (X + L_s/4) \quad (m/sec)$

ω_e : As obtained from the following formula.

$\omega_e = \omega + 2\pi V_s/\lambda$

ω : As obtained from the following formula.

$\omega = \sqrt{2\pi g/\lambda}$

V_s : The advancing speed, which is independent of the maximum speed specified in 2.1.8, Part 1 of this Rule, is to be the obtained bottom impact load and is not to be less than the value obtained from the following formula.

$V_{S1} = F_m\sqrt{gLs} \quad (m/sec)$

F_m : As obtained from the following formula.

$$F_m = 0.8761\sqrt{A_f} - 0.0565A_f - 0.0677/A_f - 0.4726$$

λ : The wave length as obtained from the following formula.

$$\lambda = (0.7174 + 1.101F_m - 0.009F_m^2)L_S \ (m)$$

H_w : The significant wave height as obtained from the following formula.

$$H_w = \lambda/20 \ (m)$$

X : Distance from the middle of craft length L_S, assuming it positive toward the bow.

V_{wz} : The vertical velocity of wave as obtained from the following formula.

$$V_{wz} = \omega H_w/2 \ (m/sec)$$

A_f : The designed vertical acceleration at forward end specified by the builder. However, the value of A_f is not to be less than the minimum value specified in **Table 5.2.1** corresponding to the intended service area and the type of the craft,

θ : The slope angle of bow line as obtained from the following relation.

$$\tan\theta = \tan\alpha\tan\beta$$

F : The factor to be necessary for converting a peak value of bottom impact load to the mean effective pressure, and is selected from the following **(a)** through **(c)**, according to the value of ξ. In case where the value of S_0/Y exceeds 1, the value of S_0/Y is to be taken as 1.

(a) In case of $\xi \leq 20°$;

$$F = 0.172 + (0.03 - 0.064/\xi - 0.0008\xi)/(S_0/Y) - (0.1 - 0.1/\xi + 0.008\xi)(S_0/Y) - 0.366/\xi + 0.03\xi$$

(b) In case of $\xi > 20°$;

$$F = 1.653 - (0.02 - 0.504/\xi - 0.0002\xi)/(S_0/Y) - (0.41 + 0.788/\xi - 0.008\xi)(S_0/Y) - 15/\xi - 0.007\xi$$

(c) However, if the value obtained from **(a)** or **(b)** above exceeds 1, it shall be regarded as 1.

S_0: Spacing (m) as follows ;

For plating and stiffeners: Spacing of stiffeners

For bottom girders: Breadth of the area supported by the girder

For bottom transverses: Spacing measured from the cross point of base line and centreline to upper edge of the bottom shell plating to be considered.

Y: Half of the distance from bottom centre to the chain or the bottom plating end to be considered (*See* **Fig.5.2.1**). However, for bottom transverses, the distance from the bottom centre to the chin or the bottom plating end to be considered.

(2) Where the transverse section considered is positioned outside of the range of the strengthened bottom forward:
The designed load for bottom construction for the aft end of the range of the strengthened bottom forward (P_0) is to be obtained by the requirement in preceding **(1)**, and the designed load for bottom construction for the aft end of *Ls* is to be taken as $P_0/2$. The intermediate value of the design loads for bottom construction is to be obtained by linear interpolation as shown in **Fig. 5.2.2**.

(3) Notwithstanding the requirements of the preceding **(1)** and **(2)**, any P_B are not to be less than the minimum value of $P_{B_{\min}}$ obtained from the following formula.

$$P_{B_{\min}} = 10(d + H_w + f_h B) \ (kN/m^2)$$

where:

H_w : As specified in **(1)**.

f_h : Coefficient corresponding to the kinds of the craft as follows ;

Passenger craft : 0.13

Cargo craft : 0.18

Table 5.2.1 Minimum Vertical Acceleration at Forward End

	Passenger craft	Cargo craft
Smooth water service	1.00	1.00
Coasting service	1.25	1.50
Others	1.50	2.00

Fig. 5.2.1 Measurement of Y

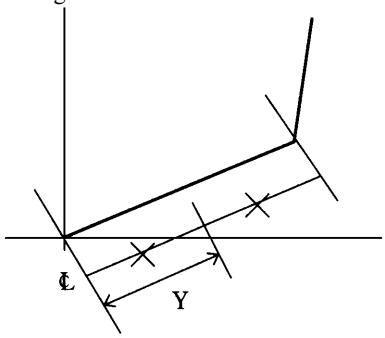
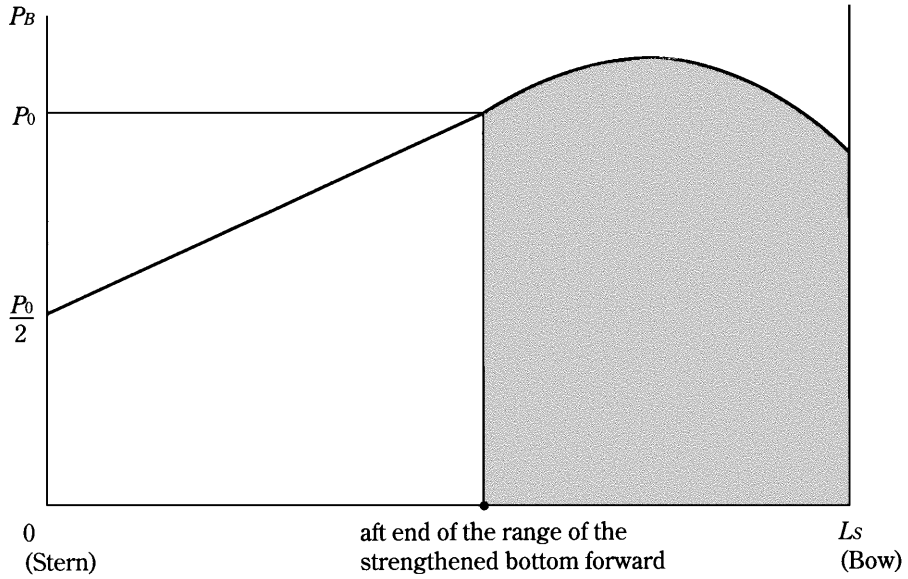


Fig. 5.2.2 Distribution of Design Loads for Bottom Construction



Note:

1. 0 and L_S on the horizontal axis mean the aft and forward end of L_S respectively.
2. The coloring part in this figure is to be in accordance with 2.2.1(1) in this Chapter.

2.3 Design Loads for Side Construction

2.3.1 Design Loads for Side Construction

The design load for side construction (P_S) is not to be less than the value obtained from the following formula.

$$P_S = 10(d + H_w + f_h B - h') \quad (kN/m^2)$$

where:

H_w : As specified in 2.2.1(1).

f_h : As specified in 2.2.1(3).

h' : Vertical distance measured in *metres* from the top of keel to the chine or the upper edge of the bottom shell plating to be considered (*Referred* in 1.2.6 in this Chapter).

2.4 Design Loads for Deck Construction

2.4.1 Design Loads for the Exposed Deck Construction

1 The design load for freeboard decks, superstructure decks deckhouses right above the freeboard deck is not to be less than the value obtained from the following formula.

$$P_D = kaL_S + b \ \ (kN/m^2)$$

where:

a and b: Coefficient as given in **Table 5.2.2**.

k: Coefficient corresponding to the intended service area of the craft as follows;

Smooth water service : 0.25

Coasting service : 0.50

Others : 1.00

2 The design load for the second or more tier superstructure decks above freeboard deck may be determined by using $0.5a$ in lieu of a in the formula specified in preceding **-1**.

2.4.2 Design Loads for Other Deck Construction

The design loads for decks intended to carry ordinary cargoes, passenger, stores, etc. are not to be less than that obtained from the following formula.

$$P_D = CA_f P_{cargo} \ \ (kN/m^2)$$

where:

C : Coefficient as shown in **Fig. 5.2.3** corresponding to the position where cargoes are loaded.

A_f : As specified in **2.2.1(1)** in this Chapter.

P_{cargo}: The standard design loads for decks corresponding to the purpose of the deck as follow;

For decks intended to carry ordinary cargoes: Maximum design load specified by the builders (kN/m^2).

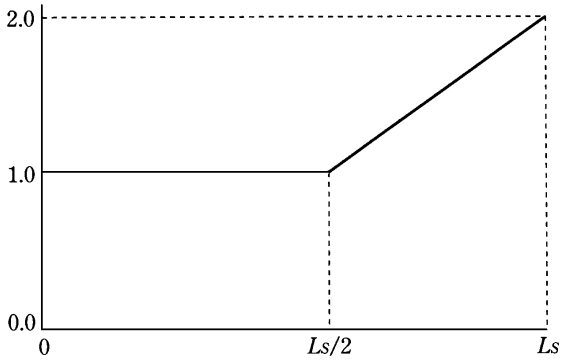
For decks used for stores: 7.0 (kN/m^2).

For decks exclusively used for passengers, accommodation or navigation spaces: 4.6 (kN/m^2).

Table 5.2.2 Values of a and b

	a			*b*
	Decks	Beams	Girders, Pillars	
Afore 0.3 L_S from the fore end (including the location at 0.3L_S from the fore end)	0.51	0.33	0.13	4.6
Abaft 0.3 L_S from the fore end and supertructure deck	0.27	0.16	0.11	

Fig. 5.2.3. Distribution of the Vertical Acceleration



Note:

0 and L_S on the horizontal axis mean the aft and forward end of L_S respectively.

2.5 Design Loads for Deck Houses and Superstructures

2.5.1 Design Loads for Deck Houses and Superstructures

1 The design loads for deck houses and superstructures (P_H) are not to be less than that obtained from the following formulae.

Exposed front bulkhead and wall on the first tier: $P_H = 12.5 + 0.05L_S$ (kN/m^2)

Others: $P_H = 6.25 + 0.025L_S$ (kN/m^2)

2 The design loads for deck houses and superstructures (P_H) need not exceed the values stipulated in preceding 2.4.1 in this Chapter.

2.6 Design Loads for Watertight Bulkheads and Deep Tanks

2.6.1 Design Loads for Watertight Bulkheads

The design loads for watertight bulkheads (P_{WT}) are not to be less than that obtained from the following formula.

$P_{WT} = 10h_W$ (kN/m^2)

where:

h_W: Vertical distance measured from the lower edge of the plates to the top of upper deck on centre line (m). However, for the collision bulkhead, the value specified above is to be multiplied by 1.25.

2.6.2 Design Loads for Deep Tanks

The design loads for deep tanks (P_{DT}) are to be those obtained from the following formulae.

(1) Sea Going Condition

$P_{DT} = 10\rho CA_f h_D$ (kN/m^2)

where:

ρ: The specific gravity of liquid which is intended to carry. However, where the value is less than 1, the specific gravity is to be taken 1.

C and A_f: As specified in 2.4.2 in this Chapter.

h_D: Vertical distance measured from the lower edge of the plates to the mid-point of the height between the top of tanks and the top of overflow pipes (m).

(2) Tank Test Condition

$P_{DT} = 10 \cdot h_T$ (kN/m^2)

where:

h_T: Test head specified in Annex 2.1.5, Part B of the Rules for the Survey and Construction of Steel Ships (m).

2.7 Deck Load Supported by Pillars

2.7.1 Deck Load Supported by Pillars

1 Deck Load w supported by Pillar is not to be less than the value obtained from the following formula:

$w = kw_0 + SbP_D$ (kN)

where:

S : Distance between the mid-points of two adjacent (before or behind) spans of girders supported by the pillars, the bulkhead stiffeners or girders at respective subdivisions (m) (*See* Fig. 5.2.4).

b : Mean distance between the mid-points of two adjacent (right or left) spans of beams supported by the pillars or the frames (m) (*See* Fig. 5.2.4).

P_D : Deck load specified in 2.4.1 for the deck supported (kN/m^2).

w_0 : Deck load supported by the upper tween deck pillar (kN).

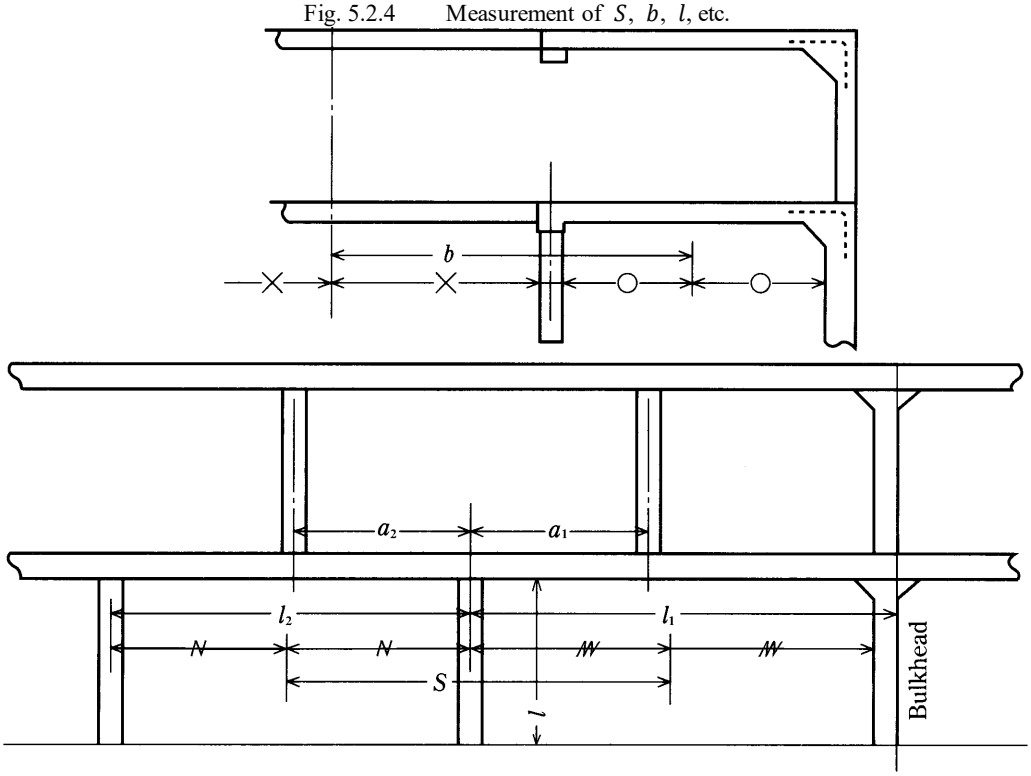
k : As obtained from the following formula according to the ratio of the horizontal distance a_i (m) from the pillar to the tween deck pillar above to the distance l_j (m) from the pillar to the pillar or bulkhead (*See* Fig. 5.2.4).

$$2\left(\frac{a_i}{l_j}\right)^3 - 3\left(\frac{a_i}{l_j}\right)^2 + 1$$

2 Where there are two or more tween deck pillars provided on the deck girder supported by a line of lower pillars, the lower pillar is to be of the scantlings required by **-1**, taking kw_0 for each tween deck pillar provided on two adjacent spans supported by the lower pillars.

3 Where tween deck pillars are shifted from the lower pillars in athwartship direction, the scantlings of lower pillars are to be determined in accordance with the principle in **-1** and **-2**.

Fig. 5.2.4 Measurement of S, b, l, etc.



2.8 Longitudinal Bending Moments

2.8.1 Maximum Longitudinal Bending Moments at the Midship Part

1 Maximum longitudinal bending moment at the midship part (M) is not to be less than that obtained from following formula.

$$\frac{0.351 \cdot A_f \cdot L_S^3 \cdot B_W}{13.7 + 18.5F_m + 9.91F_m^2} \quad (kN\text{-}m)$$

where:

A_f and F_m: As specified in preceding **2.2.1(1)** in this Chapter.

B_W: Horizontal distance measured from the outside of shell plating to the opposite outside of shell plating at the designed maximum load line (m).

2 In addition to **-1** above, for the craft with Ls more than 60 m, maximum longitudinal bending moment at the midship part (M) is not to be less than that obtained from following formula in consideration of longitudinal bending moment in still water and wave induced longitudinal bending moment.

$$M_S + M_W \quad (kN\text{-}m)$$

where:

M_S and M_W: As specified in **4.3.2, Part 1, Part C** or **15.2.1, Part CS of the Rules for the Survey and Construction of Steel Ships**.

Part 6 SCANTLING DETERMINATION OF HULL CONSTRUCTION

Chapter 1 HULL CONSTRUCTION FOR STEEL OR ALUMINIUM ALLOYS CRAFT

1.1 General

1.1.1 Application*

The requirements of this chapter apply to the craft constructed in steel aluminium alloy.

1.1.2 Special Cases in Application

In craft of which scantling length is specially short or in craft to which requirements in this Part, for some special reasons, are not directly applicable, hull construction, equipment, arrangement and scantlings are to be at the Society's discretion, notwithstanding the provisions in the preceding 1.1.1.

1.2 Definition

1.2.1 Application

The definitions and characters that appear in this Chapter are to be as specified in this Chapter, unless otherwise specified elsewhere.

1.2.2 Yield Point or Proof Stress of the Material Used

1 Yield point or proof stress (σ_y) of rolled steels for hull structure specified in this Chapter is to be given in Table 6.1.1.

2 Proof stress (σ_y) of aluminium alloys for hull structure is not to be less than the minimum ultimate proof stress specified for the base metal except when specified in Table 6.1.2.

Table 6.1.1 Yield Point or Proof Stress of Rolled Steels for Hull Structure

Symbols of materials	Yield point or proof stress (N/mm^2)
KA, *KB*, *KD*, *KE*	235
*KA*32, *KD*32, *KE*32, *KF*32	315
*KA*36, *KD*36, *KE*36, *KF*36	355
*KA*40, *KD*40, *KE*40, *KF*40	390

Table 6.1.2 Grades and Proof Stress of Aluminium Alloys for Hull Structures

Grades and symbols of aluminium alloys		Temper condition	Thickness t (mm)	Proof stress (N/mm^2)
5000 series	5083*P*	*H*116, *H*321	$t \leq 50$	125 min.
	5383*P*	*H*116, *H*321	$t \leq 50$	145 min.
	5059*P*	*H*116, *H*321	$t \leq 50$	160 min.
	5086*P*	*H*112, *H*116	$t \leq 50$	95 min.
	5456*P*	*H*116, *H*321	$t \leq 6.3$	130 min.
			$6.3 < t \leq 50$	125 min.
	5083*S*	*H*111	$t \leq 50$	110 min.
	5383*S*	*H*112	$t \leq 50$	145 min.
	5086*S*	*H*111	$t \leq 50$	95 min.
6000 series	6005*AS*	*T*5, *T*6	$t \leq 50$	115 min.
	6061*P*	*T*6	$t \leq 6.5$	115 min.
	6061*S*	*T*6	$t \leq 50$	115 min.
	6082*S*	*T*5, *T*6	$t \leq 50$	115 min.

1.3 General Requirements on Hull Construction

1.3.1 Application for Steels

Where the steels are used for hull structures, the grades of the steels are to be in accordance with the requirements specified in **3.2.2, Part 1, Part C of the Rules for the Survey and Construction of Steel Ships**.

1.3.2 Restriction of Application for Aluminium Alloys

1 Aluminium alloys whose symbols are 6005*AS*, 6061*P* and 6061*S* and do not have suitable characteristic for anti-corrosion against sea water as considered by the Society, in principle, are not to be used for parts likely to contact with sea water in normal operation.

2 Where suitable corrosion protection measures such as surface treatment are provided to aluminium alloys specified in **-1** and effectiveness of those corrosion protection are deemed appropriately by the Society, such aluminium alloys may be used for parts likely to contact with sea water in normal operation.

1.3.3 Scantlings

1 Unless otherwise specially specified, the section modules of members required by this Part are those including the plates with the effective breadth of 0.1l on either side of the members. However, the breadth of 0.1l is not to exceed one-half of the spacing of member. l is the length specified in the relevant requirements.

2 Where flat bars, angles or flanged plates welded to form beams, frames or stiffeners for which section modules are specified, they are to be of suitable depth and thickness in proportion to the section modulus specified in this Part.

3 The flanging inner radius is not to be less than two times but not greater than three times thickness of plates.

4 Tripping brackets are to be provided at an suitable interval so as to support girders.

1.3.4 Connection of Ends of Stiffeners, Girders and Frames

1 Where the ends of girders are connected to bulkheads, tank tops, etc., the end connections of all girders are to be balanced by effective supporting members on the opposite side of bulkheads, tank tops, etc.

2 Length of the frame-side arm of bracket, connected to the frames or stiffeners of the bulkhead or deep tanks etc., is not to be less the one-eighth of l specified in the relevant requirements, unless otherwise specially specified.

1.3.5 Brackets

1 The thickness of brackets is to be suitably increased where the depth of brackets at throat is less than two-thirds of that of the bracket.

2 Where lightening holes are cut in brackets, the distance from the circumference of hole to the free flange of bracket is not to be less than the diameter of lightening hole.

3 Where the length of the longer arm exceeds 800 *mm*, the free edges of brackets are to be stiffened by flanging or by other means, except where tripping brackets or the like are provided.

1.3.7 Modification of Span (*l*) for Thicker Brackets

Where brackets of not less thickness than that of the girder plates, the value of *l* specified in **1.7.1** of this Chapter may be modified in accordance with the following:

(1) Where the sectional area of face plate of the bracket is not less than one-half of that of the girder and the face plate of the girder is carried to the bulkhead, deck, tank top, etc., *l* may be measured to a point 0.15 *m* inside the toe of bracket.

(2) Where the sectional area of face plate of the bracket is less than one-half of that of the girder and the face plate of the girder is carried on to the bulkhead, deck, tank top, etc., *l* may be measured to a point where the sum of sectional areas of the bracket and its face plate outside the line of girder is equal to the sectional area of face plate of girder, or to a point 0.15 *m* inside the toe of bracket, whichever is greater.

(3) Where brackets are provided and the face plates of girders extend along the free edge of brackets to the bulkhead, deck, tank top, etc., even if the free edge of brackets is curved, *l* is to be measured to the toe of bracket.

(4) Brackets are not to be considered effective beyond the point where the arm along the girder is 1.5 times the length of arm on the bulkhead, deck, tank top, etc.

(5) In no case is the allowance in *l* at either end to exceed one-quarter of the overall length of the girder including the part of end connection.

1.3.8 Workmanship

1 The workmanship is to be of the best quality. During construction, the builder is to supervise and inspect in detail every job performed in shed and yard as well.

2 The connection of structural parts of hull is to be fair and sound.

3 The edges of plates are to be accurate and fair.

4 Where frames or beams pass through watertight deck or bulkhead, the deck or bulkhead is to be constructed watertight without using wooden materials or cement.

5 The details of welded joints and their workmanship are to be as specified in **Part 3** of this Rule.

1.3.9 Structural Details

1 Special attention is to be paid to the arrangements of hull structural members so that welding may be carried out without much difficulty.

2 Structural discontinuities and the abrupt changes of cross sections are to be avoided as far as practicable, and welding joints are to be properly shifted from places where the stresses may highly concentrate.

3 Corners of all openings are to be well rounded.

4 Where rigid structural members with small sectional area, such as brackets, are welded on relatively thin plate, at least the toes of members are to be welded just on other rigid members.

5 Upper ends of sheer strakes in midship part are to be finished smooth, and bulwark or equipment is not to be directly welded to the shear strakes.

1.4 Longitudinal Strength

1.4.1 Special Case in Application

In case there are items for which direct application of the requirements in this Chapter is deemed unreasonable for craft, these items are to be in accordance with the discretion of the Society.

1.4.2 Loading Manual

1 In order to enable the ship master to adjust the loading of cargo and ballast to avoid the occurrence of unacceptable stress in the craft's structure, the craft, with L_f not less than 100*m*, is to be provided with a loading manual approved by the Society.

2 In the loading manual, as required in the preceding **-1**, at least the following items are to be included.

(1) Loading conditions on the basis of which the craft is designed, and the allowable limits of longitudinal still water bending moment and still water shearing force.

(2) Results of calculation of longitudinal still water bending moment and still water shearing force corresponding to the loading

conditions.

(3) Allowable limits of local loads applied to hatch covers, deck, double bottom construction, etc., where deemed necessary by the Society.

1.4.3 Loading Computers

For craft to be provided with a loading manual in accordance with the requirements of the preceding **1.4.2**, a loading computer capable of readily computing longitudinal still water bending moment and still water shearing force generated in the craft corresponding to all the loading conditions of cargo and ballast having the performance and functions as deemed appropriate by the Society is to be provided.

1.4.4 Continuity of Strength

Longitudinal members are to be so arranged as to maintain the continuity of strength.

1.4.5 Bending Strength at the Midship Part

The section modules of the transverse sections of hull at the midship part of *Ls* are not to be less than the values obtained from the following formula.

$M/\sigma_{all} \times 10^3 \ (cm^3)$

where:

M : As specified in **2.8, Part 5** of this Rule.

σ_{all} : Allowable stress obtained from the following formula.

$0.60\sigma_y \ (N/mm^2)$

σ_y : Yield point or proof stress of the materials used. (N/mm^2)

1.4.6 Calculation of Section Modulus of Transverse Section of Hull

The calculation of the section modulus of the transverse section of hull is to be based on the following requirements, as given in **(1)** through **(6)**.

(1) All longitudinal members which are considered effective to the longitudinal strength are to be included in the calculation.

(2) Deck openings on the strength deck are to be deducted from the sectional area used in the calculation of section modulus.

(3) Notwithstanding the requirements in **(2)**, small openings on the strength deck need not be deducted, provided that the sum of their breadths in one single transverse section does not reduce the section modulus at the strength deck or the craft bottom by more than 3%.

(4) Deck openings specified in **(2)** and **(3)** include shadow area obtained by drawing two tangential lines with an opening angle of 30 degrees having their apex on the line drawn through the centre of the small openings along the length of the craft.

(5) The section modulus at the strength deck is to be calculated by dividing the moment of inertia of the athwartship section about its horizontal neutral axis by the following distance **(a)** or **(b)**, whichever is greater.

(a) Vertical distance from the neutral axis to the top of the strength deck beam and the side of the craft (m).

(b) Distance obtained from the following formula :

$$Y\left(0.9 + 0.2\frac{X}{B}\right) \ (m)$$

where:

X : Horizontal distance from the top of continuous strength member to the centre line of the craft (m).

Y : Vertical distance from the neutral axis to top of continuous strength member (m). In this case, X and Y are to be measured at the point which gives the largest value to the above formula.

(6) The section modulus at craft bottom is to be calculated by dividing the moment of inertia of the athwartship section about its horizontal neutral axis by the following distance **(a)** or **(b)**, whichever is greater.

(a) Vertical distance from the neutral axis to the base point of *D*.

(b) Vertical distance from the neutral axis to the bottom of keel in case where the keel is of hat-type construction.

1.5 Plating

1.5.1 General

1 All openings in the shell plating where provided, are to have their corners well rounded and to be compensated as necessary.

2 In cases where the recesses are provided in the shell plating for sea suction or discharge, the shell plating around recesses are

to be suitably reinforced as necessary.

3 The shell platings which are likely to contact with an anchor or anchor chain cables are to be increased in thickness or to be doubled as necessary.

4 The shell plating fitted with water jet propulsion systems are to be increased in thickness or to be doubled as necessary.

1.5.2 Minimum Thickness

Minimum thickness of the respective plating is not to be less than the that obtained from the following formula.

$\gamma\sqrt{L_s}$ (mm)

where:

γ : Values as given in **Table 6.1.3**.

Table 6.1.3 Values of γ

	Steels	Aluminium Alloys
Bottom shell plating	$0.65f_s$	$0.75f_a$
Side shell plating	$0.60f_s$	$0.65f_a$
Exposed deck plating	-	$0.50f_a$
Cargo/car deck plating	-	$0.50f_a$
Other deck plating	-	$0.45f_a$
Watertight bulkhead plating	-	$0.45f_a$
Deep Tank Bulkhead plating	-	$0.50f_a$

Note:

f_s : Coefficient obtained from the following formula.

$\sqrt{235/\sigma_Y}$

σ_Y : Yield point or proof stress of steels used (N/mm^2)

f_a : Coefficient obtained from the following formula.

$\sqrt{128/\sigma_P}$

σ_p : Proof stress of aluminium alloys used in the unwelded condition. However, it is to be less than 70% of its tensile strength (N/mm^2).

1.5.3 Scantling Determination of Plating

Thickness of plating is not to be less than that obtained from the following formula.

$$\frac{QS\sqrt{P}}{\sqrt{\sigma_{all}}} + C \quad (mm)$$

Where:

Q : As given by following.

For watertight bulkhead plating: 15.8

For other plating: 22.4

S : Spacing of longitudinals or stiffeners (m)

P : Design load specified in **Table 6.1.4** corresponding to the kind of plating. Design loads specified in **Table 6.1.4** are to be in accordance with **Part 5** (kN/m^2).

σ_{all} : Allowable stress specified in **Table 6.1.4** (kN/m^2)

C : Corrosion margin corresponding to the material used as given by following.

For steels: 1.0 (mm)

For aluminium alloys: 0 (mm)

Table 6.1.4 Design Load and Allowable Stress

	P	σ_{all} (1)
Bottom shell plating	P_B	$0.73\sigma_y$
Side shell plating	P_S	$0.73\sigma_y$
Deck plating	P_D	$0.73\sigma_y$
Deckhouse/superstructure bulkhead planting	P_H	$0.91\sigma_y$
Longitudinal watertight bulkhead planting	P_{WT}	$0.73\sigma_y$
Transverse watertight bulkhead planting	P_{WT}	$0.91\sigma_y$
Longitudinal deep tank bulkhead planting	P_{DT}	$0.73\sigma_y$ (2)
Transverse deep tank bulkhead planting	P_{DT}	$0.91\sigma_y$ (2)

Notes:

(1) σ_y is yield point or proof stress of the material used (N/mm^2)

(2) For tank test conditions of deep tanks, σ_{all} is to be $1.0\sigma_y$ (N/mm^2)

1.5.4 Plating of Extruded Shapes

Where platings of extruded shapes are used, bending stress at any point on the subject plating between stiffeners is to be less than allowable stress, provided that the subject plating is to be fixed at positions of stiffeners.

1.6 Longitudinals and Stiffeners

1.6.1 Connections of Ends of Longitudinals and Stiffeners

Longitudinals and stiffeners are to be connected to bulkheads, girders or similar rigid construction by brackets in general. However, lug-connection may be substituted at the Society's discretion.

1.6.2 Continuity of Longitudinals

Longitudinals are to be continuous or to be connected with careful attention to the continuity of strength.

1.6.3 Parts where Longitudinals are Transformed to Transverse Stiffeners

In parts where longitudinals are transformed to transverse stiffeners, special care is to be taken to keep continuity of strength.

1.6.4 Scantling Determination of Longitudinals and Stiffeners

Section modulus of longitudinals and stiffeners is not to be less than that obtained from the following formula.

$$\frac{83.3CSPl^2}{\sigma_{all}} \ (cm^3)$$

where:

C : Safety factor for corrosion as given by following.

For steels: 1.1

For aluminium alloys: 1.0

S : Spacing of longitudinals or stiffeners (m)

P : Design load specified in **Table 6.1.5** corresponding to the kind of longitudinals or stiffeners. Design loads specified in **Table 6.1.5** are to be in accordance with **Part 5** (kN/m^2).

l : Span measured between the adjacent supports of stiffeners including the length of connection (m). Where girders are provided, l is the distance from the heel of end connection to the first girders or the distance between the girders.

σ_{all} : Allowable stress specified in **Table 6.1.5** (kN/m^2)

Table 6.1.5 Design Load and Allowable Stress

	P	σ_{all} (1)
Bottom longitudinals	P_B	$0.73\sigma_y$
Bottom frames	P_B	$0.91\sigma_y$
Side longitudinals	P_S	$0.73\sigma_y$
Side frames	P_S	$0.91\sigma_y$
Longitudinal beams	P_D	$0.73\sigma_y$
Transverse beams	P_D	$0.91\sigma_y$
Stiffeners fitted on deckhouse/superstructure bulkheads	P_H	$0.91\sigma_y$
Longitudinals fitted on watertight bulkheads	P_{WT}	$0.73\sigma_y$
Stiffeners fitted on watertight bulkheads	P_{WT}	$0.91\sigma_y$
Longitudinals fitted on deep tank bulkheads	P_{DT}	$0.73\sigma_y$ (2)
Stiffeners fitted on deep tank bulkheads	P_{DT}	$0.91\sigma_y$ (2)

Notes:

(1) σ_y is yield point or proof stress of the material used (N/mm^2)

(2) For tank test conditions of deep tanks, σ_{all} is to be $1.0\sigma_y$ (N/mm^2)

1.6.5 Connecting Coefficient

Notwithstanding the provisions in preceding **1.6.1**, stiffeners for watertight bulkheads and deep tanks may use snips for their ends. In this case, the section modulus for stiffeners is not to be less than the value obtained by multiplying the value specified **1.6.4** with the coefficient F selected from **Table 6.1.6**.

Table 6.1.6 Coefficient F

	Supported by girders, lug or bracket connections	Only the web of stiffener attached at end	End of stiffeners unattached
Supported by girders, lug or bracket connections	1.0	1.15	1.35
Only the web of stiffener attached at end	1.15	1.35	1.60
End of stiffeners unattached	1.35	1.60	2.0

1.6.6 Deck Beams Supporting Special Heavy Loads

The deck beams supporting special heavy loads in way of deck machinery, etc. are to be properly reinforced by increasing the scantlings of beams, or by the additional deck girders or pillars.

1.7 Girders

1.7.1 Scantling Determination of Girders

1 Section modulus of girders supporting longitudinals or stiffeners is not to be less than that obtained from the following formula.

$$\frac{mCSPl^2}{\sigma_{all}} \ (cm^3)$$

Where:

m : Coefficient as given in **Table 6.1.8**, according to the boundary condition of end connection.

C : Safety factor for corrosion as given by following.

For steels: 1.1

For aluminium alloys: 1.0

S : Breadth of the area supported by the girder (m)

P : Design load specified in **Table 6.1.7** corresponding to the kind of girders. Design loads specified in **Table 6.1.7** are to be in accordance with **Part 5** (kN/m^2).

l : Span measured between the adjacent supports of girders (m).

σ_{all} : Allowed stress specified in **Table 6.1.7**.

2 Web sectional area of girder supporting stiffener is not less than the value obtained from the following formula.

$$\frac{nCSPl}{\tau_{all}} \ (cm^2)$$

where:

n : Coefficient as given in **Table 6.1.8**, according to the boundary condition of end connection.

C, S, l and P : As specified in preceding **-1**.

τ_{all} : Allowed stress specified in **Table 6.1.7**.

Table 6.1.7 Design Load and Allowable Stress

	P	$\sigma_{all}{}^{(1)}$	$\tau_{all}{}^{(1)}$
Bottom girders	P_B	$0.73\sigma_y$	$0.42\sigma_y$
Bottom transverses	P_B	$0.91\sigma_y$	$0.53\sigma_y$
Side stringers	P_S	$0.73\sigma_y$	$0.42\sigma_y$
Wed frames	P_S	$0.91\sigma_y$	$0.53\sigma_y$
Deck girders	P_D	$0.73\sigma_y$	$0.42\sigma_y$
Deck transverses	P_D	$0.91\sigma_y$	$0.53\sigma_y$
Girders and transverses fitted on deckhouse/ superstructure bulkheads	P_H	$0.91\sigma_y$	$0.53\sigma_y$
Girders fitted on watertight bulkheads	P_{WT}	$0.73\sigma_y$	$0.42\sigma_y$
Transverses fitted on watertight bulkheads	P_{WT}	$0.91\sigma_y$	$0.53\sigma_y$
Girders fitted on deep tank bulkheads	P_{DT}	$0.73\sigma_y{}^{(2)}$	$0.42\sigma_y{}^{(3)}$
Transverses fitted on deep tank bulkheads	P_{DT}	$0.91\sigma_y{}^{(2)}$	$0.53\sigma_y{}^{(3)}$

Notes:

(1) σ_y is yield point or proof stress of the material used (N/mm^2)

(2) For tank test conditions of deep tanks, σ_{all} is to be $1.0\sigma_y$ (N/mm^2)

(3) For tank test conditions of deep tanks, τ_{all} is to be $0.58\sigma_y$ (N/mm^2)

Table 6.1.8 Coefficients m and n

Boundary Condition(2)		m and n					
End 1	End 2	At End 1(1)		Mid Span(1)		At End 2(1)	
		m	n	m	n	m	n
Fixed	Fixed	83.3	5	41.7	3	83.3	5
Supported	Fixed	55	3.8	70.3	4.3	125	6.3
Supported	Supported	80	5	125	3	80	5

1.8 Pillars

1.8.1 Pillars in Tween Decks

Pillars in tween decks are to be arranged directly above those under the deck, or effective means are to be provided for transmitting their loads to the supports below.

1.8.2 Pillars in Holds

The pillars in holds are to be provided in line with the keel or double bottom girders or as close thereto as practicable, and the structure above and under pillars is to be of ample strength to provide effective distribution of the load.

1.8.3 Connection of Pillar Ends

The head and heel of pillars are to be secured by thick doubling plates and brackets as necessary.

1.8.4 Reinforcement of Structures to which Pillars

Where the pillars are connected to the deck plating, stiffeners or girders, these structures are to be efficiently strengthened.

1.8.5 Scantling of Pillars

The sectional area of pillars is not to be less than the value derived from the following formula.

$$\frac{21.54w}{\sigma_y - \frac{253.3}{E}\sigma_y^2\left(\frac{l}{k_0}\right)^2} \ (cm^2)$$

w : Deck load supported by pillars and is determined by provisions given in **2.7, Part 5**. (kN)

σ_y : Yield strength or proof stress of the material used. (N/mm^2)

l : Distance from the lower end of pillar to the lower side of beam or deck girder supported by the pillar. (m) (See **Fig. 5.2.4, Part 5**)

k_0 : Minimum radius of gyration of the cross section of pillars. (cm)

E : Elasticity constant of the material used. (N/mm^2)

1.8.6 Pillars Provided in Deep Tanks

For the pillars provided in deep tank, hollow typed pillars are not to be used.

1.9 Rudders

1.9.1 Applications

1 The requirements in this section apply to the hanging type of a rudder which has no bearing part below the neck bearing.

2 Rudders other than rudders specified in preceding **-1** will be considered in each case by the Society.

1.9.2 Materials

The rudder stock is to be made of steel forgings. However, steel castings may be used for the material of the rudder stock subject to the approval of the Society.

1.9.3 Sleeves and Bushes

The neck bearings are to be provided with sleeves and bushes.

1.9.4 Rudder Stocks*

1 The stock diameter (d_{st}) is not to be less than that obtained from the following formula.

$$k\sqrt[3]{V^2Ah}\sqrt{\frac{220}{\sigma_{ys}}}$$

where:

k : Coefficient obtained from the following formula, but not to be less than 9.

$$44.5\sqrt{\frac{W^{1/6}}{V}}$$

V : As specified in **2.1.8, Part 1** of this Rule.

W : As specified in **2.1.14, Part 1** of this Rule.

A : Area of rudder plate (m^2).

h : Vertical distance between the lower end of the neck bearing and the lower end of the rudder (m).

σ_{ys}: Yield point or proof stress of the material used for the rudder stock (N/mm^2).

2 For the craft whose maximum speed is not so fast, the scantling determination of the rudder stock will be considered in each case by Society.

1.9.5 Rudder Plate

1 The thickness of the rudder plate consisted of single plate is to be not less than that obtained from the following formula, but is

not to be less than 6 mm.

$$0.768(1-k)\sqrt{\frac{2b+c}{a+2b}}\sqrt{\frac{d_{st}^3}{c}}\sqrt{\frac{\sigma_{ys}}{\sigma_{yp}}}+C$$

where:

k : Ratio between the vertical distance measured from the upper end of the rudder to the lower end of the rudder stock and l.

l : Vertical distance measured between the upper end of the rudder and the lower end of the rudder (mm). (*See* **Fig. 6.1.2**)

a : Breadth of the rudder at the upper end (mm). (*See* **Fig. 6.1.2**)

b : Breadth of the rudder at the lower end (mm). (*See* **Fig. 6.1.2**)

c : Breadth of the rudder at the lower end of the rudder stock (mm). (*See* **Fig. 6.1.2**)

d_{st}: Rudder stock diameter (mm). (*See* **Fig. 6.1.2**)

σ_{ys}: As specified in preceding **1.9.4-1**.

σ_{yp}: Yield point or proof stress of the material used for the rudder plate (N/mm^2).

C : Corrosion margin corresponding to the material used for the rudder plate as given by following.

For steels : 1.0 (mm)

For stainless steels or equivalent corrosion-resistant materials : 0 (mm)

2 The thickness of the rudder plate consisting of double plates is to be not less than that obtained from the following formula.

(1) Where $V \leq 23.5\sqrt{d}$

$$14.8k_1S\sqrt{0.238\left(\frac{V}{10}\right)^2+d}\cdot\sqrt{\frac{490}{\sigma_{yp}}}+C$$

k_1 : Coefficient obtained from the following formula.

$0.688+0.205/\Lambda-0.341/\Lambda^2$

Λ :The aspect ratio of the considered panel.

S :Spacing of horizontal or vertical rudder frames, whichever is smaller (m).

V :As specified in preceding **1.9.4-1**.

σ_{yp}: As specified in preceding **1.9.5-1**.

C :Corrosion margin corresponding to the material used for the rudder plate as given by following.

For steels : 0.5 (mm)

For stainless steels or equivalent corrosion-resistant materials : 0 (mm)

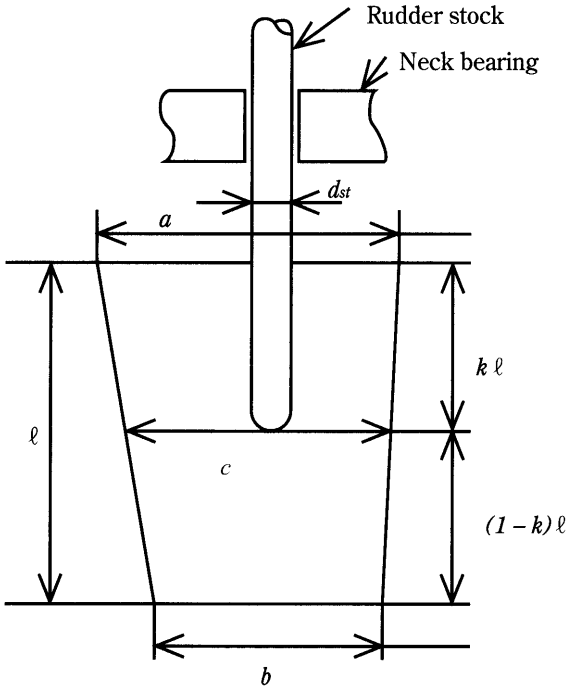
(2) Where $V > 23.5\sqrt{d}$

$$12.8k_1S\sqrt{0.741\left(\frac{V}{10}\right)^2-d}\cdot\sqrt{\frac{490}{\sigma_{yp}}}+C$$

Where:

k_1, S, V,σ_{yp} and C : As specified in **(1)** above.

Fig. 6.1.2 Measurement of a, b, c and d



Notes:

(1) The position at End 1 and 2 means the part for 0.2l from each end. And, Mid Span means the part for 0.6l amidships.

(2) "Fixed" means a case where the scantlings (sectional areas, section modulus and sectional moment of inertia) of girder adjacent to the girder concerned are larger than those of the girder concerned. When the scantlings of the girder concerned are larger than those of adjacent girder, the boundary conditions should be "Supported".

(3) In case where boundary conditions are considered as intermediate values of "fixed" and "supported", the severer condition is be selected.

1.10 Shaft Brackets

1.10.1 General*

Shaft brackets are to be of ample strength and to be strongly connected to the main hull structures.

1.11 Engine Girders and Floors

1.11.1 General*

Scantling determination of the engine girders and floors will be considered appropriate by the Society taking into account of the concentration of the heavy load and the vibration generated by the main engines, etc.

Chapter 2 HULL CONSTRUCTION FOR FRP CRAFT

2.1 General

2.1.1 Application

1 The requirements in this Chapter are applied to FRP craft moulded by hand lay-up method or spray lay-up method, using fibreglass reinforcements and unsaturated polyester resins. Wooden craft only covered with FRP or the craft of similar construction are not regarded as FRP craft.

2 The requirements in this Chapter are applied to FRP craft of less than 35 *m* in length of normal form and proportion. The requirements for FRP craft of more than 35 *m* in length will be considered in each case by the Society.

2.1.2 Special Cases in Application

In craft of which scantling length is specially long or in craft to which requirements in this Part, for some special reasons, are not directly applicable, hull construction, equipment, arrangement and scantlings are to be at the Society's discretion, notwithstanding the provisions in the preceding **2.1.1**.

2.2 Definitions

2.2.1 Application

The definitions and characters that appear in this Chapter are to be as specified in this Chapter, unless otherwise specified elsewhere.

2.2.2 Fibreglass Reinforcements

The fibreglass reinforcements are glass chopped strand mats (hereinafter referred to as "chopped mats"), glass roving cloths (hereinafter referred to as "roving cloth") and glass roving (hereinafter referred to as "roving") of reinforcements for FRP manufactured from long fibres.

2.2.3 Resins

The resins are liquid unsaturated polyester resins for laminating and gelcoat.

2.2.4 Laminating

Laminating is an operation of laying succeeding glass fibre reinforcements impregnated with resin before curing or before the preceding layer advances in cure.

2.2.5 Bonding

Bonding is an operation of connecting the FRP already advanced in cure with other FRP members, timbers, hard plastic foams, etc. by means of impregnating fibreglass reinforcements with resin.

2.2.6 Moulding

Moulding is an operation of manufacturing FRP products with definite form, strength, etc., by means of laminating or bonding.

2.2.7 Single Skin Construction

The single skin construction is a construction composed of FRP single panels moulded with fibreglass reinforcement and resin.

2.2.8 Sandwich Construction

The sandwich construction is a construction having FRP layers adhered to the both sides of core material such as hard plastic foam, balsa, timber (including plywood), etc.

2.2.9 Hand Lay-up Method

The hand lay-up method is a method of manual moulding by impregnating fibreglass reinforcements with resin.

2.2.10 Spray Lay-up Method

The spray lay-up method is a method of moulding by spraying simultaneously fibreglass reinforcements and resin using spray lay-up apparatus.

2.2.11 Bending Strength of FRP Laminates

Bending strength of FRP laminates (σ_b) (included FRP laminate of inner and outer layer of sandwich laminates) is the value in N/mm^2 obtained from the tests specified in **4.4.4-2(1)(d) of the Rules for the Survey and Construction of Ships of Fibreglass Reinforced Plastics**.

2.2.12 Modulus of Bending Elasticity of FRP Laminates

Modulus of bending elasticity of FRP laminates (E_f) (included FRP laminate of inner and outer layer of sandwich laminates) is the value in N/mm^2 obtained from the testing specified in **4.4.4-2(1)(e) of the Rules for the Survey and Construction of Ships of Fibreglass Reinforced Plastics**.

2.2.13 Tensile Strength of FRP Laminates

Tensile strength of FRP laminates (σ_t) (included FRP laminate of inner and outer layer of sandwich laminates) is the value in N/mm^2 obtained from the testing specified in **4.4.4-2(1)(f)** or **4.4.4-2(2)(b) of the Rules for the Survey and Construction of Ships of Fibreglass Reinforced Plastics**.

2.2.14 Modulus of Tensile Elasticity of FRP Laminates

Modulus of tensile elasticity of FRP laminates (E_t) (included FRP laminate of inner and outer layer of sandwich laminates) is the value in N/mm^2 obtained from the testing specified in **4.4.4-2(1)(g) of the Rules for the Survey and Construction of Ships of Fibreglass Reinforced Plastics**.

2.2.15 Sheering Strength of Sandwich Laminates

Sheering strength of Sandwich laminates (τ_a) is the value in N/mm^2 obtained from the testing specified in **4.4.4-2(2)(c) of the Rules for the Survey and Construction of Ships of Fibreglass Reinforced Plastics**.

2.2.16 Compressive Strength of Core Materials for Sandwich Construction

Compressive strength of core materials for sandwich construction (σ_c) is the value in N/mm^2 obtained from the testing whichever is better in **4.2.1** and **4.3.5-2(2)**, **4.3.5-3(2)** or **4.3.5-4(1) of the Rules for the Survey and Construction of Ships of Fibreglass Reinforced Plastics**.

2.2.17 Modulus of Compressive Elasticity of Core Materials for Sandwich Construction

Modulus of compressive elasticity of core materials for sandwich construction (E_c) is the value in N/mm^2 obtained from the testing whichever is better in **4.2.1** and **4.3.5-2(2)**, **4.3.5-3(2)** or **4.3.5-4(1) of the Rules for the Survey and Construction of Ships of Fibreglass Reinforced Plastics**.

2.3 General Requirements for Hull Construction

2.3.1 Scantlings

1 Scantlings required in this Chapter are specified for FRP craft moulded with fibreglass reinforcements composed of chopped mats or roving cloths and moulded with FRP having the strength specified in **2.1.4 in Part 3**.

2 In cases where the scantlings of laminates of sandwich construction are calculated, the modulus of bending elasticity of the inner or outer layer of FRP of laminates of sandwich construction may be obtained from the material tests specified in **4.4.4 of the Rules for the Survey and Construction of Ships of Fibreglass Reinforced Plastics**.

3 In calculating the sectional modulus of structural members, the actual FRP laminates of 150 *mm* on either side of the web are to be included.

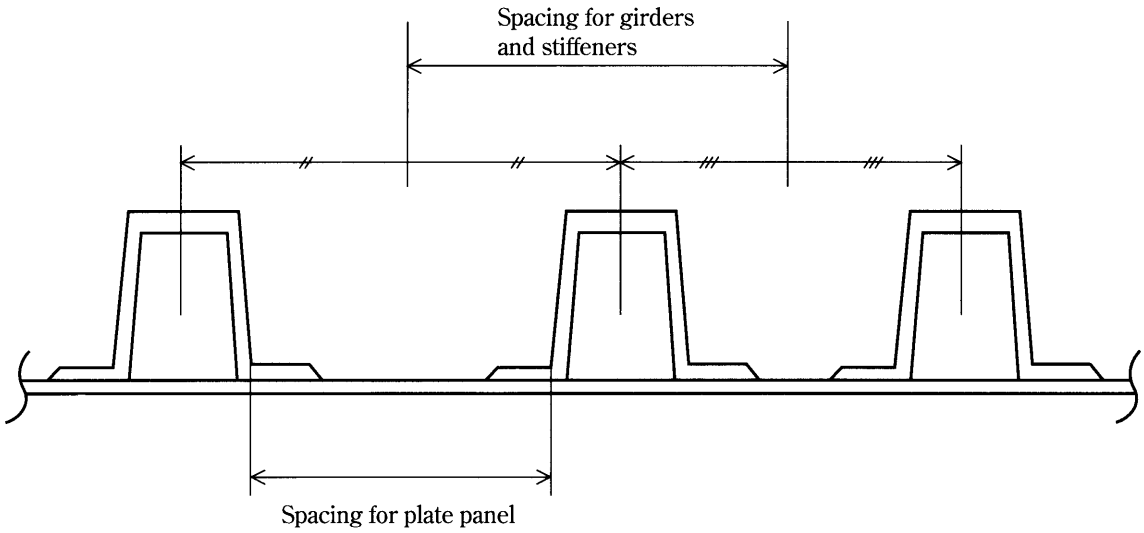
4 In cases where hat-type girders or stiffeners are used for hull construction, spacing for girders, stiffeners and plate panel for scantling determination are to be measured in accordance with following **(1)** through **(3)** respectively (*See* **Fig. 6.2.1**).

(1) Spacing for girders is to be measured from centre to centre on the girders.

(2) Spacing for stiffeners is to be measured from centre to centre on the stiffeners.

(3) Spacing for plate panel is to be measured between inner webs of hat-type girders or stiffeners which support plate panel.

Fig. 6.2.1 Spacing for Structural Members



2.3.2 Weight of Fibreglass Reinforcements and Thickness Laminates

1 The thickness of laminates per ply of chopped mats or roving cloths may be as obtained from the following formula:

$$\frac{W_G}{10\gamma_R G} + \frac{W_G}{1000\gamma_G} - \frac{W_G}{1000\gamma_R} \quad (mm)$$

where:

W_G : Designed weight per unit area of chopped mats or roving cloth (g/m^2).

G : Glass content of laminate (ratio in weight) (%).

γ_R : Specific gravity of cured resin.

γ_G : Specific gravity of chopped mats or roving cloths.

2 The glass content (G) specified in the preceding **-1** is preferable to be the value per ply for the actual laminates. However, it may be taken as the mean glass content of the whole laminates.

3 The specific gravity of chopped mats or roving cloths (γ_G) specified in the preceding **-1** may be taken as 2.5 in calculation of the thickness, if nothing specially intervenes.

4 The specific gravity of cured resin (γ_R) specified in the preceding **-1** may be taken as 1.2 in calculation of the thickness, unless any fillers are used in order to make the resin heavier.

5 Calculation of the thickness of laminates with fibreglass reinforcements other than chopped mats and roving cloths is to be in accordance with the discretion of the Society.

2.4 Longitudinal Strength

2.4.1 Special Case in Application

In case there are items for which direct application of the requirements in this Chapter is deemed unreasonable for craft, these items are to be in accordance with the discretion of the Society.

2.4.2 Continuity of Strength

Longitudinal members are to be so arranged as to maintain the continuity of strength.

2.4.3 Bending Strength at the Midship Part

The section modules of the transverse sections of hull at the midship part of L_s are not to be less than the values obtained from the following formula.

$$M/\sigma_{all} \times 10^3 \quad (cm^3)$$

where:

M :Bending moment as specified in **2.8**, **Chapter 5** of this Rule.

σ_{all} :Allowable stress obtained from the following formula.

$0.10\sigma_t$ (N/mm^2)

σ_t :Tensile strength of FRP Laminates (N/mm^2).

2.4.4 Calculation of Section Modulus of Transverse Section of Hull

The calculation of the section modulus of the transverse section of the hull is to be based on the following requirements, as given in **(1)** through **(8)**.

(1) All longitudinal members which are considered effective to the longitudinal strength are to be included in the calculation.

(2) Deck openings on the strength deck are to be deducted from the sectional area used in the calculation of section modulus.

(3) Notwithstanding the requirements in **(2)**, small openings on the strength deck need not be deducted, provided that the sum of their breadths in one single transverse section does not reduce the section modulus at the strength deck or the craft bottom by more than 3%.

(4) Deck openings specified in **(2)** and **(3)** include shadow area obtained by drawing two tangential lines with an opening angle of 30 *degrees* having their apex on the line drawn through the centre of the small openings along the length of the craft.

(5) The section modulus at the strength deck is to be calculated by dividing the moment of inertia of the athwartship section about its horizontal neutral axis by the following distance **(a)** or **(b)**, whichever is greater.

(a) Vertical distance from the neutral axis to the top of the strength deck beam and the side of the craft (m).

(b) Distance obtained from the following formula:

$$Y\left(0.9 + 0.2\frac{X}{B}\right) \ (m)$$

where:

X : Horizontal distance from the top of continuous strength member to the centre line of the craft (m).

Y : Vertical distance from the neutral axis to top of continuous strength member (m). In this case, X and Y are to be measured at the point which gives the largest value to the above formula.

(6) The section modulus at the craft bottom is to be calculated by dividing the moment of inertia of the athwartship section about its horizontal neutral axis by the following distance **(a)** or **(b)**, whichever is greater.

(a) Vertical distance from the neutral axis to the base point of D.

(b) Vertical distance from the neutral axis to the bottom of the keel in the case where the keel is of hat-type construction.

(7) Timbers or structural plywood are to be included in the calculation multiplying the sectional area by the ratio of the modulus of tensile elasticity of the relevant material to that of the FRP.

(8) Where cores of sandwich laminates or cores for moulding are included in the longitudinal strength, the sectional area multiplied by the ratio of the modulus of tensile elasticity of the relevant core to that of the FRP is to be included in the calculation. Where a joint of the core exists for $0.5L$ amidships, sufficient data with respect to the longitudinal strength and joints are to be submitted to the Society for approval.

2.5 Plating

2.5.1 General

1 All openings in the shell platings where provided, are to have their corners well rounded and to be compensated as necessary.

2 The shell platings which are likely to contact with an anchor or anchor chain cables are to be increased in thickness or to be doubled as necessary.

3 The shell plating fitted with water jet propulsion systems are to be increased in thickness or to be doubled as necessary.

2.5.2 Scantling Determination of Plating of Single Skin Construction

Thickness of plating of single skin construction is not to be less than that obtained from the following formula.

$$\frac{22.4S\sqrt{P}}{\sqrt{\sigma_{all}}}$$

where:

S : Spacing of longitudinals or stiffeners

P : Design load specified in **Table 6.1.2** corresponded to a kind of plating. Design loads specified in **Table 6.1.2** are to be in accordance with **Part 5** of this Rule (kN/m^2).

σ_{all} : Allowable stress specified in **Table 6.2.1** (kN/m^2).

Table 6.2.1 Design Loads and Allowable Stress

	P	σ_{all}
Bottom shell plating	P_B	$0.33\sigma_b$
Side shell plating	P_S	
Deck plating	P_D	
Deckhouse/superstructure bulkhead plating	P_H	
Watertight bulkhead plating	P_{WT}	
Deep Tank bulkhead plating	P_{DT}	

Note:

σ_b is bending strength of FRP laminates (kN/m^2)

2.5.3 Scantling Determination of Plating of Sandwich Construction

1 The aggregated thickness of outer layer, outer layer and core of sandwich construction is not to be less than obtained from the following formula, whichever is greater:

C_1SP (mm)

C_2t_f (mm)

where:

S and P: As specified in preceding **2.5.2**

C_1: Coefficient obtained from the following formula

C_3/τ_a

C_2 and C_3: As given in **Table 6.2.2**. For the intermediate values of a and b, C_2 and C_3 are to be obtained by linear interpolation.

τ_a: Shearing strength of sandwich laminates (N/mm^2)

t_f: Thickness in case of single skin construction specified in preceding **2.5.2**.

2 The respective thickness of inner layer and outer layer of plating of sandwich construction is not to be less than that obtained from the following formula. In no case, however, is it to be less than 2.4 mm :

$3.6\sqrt[3]{C_4S^4P^4}$ (mm)

Where:

C_4: $\frac{1}{t_c}\frac{E_c}{E_f}\left(\frac{1}{\sigma_c}\right)^4$

t_c : Thickness of core.

E_c : Modulus of compressive elasticity of core (N/mm^2).

E_f : Modulus of bending elasticity of inner layer or outer layer of FRP laminates of sandwich construction (N/mm^2).

σ_c : Compressive strength of core (N/mm^2).

S and P : As specified in previous **-1**.

3 The core of sandwich construction composing a panel is to be, as a rule, composed by one layer. The thickness of core is not to be larger than 25 mm. However, the composition of core different from these is to be at the discretion of the Society.

4 The ratio of the thickness of inner and outer layers of FRP is not to be less than 0.8. In case where the ratio of the thickness of inner and outer layers is less than 0.8, the construction will be specially considered by the Society.

5 The cores may be reckoned in the strength at the discretion of the Society.

Table 6.2.2 Values of C_2 and C_3

β		0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
C_2	α=0.8	1.62	1.42	1.31	1.25	1.20	1.16	1.14	1.12	1.10
	α=1.0	1.54	1.36	1.25	1.19	1.15	1.12	1.10	1.08	1.07
C_3		2.18	2.26	2.33	2.40	2.46	2.52	2.57	2.62	2.67

2.6 Longitudinals and Stiffeners

2.6.1 General

Connection of ends of longitudinals and stiffeners is to be in accordance with the requirements specified in **1.6.1** through **1.6.3** and **1.6.5** in this Part.

2.6.2 Scantling Determination of Longitudinals and Stiffeners

Sectional modulus of longitudinals and stiffeners is not to be less than that obtained from the following formula.

$$\frac{83.3SPl^2}{\sigma_{all}} \ (cm^3)$$

where:

S : Spacing of longitudinals or stiffeners (m).

P : Design load specified in **Table 6.2.3** corresponding to a kind of longitudinals or stiffeners. Design loads specified in **Table 6.2.3** are to be in accordance with **Part 5** of this Rule (kN/m^2).

l : Span measured between the adjacent supports of stiffeners including the length of connection (m). Where girders are provided, l is the distance from the heel of end connection to the first girders or the distance between the girders.

σ_{all} : Allowable stress specified in **Table 6.2.3** (kN/m^2)

Table 6.2.3 Design Load and Allowable Stress

	P	σ_{all}
Bottom longitudinals and frames	P_B	$0.33\sigma_t$
Side longitudinals and frames	P_S	
Deck beams	P_D	
Longitudinals and stiffeners fitted on deckhouse superstructure bulkheads	P_H	
Longitudinals and stiffeners fitted on watertight bulkheads	P_{WT}	
Longitudinals and stiffeners fitted on deep tank bulkheads	P_{DT}	

Note:

σ_t is tensile strength of FRP laminates (kN/m^2)

2.7 Girders

2.7.1 Scantlings of Girder

1 Section modulus of girder supporting stiffeners is not to be less than the value obtained from the following formula.

$$\frac{mSPl^2}{\sigma_{all}} \ (cm^3)$$

where:

m : Coefficient as given in **Table 6.2.5** according to the boundary condition of end connection.

S : Breadth of the area supported by the girders (m).

P : Design load specified in **Table 6.2.4** corresponding to a kind of girders.

Design loads specified in **Table 6.2.4** are to be in accordance with **Part 5** of this Rule (kN/m^2).

l : Span measured between the adjacent supports of girders (m).

σ_{all} : Allowed stress specified in **Table 6.2.4**.

2 Web sectional area of girder supporting stiffener is not to be less than the value obtained from the following formula.

$$\frac{nSPl}{\tau_{all}} \ (cm^2)$$

where:

n: Coefficient as given in **Table 6.2.5** according to the boundary condition of end connection.

S and l: Specified in **-1**.

P: Load specified in **Part 5** corresponded to the girder under consideration.

τ_{all}: Allowed stress specified in **Table 6.2.4**.

Table 6.2.4 Design Load and Allowable Stress

	P	σ_{all}	τ_{all}
Bottom girders and transverses	P_B	$0.33\sigma_t$	$0.19\tau_{all}$
Side stringers and web frames	P_S		
Deck girders and transverses	P_D		
Girders and transverses fitted on deckhouse/superstructure bulkheads	P_H		
Girders and transverses fitted on watertight bulkheads	P_{WT}		
Girders and transverses fitted on deep tank bulkheads	P_{DT}		

Note:

σ_t is tensile strength of FRP laminates (kN/m^2)

Table 6.2.5 Coefficient m and n

Boundary Condition(2) m and n							
End 1	End 2	At End 1(1)		Mid Span(1)		At End 2(1)	
		m	n	m	n	m	n
Fixed	Fixed	83.3	5	41.7	3	83.3	5
Supported	Fixed	5	3.8	70.3	4.3	125	6.3
Supported	Supported	80	5	125	3	80	5

Notes:

(1) The position at End 1 and End 2 means the part for $0.2l$ from each end. And, Mid Span means the part for $0.6l$ amidships.

(2) "Fixed" means a case where the scantlings (sectional area, section modulus and sectional moment of inertia) of girder adjacent to the girder concerned are larger than those of the girder concerned. When the scantlings of the girder concerned are larger than those of adjacent girder, the boundary conditions should be "Supported".

(3) In case where boundary conditions are considered as intermediate values of "Fixed" and "supported", the severer condition is to be selected.

2.8 Hat-type Construction

1 The minimum thickness of webs and faces of girders, beams, frames, floors, etc.; of hollow hat-type or hat-type with cores for moulding are not to be less than that obtained from the following formulae:

Thickness of web: $0.034d_0K$ (mm)

Thickness of face: $0.05bK$ (mm)

where:

d_0 : Depth of web (mm)

b : Breadth of face (mm)

K : 1.0. However, where the section modulus of the members exceeds the specified value, the value as obtained from the

following formula may be taken as K.

$$\sqrt{\frac{Z_R}{Z_A}}$$

where:

Z_R: Section modulus specified for the member.

Z_A: Actual section modulus of the member.

2 The core for mouldings may be reckoned in the strength at the discretion of the Society.

3 Other scantlings are to be in accordance with the relevant requirements in this chapter.

2.9 Pillars

2.9.1 Application

Construction of pillars is to be in accordance with **1.8**, **Chapter 1** of this Part.

2.10 Rudders

2.10.1 Application

Construction of rudders is to be in accordance with **1.9**, **Chapter 1** of this Part.

2.11 Shaft Brackets

2.11.1 Application

Construction of shaft brackets is to be in accordance with **1.10**, **Chapter 1** of this Part.

Chapter 3 DIRECT CALCULATIONS

3.1 General

3.1.1 General*

1 Notwithstanding the regulations of **1.7** in this Part, the scantlings of hull structural members may be determined based upon the direct calculations subject to the approval of the Society.

2 In case the direct calculations are used, structural model, loads, allowable stress and others are to be Society's desecration.

3 When direct strength calculations in preceding **-1** were executed for determination of scantlings, necessary documents and information are to be submitted.

Chapter 4 BUCKLING CONTROL

4.1 General

4.1.1 General*

Detailed assessment of buckling strength may be required as deemed necessary by the Society.

Chapter 5 FATIGUE CONTROL

5.1 General

5.1.1 General

Detailed assessment of fatigue strength may be required as deemed necessary by the Society.

Part 7 EQUIPMENT AND PAINTING

Chapter 1 EQUIPMENT

1.1 Anchors, Chain Cables and Ropes

1.1.1 General*

1 All craft, according to their equipment numbers, are to be provided with anchors, chain cables and mooring lines which are not less than given in **Table 7.1.1**. All crafts are to be provided with suitable appliances for handling the anchors and the lines.

2 Anchors, chain cables and mooring lines for craft having equipment numbers not more than 50 or more than 1,670 are to be as determined by the Society.

3 Anchors, chain cables, wire ropes and fibre ropes are to be in compliance with the requirements in **Chapter 2**, **Chapter 3**, **Chapter 4** and **Chapter 5, Part L of the Rules for the Survey and Construction of Steel Ships**.

4 The reduction of requirements in this chapter may be specially considered at the request of Owner and at the discretion of the Society.

Table 7.1.1 Anchor, Chain Cables and Ropes

Equipment letter	Equipment number		Anchor		Chain cable for anchor (Stud anchor for chain)				Tow line		Mooring line		
			Number	Mass per anchor (stockless anchor)	Total length	Diameter			Length	Breaking load	Number	Length	Breaking load
						Grade 1	Grade 2	Grade 3					
	Over	Up to		*kg*	*m*	*mm*	*mm*	*mm*	*m*	*kN*		*m*	*kN*
A_1	50	70	2	180	220	14	12.5		180	98	3	80	37
A_2	70	90	2	240	220	16	14		180	98	3	100	40
A_3	90	110	2	300	247.5	17.5	16		180	98	3	110	42
A_4	110	130	2	360	247.5	19	17.5		180	98	3	110	48
A_5	130	150	2	420	275	20.5	17.5		180	98	3	120	53
B_1	150	175	2	480	275	22	19		180	98	3	120	59
B_2	175	205	2	570	302.5	24	20		180	112	3	120	64
B_3	205	240	2	660	302.5	26	22	20.5	180	129	4	120	69
B_4	240	280	2	780	330	28	24	22	180	150	4	120	75
B_5	280	320	2	900	357.5	30	26	24	180	174	4	140	80
C_1	320	360	2	1020	357.5	32	28	24	180	207	4	140	85
C_2	360	400	2	1140	385	34	30	26	180	224	4	140	96
C_3	400	450	2	1290	385	36	32	28	180	250	4	140	107
C_4	450	500	2	1440	412.5	38	34	30	180	277	4	140	117
C_5	500	550	2	1590	412.5	40	34	30	190	306	4	160	134
D_1	550	600	2	1740	440	42	36	32	190	338	4	160	143
D_2	600	660	2	1920	440	44	38	34	190	371	4	160	160
D_3	660	720	2	2100	440	46	40	36	190	406	4	160	171
D_4	720	780	2	2280	467.5	48	42	36	190	441	4	170	187
D_5	780	840	2	2460	467.5	50	44	38	190	480	4	170	202
E_1	840	910	2	2640	467.5	52	46	40	190	518	4	170	218
E_2	910	980	2	2850	495	54	48	42	190	559	4	170	235
E_3	980	1060	2	3060	495	56	50	44	200	603	4	180	250
E_4	1060	1140	2	3300	495	58	50	46	200	647	4	180	272
E_5	1140	1220	2	3540	522.5	60	52	46	200	691	4	180	293
F_1	1220	1300	2	3780	522.5	62	54	48	200	738	4	180	309
F_2	1300	1390	2	4050	522.5	64	56	50	200	786	4	180	336
F_3	1390	1480	2	4320	550	66	58	50	200	836	4	180	352
F_4	1480	1570	2	4590	550	68	60	52	220	888	5	190	352
F_5	1570	1670	2	4890	550	70	62	54	220	941	5	190	362

Notes:

1 Length of chain cables may include shackles for connection.

2 Values given for anchoring equipment in this table are based on an assumed maximum current speed of 2.5 *m/s*, a maximum wind speed of 25 *m/s* and a minimum scope of chain cable of 6, the scope being the ratio between the paid-out length of the chain and water depth.

1.1.2 Equipment Numbers

1 Equipment number is the value obtained from the following formula:

$W^{2/3} + 2.0C + 0.1A$

where:

W:Full load displacement as defined in **2.1.14, Part 1** of this Rule.

C and A: Values as specified in the following **(1)**, **(2)** and **(3)**.

(1) C is the value obtained from the following formula:

$fB + \sum hb$

where:

f:Vertical distance, at the midship, from the designed maximum load line to the top of uppermost continuous deck beam at side (m).

$\sum hb$:Summing up of the products of the height h (m) and breadth b (m) of superstructure, deckhouse or trunk which are located above the uppermost continuous deck and also have a breadth greater than $B/4$. In this calculation, sheer and trim may be ignored.

(2) A is the value obtained from the following formula:

$fL + \sum hl$

Where:

f:As specified in **(1)**.

$\sum hl$:Summing up of the products of the height h (m) and length l (m) of superstructures, deckhouses or trunks which are located above the uppermost continuous deck within the length of craft and also have a breadth greater than $B/4$.

(3) In the application of **(1)** and **(2)**, screens and bulwarks more than 1.5 *metres* in height are to be regarded as parts of superstructures or deckhouses.

2 In catamarans, the projected area of air gap between the designed maximum load line and the wet deck may be subtracted from the value C specified in **-1(1)**.

1.1.3 Anchors

1 The mass of individual bower anchors may vary by ±7% of the mass given in **Table 7.1.1**, provided that the total mass of bower anchors is not less than that obtained from multiplying the mass per anchor given in the table by the number installed on board. Where, however, an approval by the Society is obtained, the anchors which are increased in weight by more than 7% may be used.

2 Where high holding power anchors are used, the mass of each anchors may be 0.75 times the table mass for ordinary stockless bower anchors.

3 Where super high holding power anchors are used, the mass of each anchors may be 0.5 times the mass for ordinary stockless bower anchors. However, the mass of super high holding power anchor is generally not to exceed 1,500kg.

4 For the craft affixed with classification character "*Coasting service*", the mass of one bower anchor is to be not less than the values given in **Table 7.1.1**, another bower anchor may be 0.85 times the table mass.

5 For the craft affixed with classification character "*Smooth water service*", the mass of bower anchors may be reduced by one column of the equipment number given in **Table 7.1.1**.

1.1.4 Chain Cables

Chain cables for bower anchors are to be stud link chains of Grade 1, 2 or 3 specified in **3.1** of **Chapter 3, Part L of the Rules for the Survey and Construction of Steel Ships**. However, Grade 1 chains made of Class 1 chain bars (*KSBC* 31) are not to be used in association with high holding power anchors.

1.1.5 Mooring Lines

1 As for wire ropes and fibre ropes used as mooring lines, the breaking test load specified in **Chapter 4** or **5, Part L of the Rules for the Survey and Construction of Steel Ships** is not to be less than the breaking load given in **Table 7.1.1** respectively.

2 Application of fibre ropes for mooring lines is to be as deemed appropriate by the Society.

3 For mooring lines connected with powered winches where the rope is stored on the drum, steel cored wire ropes of suitable flexible construction may be used instead of fibre cored wire ropes subject to the approval by the Society.

4 The length of individual mooring lines may be reduced by up to 7% of the length given in **Table 7.1.1**, provided that total length of the stipulated number of mooring lines is not less than that obtained from multiplying the length by number respectively given in **Table 7.1.1**.

1.1.6 Chain Lockers

1 All craft are to be provided with suitable appliances for handling of anchors.

2 Chain lockers are to be of capacities and depths adequate to provide an easy direct lead of the cables through the chain pipes and a self-stowing of the cables.

3 Chain lockers including spurling pipes are to be watertight up to the weather deck and to be provided with a means for drainage.

4 Chain lockers are to be subdivided by centre line screen walls.

5 Where a means of access is provided, it is to be closed by a substantial cover and secured by closely spaced bolts.

6 Where a means of access to spurling pipes or cable lockers is located below the weather deck, the access cover and its securing arrangements are to be to the satisfaction of the Society. Butterfly nuts and/or hinged bolts are prohibited as the securing mechanism for the access cover.

7 Spurling pipes through which anchor cables are led are to be provided with permanently attached closing appliances to minimize water ingress.

8 The inboard ends of the chain cables are to be secured to the structures by fasteners able to withstand a force not less than 15% and not more than 30% breaking load of the chain cable.

9 Fasteners are to be provided with a means suitable to permit, in case of emergency, an easy slipping of chain cables to the sea, operable from an accessible position outside the chain locker.

1.1.7 Supporting Hull Structures of Anchor Windlasses and Chain Stoppers

1 The supporting hull structures of anchor windlasses and chain stoppers are to be sufficient to accommodate operating loads and sea loads

(1) Operating loads are to be taken as not less than the following:

(a) For chain stoppers, 80% of the chain cable breaking load

(b) For windlasses, where no chain stopper is fitted or a chain stopper is attached to the windlass, 80% of the chain cable breaking load

(c) For windlasses, where chain stoppers are fitted but not attached to the windlass, 45% of the chain cable breaking load

(2) Sea loads are to be taken according to **2.1.6, Section 4, Chapter 11, Part 1 of Part CSR-B&T**

2 The permissible stresses for supporting hull structures of windlasses and chain stoppers are not to be greater than the following permissible values:

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

(a) Normal stress: 1.00 R_{eH}

(b) Shear stress: 0.60 R_{eH}

R_{eH}: The specified minimum yield stress of the material

(2) For strength assessments using finite element analysis:

(a) Von Mises stress: 1.00 R_{eH}

(3) The normal stress referred to in **(1)** above is the sum of bending stress and axial stress with the corresponding shearing stress acting perpendicular to the normal stress. No stress concentration factors are to be considered.

(4) The followings are recommended to be followed for the strength assessment by means of finite element analysis referred to in **(2) above**.

(a) The geometry is to be idealized as realistically as possible.

(b) The ratio of element length to width is not to exceed 3.

(c) Girders are to be modelled using shell or plane stress elements.

(d) Symmetric girder flanges may be modelled by beam or truss elements.

(e) The element height of girder webs is not to exceed one-third of the web height.

(f) In way of small openings in girder webs the web thickness is to be reduced to a mean thickness over the web height.

(g) Large openings are to be modelled

(h) Stiffeners may be modelled by using shell, plane stress, or beam elements.

(i) Stresses are to be read from the centre of the individual element.

(j) For shell elements the stresses are to be evaluated at the mid-plane of the element.

3 For strength assessments of supporting hull structures, beam theory or finite element analysis using net scantlings is to be applied as appropriate. In addition, the scantlings of supporting hull structure are to be built at least with the gross scantling obtained by adding the corrosion addition 2.0 *mm* to net scantlings obtained by the criteria specified in this section.

1.1.8 Miscellaneous

1 Bower anchors are to be located on the suitable position to prevent any damage on hull structures in the cases of anchoring operation. If necessary, anchor bell mouths are to be fitted for this purpose.

2 The arrangements for anchoring, towing and berthing and the local craft structure and the design of the anchor, towing and berthing arrangements and the local craft structure are to be such that risks to persons carrying out anchoring, towing or berthing procedures are kept to a minimum.

3 All anchoring equipment, towing bitts, mooring bollards, fairleads, cleats and eyebolts are to be so constructed and attached to the hull that, in use up to design loads, the watertight integrity of the craft will not be impaired.

4 Under any operating load up to the breaking strength of the anchor cable or mooring lines, the loads on the bitts, bollards, etc., is not to result in any damage to the hull structure that will impair its watertight integrity. A strength margin of at least 20% above the resultant load based on the minimum specified breaking strength of the relevant cable or warp shall be required.

Chapter 2 HATCHWAYS, MACHINARY SPACE OPENINGS AND OTHER DECK OPENINGS

2.1 General

2.1.1 Relaxation from the Requirements

Relaxation from the requirements in this Chapter will be specially considered where the craft have an unusually large freeboard.

2.1.2 Position of Exposed Deck Openings*

For the purpose of this chapter, two positions of exposed deck openings are defined as follows:

Position I: Upon exposed freeboard and raised quarter decks and exposed superstructure decks situated forward of a point located $0.25L_f$ abaft the fore end of L_f.

Position II: Upon exposed superstructure decks abaft the forward $0.25L_f$ and located at least one standard height of superstructure above the freeboard deck, or

Upon exposed superstructure decks situated forward of a point located $0.25L_f$ abaft the fore end of L_f and located at least two standard heights of superstructure above the freeboard deck.

2.2 Hatchways

2.2.1 Application

The construction and the closing means of cargo and other hatchways are to be comply with the requirements in **14.6** and **14.7, Part 1, Part C of the Rules for the Survey and Construction of Steel Ships** or **Chapter 19, Part CS of the Rules for the Survey and Construction of Steel Ships**, unless otherwise specified in this chapter.

2.2.2 Height of Hatchway Coamings

1 The minimum height of coamings above upper surface of deck is to be in accordance with **Table 7.2.1-1** or **Table 7.2.1-2** according to the length and the operating area of the craft.

2 Notwithstanding the operational areas of the craft, the minimum height of coamings above the upper surface of deck for the craft which is engaged in international voyage is not to be less than that required for "Others" specified in **Table 7.2.1-1** or **Table 7.2.1-2**.

3 For hatchways closed by watertight hatch covers, the height of coamings may be reduced from that prescribed in **-1** subject to the satisfaction of the Society.

4 The height of hatchway coamings other than those provided in exposed portions of the freeboard or superstructure decks is to be to the satisfaction of the Society having regard to the position of hatchways or the degree of protection provided.

Table 7.2.1-1 Minimum Height of Hatchway Coamings and Minimum Sill Height of Doorways ($L \geq 30m$)

Service area	Position	Hatchway coamings (mm)	Small weathertight hatchway coamings		Access openings in superstructure end bulkheads/ deck house (mm)	Access openings in companinoways (mm)	Machinery space openings (mm)
			A (mm)	B (mm)			
Others	I	600	450	380	380	600	600
	II	450	380	230	380	380	380
Coasting service	I	600	450	380	380	450	600
	II	450	380	230	300	300	380
Smooth water service	I	450	380	230	300	300	300
	II	300	230	180	100	100	150

Table 7.2.1-2 Minimum Height of Hatchway Coamings and Minimum Sill Height of Doorways ($L < 30m$)

Service area	Position	Hatchway coamings (mm)	Small weathertight hatchway coamings		Access openings in superstructure end bulkheads/ deck house (mm)	Access openings in companinoways (mm)	Machinery space openings (mm)
			A (mm)	B (mm)			
Others	I	600	450	380	380	600	600
	II	450	380	230	380	380	380
Coasting service	I	450	380	230	300	300	300
	II	300	230	180	150	150	150
Smooth water service	I	300	230	150	150	150	300
	II	150	150	100	100	100	150

Notes:

A: Hatchways, area of which is smaller than $1.5m^2$, and which are fitted with closing means of other than B stated below.

B: Hatchways, area of which is smaller than $0.45m^2$, and which are fitted with closing means capable of operating form inside and outside.

2.2.3 Closing Appliances

1 Hatchway openings on exposed decks are to be provided with efficient weathertight closing appliances with cleating devices.

2 Hatchway covers fitted with hatchway openings in way of escape routes are to be capable of being operated from both sides.

2.3 Closing Means for Access Openings in Superstructure End Bulkheads

2.3.1 Closing Means for Access Openings*

1 The doors to be provided on the access openings in the end bulkheads of enclosed superstructures are to be in accordance with the requirements in **(1)** through **(5)**:

(1) The doors are to be made of suitable materials having equivalent strength to those of the bulkheads to and to be permanently and rigidly fitted up to the bulkheads.

(2) The doors are to be rigidly constructed, to be of equivalent strength to that of the intact bulkhead and to be weathertight when closed.

(3) The means for securing weathertightness are to consist of gaskets and clamping devices or other equivalent devices and to be permanently fitted up to the bulkheads or door itself.

(4) The doors are to be operated from both sides of the bulkheads.

(5) Hinged doors are, as a rule, to open outward.

2

(1) The height of sills of access openings above upper surface of deck specified in preceding **-1** is not less than the minimum height specified in **Table 7.2.1-1** or **Table 7.2.1-2** according to the length and the operating area of the craft except where higher sills may be required when deemed necessary by the Society.

(2) In principle, portable sills are not permitted.

3 Notwithstanding the operational areas of the craft, the minimum height of sills of access openings above the upper surface of deck for the craft which is engaged in international voyage is not to be less than that required for "Others" specified in **Table 7.2.1-1** or **Table 7.2.1-2**.

2.4 Machinery Space Openings

2.4.1 Protection of Machinery Space Openings

Machinery space openings are to be enclosed by rigid castings.

2.4.2 Constructions

The constructions of exposed machinery space casings, machinery space casings below the freeboard deck or within enclosed

superstructures or deckhouses will be considered in each case by the Society.

2.4.3 Access Openings to Machinery Spaces

1 All access openings to machinery spaces are to be located in protected positions as far as possible and provided with doors capable of being closed and secured from both sides. Such doors in exposed machinery casings on the freeboard deck are to comply with the requirements in **2.3.1-1**.

2 The height of sills of doorways in machinery casings above upper surface of deck is not less than the minimum height specified in **Table 7.2.1-1** or **Table 7.2.1-2** according to the length and the operating area of the craft except where higher sills may be required when deemed necessary by the Society.

3 Notwithstanding the operational areas of the craft, the minimum height of sills of doorways in machinery casings above the upper surface of deck for the craft which is engaged in international voyage is not to be less than that required for "Others" specified in **Table 7.2.1-1** or **Table 7.2.1-2**.

2.4.4 Miscellaneous Openings in Machinery Casings

1 Coamings of any fiddley, funnel and machinery space ventilator in an exposed position on the freeboard or superstructure deck are to be as high above the deck as reasonable and practicable.

2 In exposed positions on the freeboard and superstructure decks, fiddlry openings and all other openings in the machinery casings are to be provided with strong weathertight covers permanently fitted up in their proper positions.

3 Annular spaces around funnels and all other openings in the machinery casings are to be provided with closing means capable of being operated from outside the machinery space in case of a fire.

2.5 Companionways and Other Deck Openings

2.5.1 Manholes and Flush Deck Openings

Manholes and flush deck openings in exposed positions on the freeboard and superstructure decks or within superstructures other than enclosed superstructures are to be closed by covers capable of being made watertight. These covers are to be secured by closely spaced bolts or to be permanently fitted up.

2.5.2 Companionways*

1 Access openings in the freeboard deck are to be protected by enclosed superstructures, or by deckhouses or companionways of equivalent strength and weathertightness.

2 Access openings in exposed superstructure decks or in the top of deckhouses on the freeboard deck which give access to a space below the freeboard deck or a space within an enclosed superstructure are to be protected by efficient deckhouses or companionways.

3 Doorways in deckhouses or companionways such as specified in preceding **-1** and **-2** are to be provided with doors complying with the requirements in **2.3.1-1** of this chapter. Where, however, companionways are to be enclosed with boundary wall fitted with closing means complying with the requirements in **2.3.1-1** of this chapter, the external doors needs not to be weathertight.

4 The height of sills of doorways in deckhouses or companionways such as specified in preceding **-1** through **-3** above upper surface of deck is not less than the minimum height specified in **Table 7.2.1-1** or **Table 7.2.1-2** according to the length and the operating area of the craft.

5 Where the access openings in superstructures and deckhouses which protect access openings to spaces below the freeboard deck do not have closing appliances in accordance with the requirements of **2.3.1-1.**, the openings to spaces below the freeboard deck are to be considered exposed.

6 Notwithstanding the operational areas of the craft, the minimum height of sills of doorways in deckhouse or companionways above the upper surface of deck for the craft which is engaged in international voyage is not to be less than that required for "Others" specified in **Table 7.2.1-1** or **Table 7.2.1-2**.

2.5.3 Openings to Cargo Spaces

Access and other openings to cargo spaces are to be provided with closing means capable of being operated from outside the spaces in case of a fire. Such closing means for any opening leading to any other space inboard the craft is to be of equivalent strength to that of the intact bulkhead of cargo spaces.

Chapter 3 BULWARKS, GUARDRAILS, FREEING ARRANGEMENTS, CARGO PORTS AND OTHER SIMILAR OPENINGS, SIDE SCUTTLES, VENTILATORS AND GANGWAYS

3.1 Bulwarks and Guardrails

3.1.1 General*

1 Efficient guardrails or bulwarks are to be provided around all exposed decks.

2 Guardrails specified in **-1** above are to comply with the followings:

(1) Fixed, removable or hinged stanchions are to be fitted about 1.5 *m* apart. Removable or hinged stanchions are to be capable of being locked in the upright position.

(2) At least every third stanchion is to be supported by a bracket or stay. Alternatively, measures deemed appropriate by the Society are to be taken.

(3) Where necessary for the normal operation of the ship, steel wire ropes may be accepted in lieu of guardrails. The wires are to be made taut by means of turnbuckles.

(4) Where necessary for the normal operation of the ship, chains fitted between two fixed stanchions and/or bulwarks are acceptable in lieu of guardrails.

3.1.2 Dimensions

1 The height of bulwarks or guardrails specified in **3.1.1** is to be at least 1 *metre* from the upper surface of deck, provided that where this height would interfere with the normal operation of the craft, a less height may be permitted where the Society is satisfied that adequate protection is provided.

2 The clearance below the lowest course of guardrails on superstructure and freeboard decks is not exceed 230 *mm*, and those for the other courses are not to be exceed 380 *mm*.

3 Guardrails fitted on superstructures and freeboard decks are to have at least three courses. In other locations, guardrails are to have at least two courses.

3.1.3 Construction

1 Bulwarks are to be strongly constructed and effectively stiffened on their upper edges.

2 Bulwarks are to be supported by stiffened stays connected to the deck in way of beams or at effectively stiffened positions. The spacing of these stays on the freeboard deck is not to be more than 1.8 *metres*.

3.1.4 Miscellaneous

1 Gangways and other openings in bulwarks are to be well clear of the breaks of superstructures.

2 Where bulwarks are cut to form gangways or other openings, stays of increased strength are to be provided at the ends of the openings.

3 The plating of bulwarks in way of mooring pipes is to be doubled or increased in thickness.

4 At ends of superstructures, the bulwark rails are to be bracketed either to the superstructure end bulkheads or to the stringer plates of the superstructure deck, or other equivalent arrangements are to be made so that the abrupt change of strength may be avoided.

3.2 Freeing Arrangements

3.2.1 General

1 Where bulwarks on the weather parts form wells, ample provision is to be made for rapidly freeing the deck off water.

2 Ample freeing ports are to be provided for clearing any space other than wells, where water is liable to be shipped and to remain.

3 In craft having superstructures which are open at either or both ends, adequate provision for freeing the space within superstructures is to be provided.

3.2.2 Freeing Port Area*

1 The freeing port area on each side of the craft for each well on the freeboard and raised quarter decks is not to be less than that obtained from the following formulae. The area for each well on superstructure decks other than raised quarter deck is not to be less than one-half of that obtained from the formulae.

Where l is not more than 20 *metres*:

$0.7 + 0.035l + a \ (m^2)$

Where l is more than 20 *metres*:

$0.07l + a \ (m^2)$

where:

l: Length of bulwark, but need not be taken as greater than $0.7L_f$ (m).

a: As obtained from the following formulae.

Where h is more than 1.2 *metres* : 0.04 l $(h\text{-}1.2)$ (m^2)

Where h is not more than 1.2 *metres*, but not less than 0.9 *metres* : 0 (m^2)

Where h is less than 0.9 *metres* : -0.04 l $(0.9\text{-}h)$ (m^2)

h:Average height of bulwarks above the deck (m).

2 In ships either without sheer or with less sheer than the standard, the minimum freeing port area obtained from the formulae in **-1** is to be increased by multiplying with the factor obtained from the following formula:

$$1.5 - \frac{S}{2S_0}$$

S: Average of actual sheer (mm).

S_0: Average of the standard sheer according to the requirements in **Part V** (mm).

3 Where a craft is provided with a trunk or a hatch side coaming which is continuous or substantially continuous between detached superstructures, the area of freeing port opening is not to be less than that given by **Table 7.3.1**.

Table 7.3.1 Area of Freeing Ports

Breadth of hatchway or trunk	Area of freeing ports in relation to the total area of bulwark
$0.4B_f$ or less	0.1
$0.75B_f$ or more	0.05

Note:

The area of freeing ports at intermediate breadth is to be obtained by linear interpolation.

3.2.3 Arrangement of Freeing Ports*

1 Two-thirds of the freeing port area required by **3.2.2** is to be provided in the half of the well near the lowest point of the sheer curve, and the remaining one-third is to be evenly spread along the remaining length of the well.

2 The freeing ports are to have well rounded corners and their lower edges are to be as near the deck as practicable.

3.2.4 Construction of Freeing Ports

1 Where both the length and the height of freeing ports exceed 230 *mm* respectively, freeing ports are to be protected by rails spaced approximately 230 *mm* apart.

2 Where shutters are provided to freeing ports, ample clearance is to be provided to prevent jamming. Hinge pins or bearings of the shutters are to be of non-corrosive materials.

3 Where the shutters referred to in **-2** are provided with securing appliances, these appliances are to be of approved construction.

3.3 Cargo Ports and Other Similar Openings

3.3.1 Arrangement of Bow Doors

1 Bow doors are in principle to be situated above the freeboard deck.

2 Where bow doors are leading to a complete or long forward enclosed superstructure, an inner door which forms a part of

collision bulkhead is to be fitted in the above superstructure. Where the craft which are not engaged in international voyage and for are for restricted service, an inner doors may be omitted at the discretion of the Society.

3 Vehicle ramp way may be arranged for this purpose, provided that it forms a part of collision bulkhead and satisfies the requirements for position of the collision bulkhead as stipulated in **2.1.2, Part 4** of this Rule.

4 Bow doors are to be so fitted as to ensure effective protection to inner doors.

3.3.2 Arrangement of Side Doors and Stern Doors

1 The lower edge of any openings of side doors and stern doors which are provided abaft the collision bulkhead is in principle not to be below a line which is parallel to the freeboard deck at the craft's side and has the lowest point on the uppermost load line.

2 Where side door and stern door are unavoidably provided below the line as stipulated in **-1**, the following conditions are to be satisfied.

(1) Compartment being equivalent to watertight bulkhead in strength and watertightness is to be provided and the second door is to be fitted for the compartment.

(2) Detecting device for sea water leakage is to be provided in the compartment.

(3) Drainage means of the compartment with a screw down stop valve capable of being controlled from easily accessible position is to be provided.

3 The number of door openings is to be kept to the minimum compatible with design and proper operation of the craft.

3.3.3 Construction of Doors and Inner Doors

1 Bow door, side door and stern door to have openings below the freeboard deck (hereinafter collectively referred to as the "door(s)" in this Chapter) are to be made watertight.

2 Doors leading to an enclosed superstructure and the inner door as stipulated in **3.3.1-2** in this Chapter (hereinafter referred to as the "inner door" in this Chapter) are to be made weathertight.

3 Strength of the door and the inner door is in principle to be equivalent to that of the surrounding hull structure.

4 Doors and inner doors are adequately stiffened and means is to be provided to prevent lateral or vertical movement of the doors when closed. Hinges and lifting arms of the door and the inner door are to be rigidly fixed with the door plating and the hull structure.

5 Where a bow door is provided in craft with a rounded nose bow and a large stem angle, impact force by water is to be considered.

6 Doors and inner doors are in principle to open outwards.

7 Gutter waterways and scuppers are to be provided to prevent spread of leaked water over the deck.

3.3.4 Closing Devices of Doors and Inner Door

1 Closing devices of sufficient strength are to be provided to the door and the inner door so that they are able to keep strength equivalent to surrounding hull structure in closed condition.

2 The closing devices in **-1** above are to be simple and easily accessible.

3 Where hydraulic cleating is applied, the system is to be mechanically lockable in closed condition even in the event of failure of the hydraulic system.

4 Cleating devices and supporting devices are in principle to be provided at appropriate intervals and as close to each corner of the door.

5 Caution plate giving instructions that all closing devices are to be closed before leaving ports and warning indicator lamps are to be provided at the operation panel of remote control of the door.

6 Indicators showing whether the doors are opened or closed are to be provided with at the wheel house where deemed necessary by the Society.

7 Devices are to be arranged for the door and the inner door to lock them in open position.

8 Design load for closing devices of the door is to be as considered appropriate by the Society.

3.4 Side Scuttles

3.4.1 General*

1 No side scuttle is to be provided in such a position as its sill is below a line drawn parallel to the freeboard deck at side and having its lowest point $0.025B_f$ or 500 mm, whichever is greater, above the uppermost load line.

2 No side scuttle is in principle to be provided to any space solely engaged in carriage of cargoes. Where side scuttles are provided to such spaces, the special consideration will be give by the Society.

3.4.2 Application

1 Side scuttles to spaces below the freeboard deck and those provided to sunken poop are to be class *B* side scuttles complying with the requirements in **Chapter 7, Part L of the Rules for the Survey and Construction of Steel Ships** or equivalent thereto.

2 Side scuttles to spaces within enclosed superstructures, those fitted up to the side and front walls of deckhouses and companionways on the freeboard deck which have unprotected deck openings leading to spaces below the freeboard deck inside and those exposed to direct blow of seas are to be class *C* side scuttles with hinged dead-light complying with the requirements in **Chapter 7, Part L of the Rules for the Survey and Construction of Steel Ships** or equivalent thereto.

3 Where an openings in the superstructure deck or in the top of deckhouse on the freeboard deck which gives access to spaces below the freeboard deck or to a space within an enclosed superstructure is protected by the deckhouse or companion, side scuttles fitted in spaces which give direct access to an open stairway are to be class *C* side scuttles with hinged dead-light complying with the requirements in **Chapter 7, Part L of the Rules for the Survey and Construction of Steel Ships** or equivalent thereto.

3.4.3 Protection of Side Scuttles

All side scuttles in way of spaces where they are liable to be damaged are to be protected by strong gratings.

3.5 Other Windows

3.5.1 Application

1 Side scuttles to spaces within enclosed superstructures, those fitted up to the side and front walls of deckhouses and companionways on the freeboard deck which have unprotected deck openings leadng to spaces below the freeboard deck inside and those exposed to direct below of seas are to be class *C* side scuttles with hinged dead-light complying with the requirements in or equivalent thereto.

2 Spaces which are fitted with windows applying this are not to be the reserve of buoyancy.

3.5.2 General

Rectangular windows on the surrounding of deck houses or superstructures are to be of fixed type except wheel house windows or windows used for means of escape.

3.5.3 Construction

1 Windows are to be rigidly framed and strongly fitted on the hull structures.

2 Thickness of glass is not to be less than 6 mm or that obtained from the following formulae, whichever is the greater.

$$31.3a\sqrt{KP/\sigma_{\max}} \quad (mm)$$

where:

a: Length of shorter side of window (m).

K: As given by following formulae corresponding to the aspect ratio of window:

$$1.0414-\frac{0.7375}{\Lambda}-0.0244\Lambda \text{ or } 0.75$$

where:

Λ: Aspect ratio of window

P: Design loads for deck houses and superstructures as specified in **2.5**, **Part 5** of this Rule.

$\sigma_{\max}$: Breaking stress of glass as specified in **Table 7.3.2** corresponding to the materials.

3 Where materials other than those specified in **-2** are used, the use of such materials and corresponding breaking stress are to be specially considered by the Society.

Table 7.3.2 Breaking Stress (σ_{max})

Materials	Breaking σ_{max}	
	Front windows	Others
Toughened safety glass	40	100
Acrylite	39	98
Policarbonate	33	83

3.5.4 Closing Appliances*

1 Dead-rights or storm shutters are to be fitted with following windows:

(1) All windows on the first tier above freeboard deck

(2) Windows on the second tier above freeboard deck and deemed necessary by the Society

2 Notwithstanding **-1**, for the craft which are for restricted service, dead-lights or storm shutters may be partly or fully omitted at the discretion of the Society.

3.5.5 Other Requirement

Windows used for means of escape are also to comply with the requirements in **Chapter 6, Part 11** of this Rule. The minimum clear opening is not to be less than 600 *mm*×600 *mm*.

3.6 Ventilators

3.6.1 Height of Ventilator Coamings

The height of ventilator coamings above the upper surface of the deck is not less than the minimum height specified in **Table 7.3.3**. Where the craft has an unusually large freeboard or where the ventilator serves spaces within unenclosed superstructures, the height of ventilator coamings may be suitably reduced.

Table 7.3.3 Minimum Height of Ventilator

Service Area	Position	Height of ventilator
Smooth water service area	I	760
	II	450
Other area	I	900
	II	760

Note:

Position I and II are to be defined in **2.1.2** in this Part.

3.6.2 Connection

Ventilator coamings are to be efficiently connected to the deck and, where their height exceeds 900 *mm*, are to be specially supported.

3.6.3 Closing Appliances*

1 Ventilators to machinery and cargo spaces are to be provided with means for closing openings capable of being operated from outside the spaces in case of a fire.

2 All ventilator openings on exposed decks are to be provided with efficient weathertight closing appliances. Where the coaming of any ventilator extends to more than 4.5 *metres* above the surface of the deck in Position I or more than 2.3 *metres* above the surface of the deck in Position II specified in **2.1.2** of this Part, such closing appliances may be omitted unless requirement in **-1**.

3 In cases where ventilation louvers with means for closure are fitted to emergency generator rooms or closing appliances are fitted to ventilators serving emergency generator rooms, the requirements specified in the **1.2.5-2, Part 9** are to be satisfied.

3.6.4 Ventilators for Accommodation Spaces

Ventilation intakes for the accommodation spaces are to be so arranged as to prevent to absorb gases from machinery spaces and fuel oil tanks.

3.6.5 Ventilators for Deckhouses

The ventilators for the deckhouses which protect the companionways leading to spaces below the freeboard deck are to be equivalent to those for the enclosed superstructures.

3.7 Gangways

3.7.1 General

Satisfactory means (in the form of guardrails, life lines, gangways or under deck passages, etc.,) are to be provided for the protection of the crew in getting to and from their quarters, the machinery space and all other parts used in the necessary work of the craft.

Chapter 4 PAINTING AND PROTECTION AGAINST CORROSION

4.1 Painting

4.1.1 General

1 All structural members of steel works are to be coated with a suitable paint. For structural members inside of oil tanks, painting may be omitted.

2 Structural members of aluminium alloys works are recommended to be coated with a suitable paint.

3 Outer shell of FRP craft are to be coated with suitable gelcoat or composition having the property of low water absorption.

4.2 Protection against Corrosion

4.2.1 General

1 Where two or more kinds of different metallic materials (for example, steel and aluminium alloy) are used for structural members of a craft, different metals are to be insulated by electrical insulation having the property of anti water absorption against galvanic corrosion.

2 Where two or more kinds of different metallic materials (for example, steel and aluminium alloy) are used for structural members of a craft and such different metals are closed to each other in salt water, a suitable method against galvanic corrosion is to be applied.

Part 8 BUOYANCY, STABILITY AND SUBDIVISION

Chapter 1 GENERAL

1.1 General

1.1.1 General Requirements

A craft is to be provided with:

(1) stability characteristics and stabilization systems adequate for safety when the craft is operated in the non-displacement mode and during the transient mode ;

(2) buoyancy and stability characteristics adequate for safety where the craft is operated in the displacement mode, both in the intact condition and the damaged condition ; and

(3) stability characteristics in the non-displacement and transient modes adequate to transfer the craft safely to displacement mode in case of any system malfunction.

1.1.2 Ice Accretion Allowances*

Account are to be taken of the effect of icing in the stability calculations. Ice accretion allowances will be considered by the Society.

1.1.3 Definitions

For the purpose of this and other chapters, unless expressly defined otherwise, the following definitions apply:

(1) “Down flooding point” means any opening, irrespective of size, that would permit passage of water through a water/weathertight structure (e.g., opening windows), however excludes any opening kept closed to an appropriate standard of water/weathertightness at all times other than when required for access or for operation of portable submersible bilge pumps in an emergency (e.g., non-opening windows of similar strength and weathertight integrity to the structure in which they are installed).

(2) “Fully submerged foil” means a foil having no lift components piercing the surface of the water in the foil borne mode.

(3) “Multihull craft” means a craft which in any normally achievable operating trim or heel angle, has a rigid hull structure which penetrates the surface of the sea over more than one discrete area.

(4) “Permeability” of a space means the percentage of the volume of that space which can be occupied by water.

(5) “Skirt” means a downwardly-extending, flexible structure used to contain or divide an air cushion.

(6) “Watertight” in relation to a structure means capable of preventing the passage of water through the structure in any direction under the head of water likely to occur in the intact or damaged condition.

(7) “Weathertight” means that water will not penetrate into the craft in any wind and wave conditions up to those specified as critical design conditions.

1.1.4 Equivalent Method

Other means of demonstrating compliance with the requirements of this part may be accepted, provided that the method chosen can be shown to provide an equivalent level of safety. Such methods may include:

(1) Mathematical simulation of dynamic behaviour

(2) Scale model testing

(3) Full-scale trials

1.2 Buoyant Spaces

1.2.1 Reserve of Buoyancy

1 All craft are to have a sufficient reserve of buoyancy at the design waterline to meet the intact and damage stability

requirements of this Part. The Society may require a larger reserve of buoyancy to permit the craft to operate in any of its intended modes. This reserve of buoyancy is to be calculated by including only those compartments which are:

(1) watertight;

(2) accepted as having scantlings and arrangements adequate to maintain their watertight integrity; and

(3) situated in locations below a datum, which may be a watertight deck or equivalent structure of a non-watertight deck covered by a weathertight structure as defined in **1.2.3(1)**.

2 Where a buoyant space may be subjected to increased fluid pressure in the equilibrium position after damage, the boundaries and associated openings and penetrations of that space are to be of sufficient strength and watertight for that pressure.

1.2.2 Checking of Watertight Integrity

Arrangements are to be provided for checking the watertight integrity of those compartments taken into account in **1.2.1**.

1.2.3 Requirements for Structures above the Datum

Where entry of water into structures above the datum as defined in **1.2.1(3)** would significantly influence the stability and buoyancy of the craft, such structures are to be:

(1) of adequate strength to maintain the weathertight integrity and fitted with weathertight closing appliances; or

(2) provided with adequate drainage arrangements; or

(3) an equivalent combination of both measures.

1.2.4 Maintenance of Weathertight Integrity

The means of closing openings in the boundaries of weathertight structures are to be such as to maintain weathertight integrity in all operational conditions.

1.3 Intact Stability in the Displacement Mode

1.3.1 Intact Stability for Hydrofoil Craft*

Hydrofoil craft fitted with surface-piercing foils and/or fully submerged foils are to have sufficient stability under all permitted cases of loading to comply with the relevant provisions which will be individually determined by the Society.

1.3.2 Intact Stability for Multihull Craft*

Multihull craft are to have sufficient stability under all permitted cases of loading to comply with the relevant provisions which will be individually determined by the Society.

1.3.3 Intact Stability for Any Other Craft

Any other craft are to meet the following criteria in all permitted conditions of loading :

(1) Stability requirements in wind and waves in **2.3, Part U of Rules for the Survey and Construction of Steel Ships**;

(2) The area under the righting lever curve (GZ-curve) is not to be less than 0.07 *m-rad* up to $\theta = 15^\circ$ when the maximum righting lever (GZ_{MAX}) occurs at $\theta = 15^\circ$ and 0.055 *m-rad* up to $\theta = 30^\circ$ when GZ_{MAX} occurs at $\theta = 30^\circ$ or above.

Where GZ_{MAX} occurs at angles of between $\theta = 15^\circ$ and $\theta = 30^\circ$, the corresponding area under the righting lever curve is not to be less than that obtained from the following formula:

$A = 0.055 + 0.001(30^\circ - \theta_{max})$ $(m\text{-}rad)$

where:

θ_{max} : The angle of heel in degrees at which the righting lever curve reaches its maximum;

(3) The area under the righting lever curve between $\theta = 30^\circ$ and $\theta = 40^\circ$ or between $\theta = 30^\circ$ and the angle of flooding θ_f*, if this angle is less than 40 degrees, is not to be less than 0.03 *m-rad*

(* : Small openings, which are not causing more flooding, may be ignored.)

(4) The righting lever (GZ) is to be at least 0.20 *m* at an angle of heel equal to or greater than 30 degrees;

(5) GZ_{MAX} is to occur at an angle of heel not less than 15 degrees; and

(6) The initial metacentric height (G_0M) is not to be less than 0.15 *m*.

1.3.4 Equivalent Criteria

Where the characteristics of the craft are unsuitable for application of **1.3.3**, the Society may accept alternative criteria equivalent to those stipulated in **1.3.3**, appropriate to the type of craft and area of operation.

1.4 Intact Stability of Craft in the Non-displacement Mode

1.4.1 Application

The requirements of this section and section 2.2.2 of this Part are to be applied on the assumption that any stabilization systems fitted are fully operational.

1.4.2 Calculation on Stability

Suitable calculations are to be carried out and/or tests conducted to demonstrate that, when operating in the non-displacement and transient modes within approved operational limitations, the craft will, after a disturbance causing roll, pitch, heave or heel due to turning or any combination thereof, return to the original attitude.

1.4.3 Stability of Sister Craft

The roll and pitch stability on the sister craft may be qualitatively assessed by the results of suitable calculations or tests for the first and/or any other craft of a series.

1.4.4 Stability of Craft Ffitted with Surface Piercing Structure or Appendages

Where craft are fitted with surface piercing structure or appendages, precautions are to be taken against dangerous attitudes or inclinations and loss of stability subsequent to a collision with a submerged or floating object.

1.4.5 Stability of Air Cushion Vehicle

In designs where periodic use of cushion deformation is employed as a means of assisting craft control, or periodic use of cushion air exhausting to atmosphere for purposes of craft maneuvreing, the effects upon cushion-borne stability are to be determined, and the limitations on the use by virtue of craft speed or attitude are to be established.

1.4.6 Requirements for Flexible Skirts of an Air Cushion Vehicle

In the case of an air cushion vehicle fitted with flexible skirts, it is to be demonstrated that the skirts remain stable under operational conditions.

1.5 Intact Stability in the Transient Mode

1.5.1 Time of the Transient Mode

Under weather conditions up to the worst intended conditions, the time to pass from the displacement mode to the non-displacement mode and vice versa are to be minimized unless it is demonstrated that no substantial reduction of stability occurs during this transition.

1.5.2 Hydrofoil Craft*

Hydrofoil craft are to have sufficient intact stability in transient mode to comply with the relevant provisions which will be individually determined by the Society.

1.6 Buoyancy and Stability in the Displacement Mode following Damage

1.6.1 Application

The requirements of this section apply to all permitted conditions of loading.

1.6.2 Permeability

For the purpose of making damage stability calculations, the volume and surface permeabilities are to be in accordance with Table 8.1.1 in general.

Table 8.1.1 Permeabilities of Space

Spaces	Permeability
Appropriated to cargo or stores	60
Occupied by accommodation	95
Occupied by machinery	85
Intended for liquids	0 or 95*
Appropriated for cargo vehicles	90
Void spaces	95

Note:

* : whichever results in the more severe requirements

1.6.3 Permeability Determined by Direct Calculation

Notwithstanding 1.6.2, permeability determined by direct calculation are to be used where a more onerous condition results, and may be used where a less onerous condition results from that provided according to 1.6.2.

1.6.4 Buoyancy of Low Density Foam or Other Media

The Society may permit the use of low density foam or other media to provide buoyancy in void spaces, provided that satisfactory evidence is provided that any such proposed medium is the most suitable alternative and is:

(1) of closed cell form if foam, or otherwise impervious to water absorption;

(2) structurally stable under service conditions;

(3) chemically inert in relation to structural materials with which it is in contact or other substances with which the medium is likely to be in contact; and

(4) properly secured in place and easily removable for inspection of the void spaces.

1.6.5 Damage Assumptions

The assumed extent of damages is to be according to **(1)** to **(5)**:

(1) The assumed maximum extent of side damage is to be in accordance with Table 8.1.2 and following **(a)** to **(c)**.

(a) Where side plating is inclined, the damages above the design waterline are to be assumed to have the shape of a parallelepiped (Refer to Fig. 8.1.1). The inboard face at its mid-length is to be tangential to, or otherwise touching in a least 2 places, the surface corresponding to the specified transverse extent of penetration. (Refer to Fig.8.1.2 and Fig.8.1.3)

(b) Side damage may not to be transversely penetrate a greater distance than the extent of $0.2\nabla^{1/3}$ at the design waterline, except where a lesser extent is provided for in Table 8.1.2. ∇ (m^3) is volume of displacement corresponding to the design water line.

(c) If considering a multihull, the periphery of the craft is considered to only be the surface of the shell encompassed by the outboard surface of the outermost hull at any given section.

(2) The assumed maximum extent of bottom damage is to be in accordance with Table 8.1.3 and following **(a)** and **(b)**.

(a) The shape of damage is to be assumed to be rectangular in the transverse plane. (Refer to Fig.8.1.4)

(b) If considering a multihull craft , an obstruction at or below the design waterline of up to $7m$ width is to be considered in determining the number of hulls damaged at any one time.

(3) Extent of bottom damage in areas vulnerable to raking damage is to be in accordance with Table 8.1.4 and Fig.8.1.5. However these requirements may not need to apply at that same time as that stipulated in **(1)** or **(2)** above. The shape of damage is to be according to **(2)(a)** above.

(4) Extent of bow and stern damage is to be in accordance with Table 8.1.5.

(5) Any damage of a lesser extent than that postulated in **(1)** to **(4)** above, as applicable, which would result in a more severe condition, is to be also investigated.

Table 8.1.2 Extent of Side Damage

Direction	Extent of Damage
Longitudinal extent	$0.75\nabla^{1/3}$, $(3m+0.225\nabla^{1/3})$ or $11m$, whichever is the least.
Transverse extent	$0.2\nabla^{1/3}$ However, where the craft is fitted with inflated skirts or with non-buoyant side structures, the transverse extent of penetration are to be at least $0.12\nabla^{1/3}$ into the main buoyancy hull or tank structure
Vertical extent	the full vertical extent of the craft

Note:

∇ : volume of displacement(m^3) corresponding to the design water line

Table 8.1.3 Extent of Bottom Damage

Direction	Extent of Damage
Longitudinal extent	$0.75\nabla^{1/3}$, $(3m+0.225\nabla^{1/3})$ or $11m$, whichever is the least.
Athwarth ships girth extent	the athwartships girth of damage is to be $0.2\nabla^{1/3}$
Normal extent to the shell	the depth of penetration normal to the shell is to be $0.02\nabla^{1/3}$

Note:

∇ : volume of displacement(m^3) corresponding to the design water line

Table 8.1.4 Extent of Bottom Damage in Areas Not Vulnerable to Raking Damage

Direction	Extent of Damage
Longitudinal extent	55% of the length L, measured from the most forward point of the underwater buoyant volume of each hull
	a percentage of the length L, applied anywhere in the length of the craft, is as follows. Where L is 50m and over, equal to 35% for craft Where L is less than 50m, equal to $(L/2+10)$% for craft
Athwarth ships girth extent	The athwartships girth of damage is to be $0.1\nabla^{1/3}$
Normal extent to the shell	the depth of penetration normal to the shell is to be $0.04\nabla^{1/3}$ or $0.5m$, whichever is lesser

Note:

∇ : volume of displacement(m^3) corresponding to the design water line

The penetration or girth is to under no circumstances extend above the vertical extent of the vulnerable area as stipulated in **Fig.8.1.5**.

Table 8.1.5 Extent of Bow and Stern Damage

Damage Parts	Extent of Damage
Bow part	at the fore end, damage to the area defined as A_{bow}, the aft limit of which being a transverse vertical plane, provided that this area need not extend further aft from the forward extremity of the crafts watertight envelope than the longitudinal distance of side damage.
Stern part	at the aft end, damage to the area aft of a transverse vertical plane at a distance $0.2\nabla^{1/3}$ forward of the aft extremity of the watertight envelope of the hull.

Note:

$A_{bow} = 0.0035AmfV$, however never less than $0.04A$

Where:

A_{bow} : the plan projected area (m^2) of craft energy-absorbing structure forward of the transverse plane

A : the plan projected area (m^2) of craft

m : material factor $0.95/M$

M : appropriate hull material factor as follows

(a) high-tensile steel : 1.3

(b) aluminium alloy : 1.0

(c) mild steel : 0.95

(d) fibre-reinforced plastics : 0.8

Where materials are mixed, the material factor is to be taken as a weighted mean, weighted according to the mass of material in the area defined by A_{bow}.

f : framing factor as follows

(a) longitudinal deck and shell stiffening : 0.8

(b) mixed longitudinal and transverse : 0.9

(c) transverse deck and shell stiffening : 1.0

V : 90% of maximum speed

∇ : volume of displacement(m^3) corresponding to the design water line

Fig. 8.1.1 Transverse Extent of Side Damage

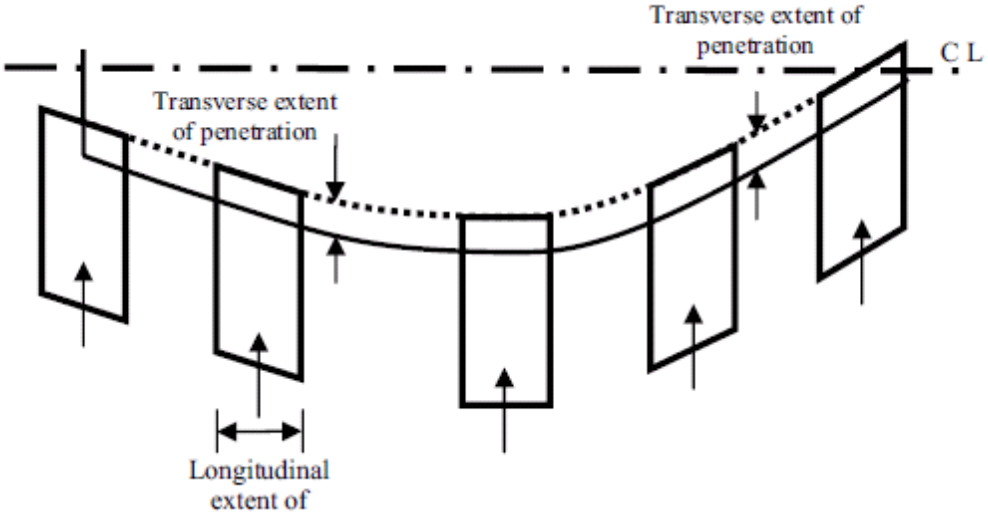


Fig. 8.1.2 Horizontal Extent of Side Damage

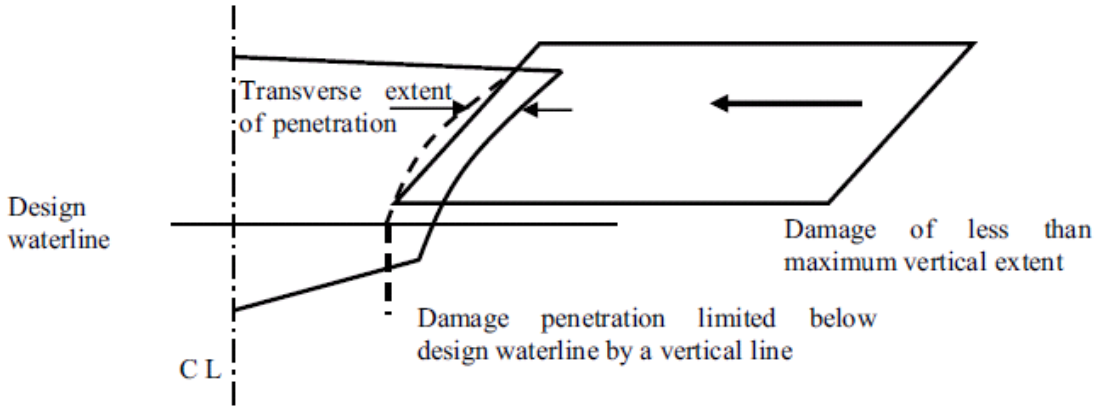


Fig. 8.1.3 Horizontal Extent of Side Damage of Multihull Craft

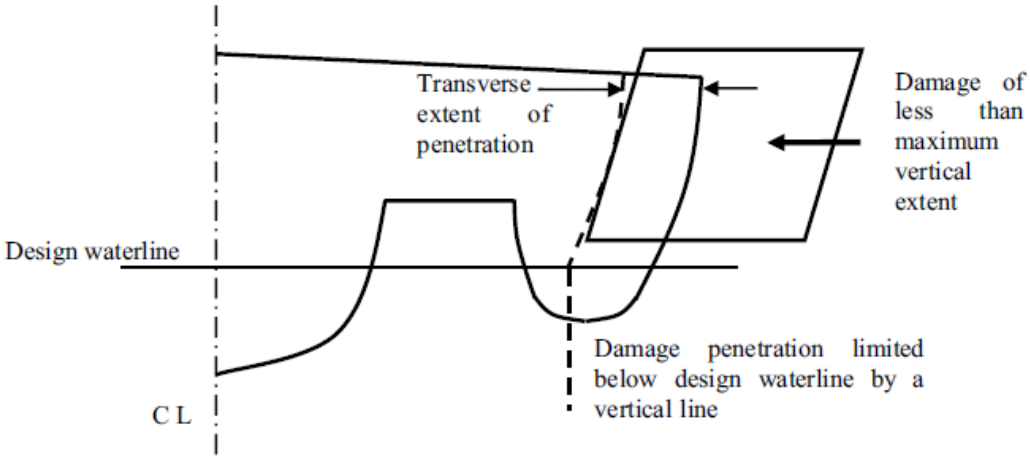


Fig. 8.1.4 Extent of Bottom Damage

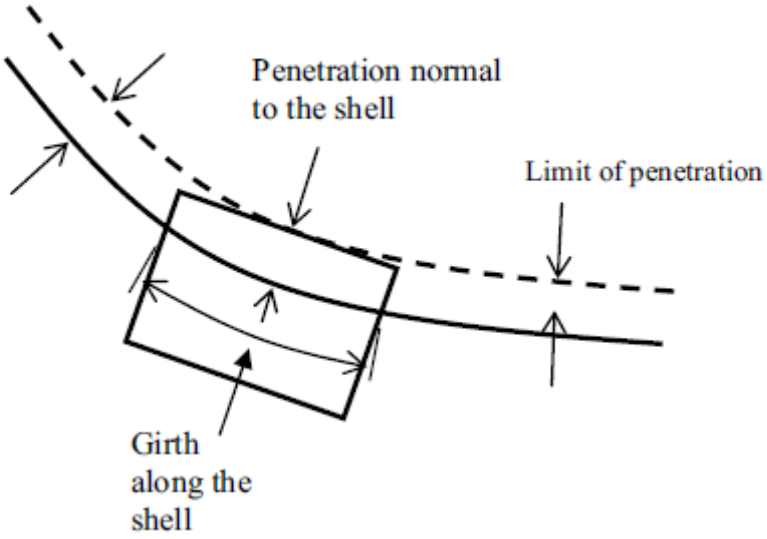


Fig. 8.1.5 Extent of Bottom Damage in Areas Vulnerable to Raking Damage

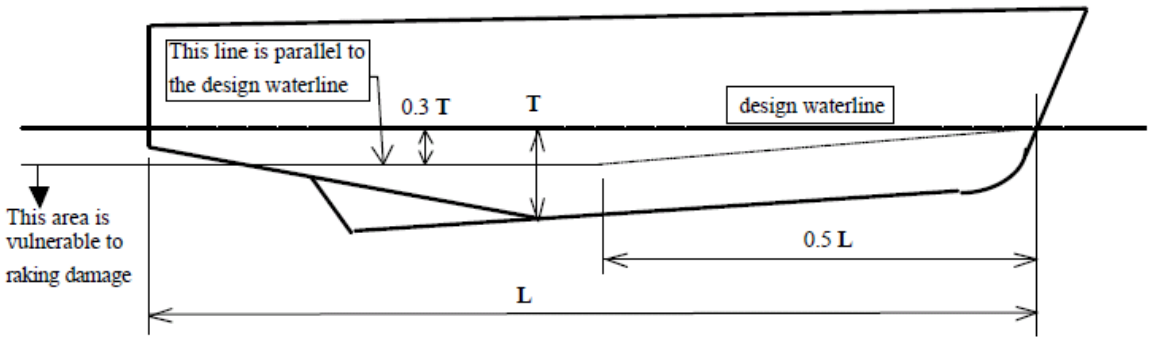
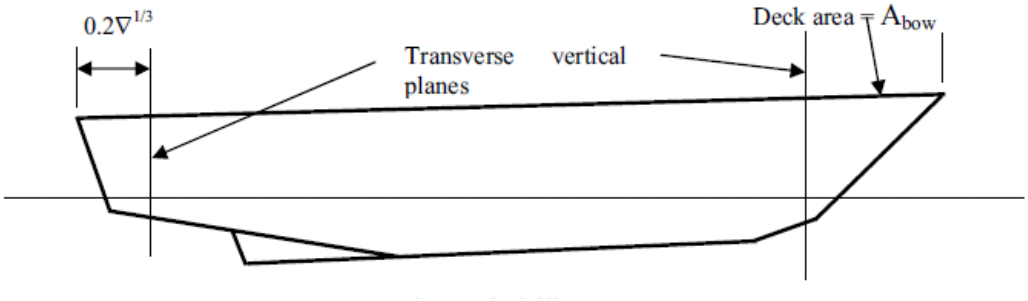


Fig. 8.1.6 Extent of Bow and Stern Damage



1.7 Inclining and Stability Information

1 Every craft on completion of build is to be inclined and the elements of its stability determined. When an accurate inclining in not practical, the lightship displacement and centre of gravity are to be determined by a lightweight survey and accurate calculation.

2 On all craft, where an accurate inclining experiment is impractical owing to the height of the centre of gravity (*VCG* or *KG*) being less than one third of the transverse metacentric height (*GM*T), *KG* may be estimated by detailed calculation in place of an inclining experiment. In such cases, a displacement check is to be confirm the calculated lightship characteristics, including *LCG*, which may be accepted if the measured lightship displacement and *LCG* are respectively within 2% and 1% L relative to the estimate.

1.7.2 Stability Information Booklet

A stability information booklet, which is to be prepared on the basis of the particulars of stability determined by the results of stability experiments and to be approved by the Society, is to be provided on board. The information is to include particulars appropriate to the craft and is to reflect the craft's loading conditions and mode of operation. Any enclosed superstructures or deckhouses include in the cross curves of stability and the critical downflooding points and angles are to be identified.

1.7.3 Amendments of Stability Information Booklet

Where any alterations are made to a craft so as to materially affect its stability, **2.3.1-5(1), Part B of the Rules for Survey and Construction of Steel Ships** is to be followed to determine the need for re-inclining tests, and the need for amending stability information.

1.7.4 Submission of Results of Stability Experiments

A report of each inclining or lightweight survey carried out in accordance with this Part and of the lightship condition particulars which are calculated from the test result is to be submitted to the Society for approval.

1.7.5 Keeping of Stability Information Booklet

A stability information booklet approved in accordance with preceding **1.7.2** and/or **1.7.3** is to be provided on board.

1.7.6 Draught Marks at Bow and Stern

Every craft is to have scales of draughts marked clearly at the bow and stern. In the case where the draught marks are not located where they are easily readable, or operational constraints for a particular trade make it difficult to read the draught marks, then the craft is to also be fitted with a reliable draught indicating system by which the bow and stern draughts can be determined. For amphibious air-cushion vehicles this may be achieved by the use of draught gauges in conjunction with deck datum plates.

1.7.7 Draught Marks

The draught marks are to be accurately determined and are located on the hull in a permanent manner.

1.8 Loading and Stability Assessment

1.8.1 Loading Computers

In addition to the stability information booklet, the Society may accept the use of an electronic loading and stability computer or equivalent means for the purpose to determine the craft's trim and stability.

1.9 Marking of the Design Waterline

1.9.1 Marking of the Design Maximum Load Line

The design maximum load line is to clearly be marked amidships on the craft's outer sides. This waterline is to be distinguished by the notation "*H*".

Chapter 2 REQUIRMENTS FOR PASSENGER CRAFT

2.1 General

2.1.1 Consideration of the Effects of Passenger Weight

Where compliance with this Part requires consideration of the effects of passenger weight, the following information are to be used:

(1) The distribution of passengers is 4 persons per square metre.

(2) Each passenger has a mass of 75 *kg*.

(3) Vertical centre of gravity of seated passengers is 0.3*m* above seat.

(4) Vertical centre of gravity of standing passengers is 1.0*m* above deck.

(5) Passengers and luggage are to be considered to be in the space normally at their disposal

(6) Passengers are to be distributed on available deck areas towards one side of the craft on the decks where muster stations are located and in such a way that they produce the most adverse heeling moment.

(7) Passengers assumed to be occupying seats are to be taken as having a vertical centre of gravity corresponding to being seated, with all others standing.

(8) On the decks where assembly stations are located, the number of passengers on each deck is to be that which generates the maximum heeling moment. Any remaining passengers are to be assumed to occupy decks adjacent to those on which the assembly stations are located, and positioned such that the combination of number on each deck and total heeling moment generate the maximum static heel angle.

(9) Passengers may not to be assumed to gain access to the weather deck nor be assumed to crowd abnormally towards either end of the craft unless this is a necessary part of the planned evacuation procedure.

(10) Where there are seats in areas occupied by passengers, one passenger per seat are to be assumed, passengers being assigned to the remaining free areas of the deck (including stairways, if appropriate) at the rate of four per square metre.

2.2 Intact Stability

2.2.1 Intact Stability in the Displacement Mode

The craft are to have sufficient intact stability that, when in still water conditions, the inclination of the craft from the horizontal would not exceed 10 degrees under all permitted cases of loading and uncontrolled passenger movements as may occur.

2.2.2 Intact Stability in the Non-displacement Mode*

1 The total heel angle in still water due to the effect of passenger movement and due to beam wind pressure is not to exceed 10 degrees.

2 In all loading conditions, the outward heel due to turning is not to exceed 8 degrees, and the total heel due to beam wind pressure and due to turning is not to exceed 12 degrees outward.

2.3 Buoyancy and Stability in the Displacement Mode Following Damage

2.3.1 Buoyancy and Stability Criteria

Following any of the postulated damages detailed in **1.6** of this Part, the craft in still water is to have sufficient buoyancy and positive stability to simultaneously ensure that:

(1) after flooding has ceased and a state of equilibrium has been reached, the final waterline be 300 *mm* below the level of any opening through which further flooding could take place;

(2) the angle of inclination of the craft from the horizontal does not normally exceed 10 degrees in any direction. However, where this is clearly impractical, angles of inclination up to 15 degrees immediately after damage may be permitted provided that the craft is to comply with the following requirements;

(a) Means to reduce the angle of inclination of the craft to 10 degrees within 15 *minutes* are provided, and

(b) Efficient non-slip deck surfaces and suitable holding points, *e.g.*, holes, bars, etc., are provided.

(3) there is a positive freeboard from the damage waterline to survival craft embarkation positions;

(4) any flooding of passenger compartments or escape routes which might occur will not significantly impede the evacuation of passengers; and

(5) essential emergency equipment, emergency radios, power supplies and public address systems needed for organizing the evacuation remain accessible and operational.

2.3.2 Residual Stability of Multihull Craft*

The residual stability of multihull craft will be individually determined by the Society.

2.3.3 Residual Stability of Any Other Crafts

The residual stability of craft other than multihull craft are to meet the following criteria;

(1) The positive residual righting lever curve is to have a minimum range of 15 degrees beyond the angle of equilibrium.

(2) The area under the righting lever curve is to be at least 0.015 *m-rad*, measured from the angle of equilibrium to the lesser of:

(a) the angle at which progressive flooding occurs;

(b) 22 degrees (measured from the upright) in the case of one-compartment flooding, or 27 degrees (measured from the upright) in the case of the simultaneous flooding of two or more adjacent compartments.

(3) A residual righting lever within the range specified in **2.3.3(1)** is not less than that obtained from the following formula. However, in no case is this righting lever to be less than $0.10m$:

$$\frac{Heeling moment}{Displacement} + 0.04 \ (m)$$

where heeling moment is the greatest of the following heeling moments (kN-m):

(a) Heeling moment due to the crowding of all passengers towards one side specified in **2.1.1**;

(b) Heeling moment due to the launching of all fully loaded davit-launched survival craft on one side;

For the purpose of calculating this heeling moment, the following assumptions are to be made:

i) all lifeboats and rescue boats fitted on the side to which the craft has heeled after having sustained damage shall be assumed to be swung out fully loaded and ready for lowering:

ii) for lifeboats which are arranged to be launched fully loaded from the stowed position, the maximum heeling moment during launching shall be taken:

iii) a fully loaded davit-launched liferaft attached to each davit on the side to which the craft has heeled after having sustained damage shall be assumed to be swung out ready for lowering:

iv) persons not in the life-saving appliances which are swung out shall not provide either additional heeling or righting moment:

v) life-saving appliances on the side of the craft opposite to the side to which the craft has heeled shall be assumed to be a stowed position.

(c) Heeling moment due to steady wind given by the following formula:

$0.12AZ$ (kN-m)

where:

A and Z are to be obtained in accordance with **2.3.1-1, Part U of the Rules for the Survey and Construction of Steel Ships**.

Chapter 3 REQUIREMENTS FOR CARGO CRAFT

3.1 General

3.1.1 Application*

The requirements in this Chapter apply to cargo craft except cargo craft which are not engaged in international voyage and are for restricted service.

3.2 Buoyancy and Stability in the Displacement Mode Following Damage

3.2.1 General Buoyancy and Stability Criteria

Following any of the postulated damages detailed in **1.6** of this Part, the craft in still water is to have sufficient buoyancy and positive stability to simultaneously ensure that:

(1) after flooding has ceased and a state of equilibrium has been reached, the final waterline be 150 *mm* below the level of any opening through which further flooding could take place;

(2) the angle of inclination of the craft from the horizontal does not normally exceed 15 degrees in any direction. However, where this is clearly impractical, angles of inclination up to 20 degrees immediately after damage may be permitted provided that the craft is to comply with the following requirements;

(a) Means to reduce the angle of inclination of the craft to 15 degrees within 15 *minutes* are provided, and

(b) Efficient non-slip deck surfaces and suitable holding points, *e.g.*, holes, bars, etc., are provided.

(3) there is a positive freeboard from the damage waterline to survival craft embarkation positions; and

(4) essential emergency equipment, emergency radios, power supplies and public address systems needed for organizing evacuation remain accessible and operational.

3.2.2 Residual Stability*

1 The residual stability of multihull craft will be individually determined by the Society.

2 The residual stability of the craft other than multihull craft are to meet **2.3.3** in this Part.

Part 9 MACHINERY INSTALLATIONS

Chapter 1 GENERAL

1.1 General

1.1.1 Scope

1 The requirement of this Part apply to the main propulsion machinery, power transmission systems, shafting systems, propellers, waterjet propulsion systems, prime movers other than main propulsion machinery, boilers, thermal oil heaters, incinerators, pressure vessels, auxiliaries, piping systems and their control systems (hereinafter referred to as "machinery installations" in this Part).

2 Machinery installations which are unusual and considered impracticable to meet the requirements of this Part may be accepted provided that they are deemed by the Society to be equivalent to those specified in this Part.

3 For machinery installations with novel design features, the Society may apply the requirements of the Rules so far as practicable and other requirements as considered necessary by the Society.

4 For machinery installations which are considered appropriate by the Society, some requirements in this Part may be modified by taking their capacity, purposes and operating conditions into account.

5 The terms specified in this part are in accordance with the requirements of **1.1.6, Part D of the Rules for the Survey and Construction of Steel Ships**.

6 The drawings and data to be submitted in connection with machinery installations are to conform to the requirements specified in each Chapter of this Part, in addition to those specified in **2.1.2 of Part 2**.

1.1.2 Materials

Materials intended to be used for machinery installations are to be selected considering the purpose and conditions of their service. Materials intended for principal components are to be of those tested and inspected in accordance with the requirements specified in this Part.

1.2 General Requirements for Machinery Installations

1.2.1 General*

1 The machinery installations are to be properly fixed and to be of construction and arrangement to facilitate operation, inspection and maintenance.

2 The machinery installations are to be of a design and construction adequate for the service for which they are intended and are to be so installed and protected as to reduce to a minimum any danger to persons on board, due regard being paid to moving parts, hot surfaces and other hazards.

3 When the following machinery is fitted singly on board, special consideration is to be given to the reliability of the machinery and its components. For craft in which unconventional machinery is used as the main propulsion machinery and propulsion shafting system, provision of additional machinery capable of ensuring the ship to proceed at navigable speed in the possible event of failure of the machinery may be requested by the Society.

(1) For crafts in which reciprocating internal combustion engines are used as main propulsion machinery (excluding electric propulsion crafts):
Reciprocating internal combustion engine, highly elastic couplings, reduction gears and propulsion shafting systems

(2) For crafts in which gas turbine are used as main propulsion machinery (excluding electric propulsion crafts):
Gas turbine engines, compressors, combusters, reduction gears and propulsion shafting systems

(3) For electric propulsion crafts (only those specified in **5.1.1-1, Part H of the Rules for the Survey and Construction of Steel Ships**, hereinafter the same in this Part):

Propulsion motors, reduction gears and propulsion shafting systems

4 Means are to be provided whereby normal operations of main propulsion machinery can be sustained or restored even though one of the essential auxiliaries becomes inoperative. Special consideration is to be given to the malfunctioning of:

(1) a generator set which serves as a main source of electrical power;

(2) the fuel oil supply systems for boilers or engines;

(3) the sources of lubricating oil pressure;

(4) the sources of water pressure;

(5) an air compressor and a receiver for starting or control purposes;

(6) the hydraulic, pneumatic or electrical means for control in main propulsion machinery including controllable pitch propellers; However, having regard to overall safety consideration, a partial reduction in propulsion capability from normal operation may be accepted.

5 Such information as is necessary to ensure that machinery can be installed correctly regarding such factors as operating conditions and limitations are to be made available by the manufacturers.

6 Main propulsion machinery and prime movers for driving generators, and auxiliary machinery (excluding auxiliary machinery for specific use, etc.) and their prime movers that are installed in the ships are to be designed to operate under the conditions given in **Table 9.1.1**. However, deviation from the angles given in **Table 9.1.1** may be permitted after taking into consideration the type, size and service conditions of the ship.

7 Machinery installations are to be fitted with adequate safety monitoring and control devices in respect of speed, temperature, pressure and other operational functions.

8 Special consideration is to be given to the design, construction and installation of the machinery installations so that any mode of vibrations, accelerations, shocks, etc., shall not cause undue stresses in normal operating ranges.

9 To prime movers used for lift or attitude control arrangements, the requirements concerning to the main propulsion machinery are to be applied.

10 The exhaust gas treatment systems specified in the following **(1)** and **(2)** fitted onto machinery installations are to comply with the requirements specified in **Chapter 21** and **Chapter 22, Part D of the Rules for the Survey and Construction of Steel Ships**.

(1) Selective catalytic reduction (SCR) systems

(2) Exhaust gas cleaning systems (EGCS) (excluding those specified in **2.1.1-4**)

Table 9.1.1 Angle of Inclination

Type of machinery installations	Athwartships(2)		Fore-and-aft (2)	
	Static inclination (List)	Dynamic inclination (Rolling)	Static inclination (Trim)	Dynamic inclination (Pitching)
Main propulsion machinery Essential auxiliary boilers Prime movers driving generators(excluding those for emergency) Auxiliary machinery (excluding auxiliary machinery for specific use, etc.) and their driving units	15°	22.5°	5° (3)	7.5°
Emergency installations (emergency generators, emergency fire pumps and prime movers to drive them) Switchgears(1) (Circuit breakers, etc.) Automatic or remote operated equipment	22.5°	22.5°	10°	10°

Notes:

(1) No undesired switching operations or operational changes are to occur.

(2) Athwartships and fore-and-aft inclinations may occur simultaneously.

(3) Where the length of the ship exceeds 100 *m*, the fore-and-aft static angle of inclination may be taken as follows:
$\theta = 500/L$

θ : The static angle of inclination (°)

L : Length of the ship specified in **2.1.2, Part A of the Rules for the Survey and Construction of Steel Ships** (m)

1.2.2 Astern Power

1 Sufficient power for going astern is to be provided to secure proper control of the ship in all normal circumstances.

2 For the main propulsion systems with reversing gears, controllable pitch propellers, waterjet propulsion systems or electric propeller drive, running astern is not to lead to the overload of propulsion machinery.

1.2.3 Limitation in the Use of Fuel Oil

Except for cases as specified in **(1)** to **(3)** below, no fuel oil with a flash point (to be determined by an approved closed cup method) of less than 60°C is to be used.

(1) In emergency generators, fuel oil with a flash point of not less than 43°C may be used.

(2) Subject to such additional precautions as it may consider necessary and on condition that the ambient temperature of the space in which such fuel oil is stored or used shall not be allowed to rise to within 10°C below the flashpoint of the fuel oil, the general use of fuel oil having a flashpoint of less than 60°C but not less than 43°C may be permitted.

(3) The use of fuel oil having a flashpoint of less than 43°C may be permitted provided that such fuel oil is not stored in any machinery space and subject to the approval by the Society of the complete installation.

1.2.4 Fire Protections*

1 Flange joints and special joints (screwed joints, mechanical joints, etc.) fitted in flammable oil piping such as fuel oil, lubricating oil, and such flammable oil systems are not to be located right above boilers, steam pipelines, thermal oil pipelines, exhaust gas pipings, silencers, exhaust gas driven turbo blowers or other highly heated surfaces, and to be arranged far apart therefrom, as far as practicable, unless proper means approved by the Society are provided against leaking or spraying of the oils from these joints and systems.

2 All surfaces of machinery installations with temperature exceeding 220°C where impingement of flammable liquids may occur as a result of a system failure are to be effectively insulated. The insulation is to be imprevious to flammable liquids and vapours.

3 The driving units for fuel oil transfer pumps and other similar fuel oil pumps, fuel purifiers, forced draft fans for boilers and ventilating fans serving machinery spaces are to be capable of being stopped from an easily accesible position outside the space concerned in the event of a fire in the space where they are located and its vicinity. The means provided for stopping the ventilation fans of the machinery spaces are to be entirely separated from those of other spaces.

4 Machinery installations are to be free from leakages of the fuel oil, lubricating oil and other flammable oils, unhealthy gases and flammable gases which may cause fire, so far as is available. For those from which these oils may leak, proper means of leading the leaked oils to other safe location are to be provided.

5 Machinery installations are to be free from leakage of such gases as to harm human health or cause fire. The possible machinery installation is to be placed at such a position as the gases can be easily drained off to a well-ventilated place.

6 Provision is to be made to drain all excess fuel and oil to a safe position so as to avoid a fire hazard.

7 Structures constructed with combustible materials such as woods and the like are not to be located above internal combustion engines and their surroundings, except where protected adequately by metal plate, rockwool or other fire-resisting materials.

8 The means specified in below are to be taken for each space where pre-treatment machinery installations for flammable liquid such as purifiers, oil heaters, etc., are installed, unless other adequate means deemed appropriate by the Society are provided.

(1) Each space in which the main components in the above system are installed is to be separated from other machinery installations, enclosed by steel bulkheads extending from deck to deck with self-closing steel doors.

(2) A fixed fire detection and fire alarm system is to be provided.

(3) A fixed fire-extinguishing system capable of being activated from outside the room is to be provided.

(4) Independent mechanical ventilation or a ventilation arrangement which can be isolated from the machinery space ventilation is to be provided.

A closing arrangement of the above ventilation openings capable of being activated from a position close to where the above fixed fire-extinguishing system is to be provided.

1.2.5 Ventilating Systems for Machinery Spaces*

1 Machinery spaces are to be adequately ventilated so as to ensure that when machinery or boilers therein are operating at full power, an adequate supply of air is maintained to the spaces for the safety and comfort of personnel, for the operation of the machinery and for the prevention of accumulation of flammable gases.

2 In cases where ventilation louvers with means for closure are fitted to emergency generator rooms and closing appliances are fitted to ventilators serving emergency generator rooms, such louvers or closing appliances are to comply with the requirements specified in the following **(1)** to **(4)**:

(1) Louvers and closing appliances may either be hand-operated or power-operated (hydraulic, pneumatic or electric) and are to be operable under fire conditions.

(2) Hand-operated louvers and closing appliances are to be kept open during normal operation of the vessel. In addition, corresponding instruction plates are to be provided at the location where hand-operation is provided.

(3) Power-operated louvers and closing appliances are to be of a fail-to-open type. However, closed power-operated louvers and closing appliances are acceptable during normal operation of the vessel. Power-operated louvers and closing appliances are to open automatically whenever the emergency generator is starting or in operation.

(4) Ventilation openings with means for closure are to be possible to close by a manual operation from a clearly marked safe position outside the space where the closing operation can be easily confirmed. In addition, the louver status (open or closed) is to be indicated at this position, and the closing of louvers and closing appliances is not to be possible from any remote position other than this position.

1.2.6 Communication between Navigating Bridge and Control Stations for Speed and Direction of Thrust of Propellers

Communication between navigating bridge and control stations for the control of speed and direction of thrust of propellers are to comply with following requirements.

(1) At least two independent communication means are to be provided for communicating orders from the navigating bridge to the position in the machinery space or in the control room from which the speed and direction of thrust of the propellers are normally controlled. One of these means is to be an engine room telegraph which provides visual indication of the orders and responses both on the navigating bridge and in such control station mentioned above.

(2) Means of communication as deemed appropriate by the Society, are to be provided from the navigating bridge and the engine room to any position, other than those specified in **(1)** above, from which the speed or direction of thrust of the propellers may be controlled.

1.2.7 Engineers' Alarm

An engineers' alarm is to be provided to be operated from the engine control room or at the manoeuvring platform as appropriate, and is to be clearly audible in the engineers' accommodation.

1.2.8 Rating Plates for *A.C.* Generating Sets

Rating plates which comply with the requirements in **1.3.10 of Part D** are to be installed on *A.C.* generating sets.

1.3 Tests

1.3.1 Shop Tests

Before installation on board, machinery installations are to be tested according to the following requirements at the plants.

(1) The tests for reciprocating internal combustion engines are to be carried out in accordance with **2.6.1, Part D of the Rules for the Survey and Construction of Steel Ships**.

(2) The tests for gas turbines are to be carried out in accordance with **4.5.1, Part D of the Rules for the Survey and Construction of Steel Ships**.

(3) The tests for power transmission systems are to be carried out in accordance with **5.5.1, Part D of the Rules for the Survey and Construction of Steel Ships**.

(4) Shaftings, Propellers and Waterjet Propulsion Systems

(a) Stern tubes, propeller shaft sleeves and stern tubes shaft sleeves are to be subjected to hydrostatic tests specified in **6.3.1, Part D of the Rules for the Survey and Construction of Steel Ships**.

(b) Propellers are to be tested in accordance with **7.4.1, Part D of the Rules for the Survey and Construction of Steel Ships**.

(c) Waterjet propulsion systems are to be subjected to the following tests.

i) Hydrostatic tests at a pressure 1.5 times the design pressure for impeller casing

ii) Balancing test of the impeller

iii) Hydrostatic tests at a pressure of at least 0.2*MPa* or 1.5 times the design pressure whichever is higher for the forward bearing tube of the main shaft and the sealing device tubes

(5) Boilers, Thermal Oil Heaters, Incinerators and Pressure Vessels

(a) Boilers with design pressure exceeding 0.35*MPa* are to be tested in accordance with **9.10.1, Part D of the Rules for the Survey and Construction of Steel Ships**.

(b) Boilers with design pressure not exceeding 0.35*MPa* are to be tested in accordance with **9.11.3-1, Part D of the Rules for the Survey and Construction of Steel Ships**.

(c) Thermal oil heaters are to be subjected to the test specified in above **(a)**.

(d) Pressure vessels are to be tested in accordance with **10.9.1, Part D of the Rules for the Survey and Construction of Steel Ships**.

(6) Welding for Machinery Installations

Welding for machinery installations is to be subjected to tests specified in **11.4**, **11.5**, **11.6** and **11.7, Part D of the Rules for the Survey and Construction of Steel Ships**.

(7) Pipes, Valves, Pipe Fittings and Auxiliaries

Pipes, valves, pipe fittings and auxiliaries are to be subjected to tests specified in **12.6.1** and **16.2.5, Part D of the Rules for the Survey and Construction of Steel Ships**. When, for technical reasons, it is not possible to carry out the complete hydrostatic testing before assembly on board, for all sections of piping, the testing may be carried out in conjunction with the checking required by **1.3.2(13)** provided that the test plans referred to in **2.1.4-5, Part 2** containing the closing lengths of piping, particularly in respect to the closing seams, are submitted to the Society and approved thereby.

(8) Steering Gears

Steering gears are to be subjected to tests specified in **15.5.1, Part D of the Rules for the Survey and Construction of Steel Ships**.

(9) Refrigerating Equipment

Refrigerating Equipment is to be tested in accordance with **17.4.1, Part D of the Rules for the Survey and Construction of Steel Ships**.

(10) Automatic and Remote Control Systems

Automatic and remote control systems are to be subjected to the tests specified in **18.7.1, Part D of the Rules for the Survey and Construction of Steel Ships**. In addition, the requirement specified in **18.7.2, Part D of the Rules for the Survey and Construction of Steel Ships** are to be complied with.

1.3.2 Tests after Installation On Board*

After installation on board, the following tests are to be carried out.

(1) Verification inspection of installation or fixing condition of machinery.

(2) Performance tests for overspeed protective devices, fuel oil leaking alarms from the injection pipes, lubricating oil low pressure alarming and automatic stopping devices, emergency stopping devices and cooling water high temperature alarming devices of reciprocating internal combustion engines.

(3) Performance tests for overspeed protective devices, lubricating oil low pressure alarming and automatic stopping devices, emergency stopping devices, flame-out alarming, excessive vibration alarming, fire detection devices in enclosures exhaust gas high temperature alarming devices and, cooling water high temperature alarming devices of gas turbine.

(4) Performance tests for lubricating oil low pressure alarming of power transmission systems.

(5) Tests for leakage under working oil pressure of stern tube sealing devices.

(6) Force-fitting tests to measure and record the pull-up length for propellers force-fitted on the propeller shaft.

(7) For boilers with design pressure exceeding 0.35*MPa*, popping tests for safety valves and function tests for the safety devices and alarm devices.

(8) For boilers with design pressure not exceeding 0.35*MPa*, function tests for the safety devices.

(9) For thermal oil heaters, popping tests for safety valves and function tests for the safety devices and alarm devices.

(10) For incinerators with maximum capacity not less than 34.5*kW*,

(a) Operation tests of the safety devices and alarming devices and burning tests.

(b) Tests for assigning the safety working temperature.

(11) For piping systems for which welding between pipes or between pipes and pipe fittings is carried out on board the ship, the non-destructive testing specified in **11.6, Part D of the Rules for the Survey and Construction of Steel Ships** on all joints welded on board the ship.

(12) For auxiliaries (excluding auxiliary machinery for specific use, etc.,) running tests as deemed appropriate by the Society. However, in the case of machinery having passed the tests specified in above **1.3.1(7)**, the test methods on board may be suitably modified at the discretion of the Society.

(13) In general, checking all the piping systems, after assembly on board, for leakage under operational conditions and, if necessary, using special techniques other than hydrostatic testing. In particular, fuel oil piping systems, thermal oil piping systems and heating coils in tanks are to be tested at a pressure of 1.5 times the design pressure or 0.4 *MPa*, whichever is the greater.

(14) For steering gears,

(a) Leak tests for the hydraulic oil systems at least a max. working pressure, after installed on board.

(b) Each operation test, after installed on board.

(15) For mooring winches,

(a) Operation tests for 15 *minutes* in each direction at max. speed under no load.

(b) Function tests for the drum brake under the operating condition specified in **(a)**.

(c) Notwithstanding the requirements specified **(a)** and **(b)**, where there are a plurarity of units of the same type, the period of testing and number of units to be tested may be reduced.

(16) For the piping systems of refrigerating equipment, which are exposed to a pressure of the primary refrigerant, leak tests at a pressure of 90% of the design pressure.

(17) For automatic and remote control systems, it is to be ensured that the systems can operate effectively, respectively under as far practical condition as possible. However, part of the tests may be carried out during sea trials.

1.3.3 Mass-production Equipment

For equipment manufactured by mass-production system deemed appropriate by the Society, the test procedure suited to the production method may be accepted in place of the tests specified in the Rules upon the request of the manufacturer, notwithstanding the requirements of **1.3.1** above.

1.3.4 Omission of Tests

Where machinery installations have test certificates which are deemed appropriate by the Society, a part or all of tests for the machinery specified in **1.3.1** may be omitted.

1.3.5 Additional Tests

The Society may require, when deemed necessary, other tests than those specified in this Part.

Chapter 2 RECIPROCATING INTERNAL COMBUSTION ENGINES

2.1 General

2.1.1 General*

1 The requirements of this Chapter apply to the reciprocating internal combustion engines used for main propulsion machinery, electric generators and auxiliary machinery (excluding auxiliary machinery for specific use, etc., hereinafter the same in this chapter).

2 For each type of reciprocating internal combustion engines, an approval of use is to be obtained by the engine designer (hereinafter referred to "licensor" in this Chapter) as specified separately by the Society.

3 The requirements of exhaust driven turbochargers specified in this chapter also apply, in principle, to engine driven chargers.

4 Reciprocating internal combustion engines fitted with exhaust gas recirculation (EGR) systems are to be in accordance with requirements specified in **Chapter 23, Part D of the Rules for the Survey and Construction of Steel Ships** in addition to those in this Chapter.

5 Gas-fuelled engines are to be in accordance with the requirements specified otherwise by the Society in addition to those in this chapter.

2.1.2 Terminology

1 In this chapter, exhaust driven turbochargers are categorised into the following three groups according to the engine power at maximum continuous rating (*MCR*) supplied by a group of cylinders served by the actual turbocharger (e.g., turbocharger size is to be 50% of total engine power for a *V*-engine with one turbocharger serving each bank of cylinders).

(1) Category *A* turbochargers
The engine power at *MCR* supplied by a group of cylinders served by the turbocharger is not more than 1000 *kW*.

(2) Category *B* turbochargers
The engine power at *MCR* supplied by a group of cylinders served by the turbocharger is not less than 1000 *kW*, but not more than 2500 *kW*.

(3) Category *C* turbochargers
The engine power at *MCR* supplied by a group of cylinders served by the turbocharger is not less than 2500 *kW*.

2 The terminology used in the application of **2.1.3** and **2.1.4** is as specified in the following **(1)** to **(36)**:

(1) "Acceptance criteria" mean a set of values or criteria which a design, product, service or process is required to conform with, in order to be considered in compliance.

(2) "Appraisal" means evaluation by a competent body.

(3) "Approval" means the granting of permission for a design, product, service or process to be used for a stated purpose under specific conditions based upon a satisfactory appraisal.

(4) "Assembly" means equipment or a system made up of components or parts.

(5) "Assess" means to determine the degree of conformity of a design, product, service, process, system or organization with identified specifications, rules, standards or other normative documents.

(6) "Certificate" means a formal document attesting to the compliance of a design, product, service or process with acceptance criteria.

(7) "Certification" means a procedure whereby a design, product, service or process is approved in accordance with acceptance criteria.

(8) "Competent body" means an organization recognized as having appropriate knowledge and expertise in a specific area.

(9) "Component" means a part, member of equipment or system.

(10) "Conformity" means that a design, product, process or service demonstrates compliance with its specific requirements.

(11) "Contract" means an agreement between two or more parties relating to the scope of service.

(12) "Customer" means a party who purchases or receives goods or services from another.

(13) "Design" means all relevant plans, documents, calculations described in the performance, installation and manufacturing of a product.

(14) "Design appraisal" means evaluation of all relevant plans, calculations and documents related to the design.
(15) "Equipment" means a part of a system assembled from components.
(16) "Equivalent" means an acceptable, no less effective alternative to specified criteria.
(17) "Evaluation" means systematic examination of the extent to which a design, product, service or process satisfies specific criteria.
(18) "Examination" means assessment by a competent person to determine compliance with requirements.
(19) "Inspection" means examination of a design, product service or process by a Surveyor.
(20) "Installation" means the assembling and final placement of components, equipment and subsystems to permit operation of the system.
(21) "Manufacturer" means a party responsible for the manufacturing and quality of the product.
(22) "Manufacturing process" means systematic series of actions directed towards manufacturing a product.
(23) "Material" means goods supplied by one manufacturer to another manufacturer that will require further forming or manufacturing before becoming a new product.
(24) "Modification" means a limited change that does not affect the current approval.
(25) "Product" means a result of the manufacturing process.
(26) "Quality assurance" means all the planned and systematic activities implemented within the quality system, and demonstrated as needed to provide adequate confidence that an entity will fulfil requirements for quality. Refer to *ISO* 9001:2015.
(27) "Regulation" means a rule or order issued by an executive authority or regulatory agency of a government and having the force of law.
(28) "Repair" means to restore to original or near original condition from the results of wear and tear or damages for a product or system in service.
(29) "Requirement" means specified characteristics used for evaluation purposes.
(30) "Information" means additional technical data or details supplementing the drawings requiring approval.
(31) "Specification" means technical data or particulars which are used to establish the suitability of materials, products, components or systems for their intended use.
(32) "Substantive modifications" mean design modifications, which lead to alterations in the stress levels, operational behaviour, fatigue life or an effect on other components or characteristics of importance such as emissions.
(33) "Sub-supplier/subcontractor" means one who contracts to supply material to another supplier.
(34) "Supplier" means one who contracts to furnish materials or design, products, service or components to a customer or user.
(35) "Test" means a technical operation that consists of the determination of one or more characteristics or performance of a given product, material, equipment, organism, physical phenomenon, process or service according to a specified procedure. A technical operation to determine if one or more characteristic(s) or performance of a product, process or service satisfies specific requirements.
(36) "Witness" means an individual physically present at a test and being able to record and give evidence about its outcome.

3 For electronically-controlled engines, the terminology is as specified in the following **(1)** to **(10)**:

(1) "Electronically-controlled engines" are engines whose fuel injection and/or Exhaust valve operation etc. are electronically controlled.
(2) "Accumulators" are small pressure vessels fitted to cylinders which provide hydraulic oil to those actuators attached to fuel injection devices or exhaust valve driving gears.
(3) "Common accumulators" are pressure vessels common to all cylinders for providing hydraulic oil or pressurized fuel oil.
(4) "Control valves" are components to control the delivery of hydraulic oil to drive actuators. The name control valve is generic for on-off-controlled solenoid valves, proportional-controlled valves or variable-controlled valves, etc.
(5) "Fuel oil pressure pumps" are pumps which provide pressurized fuel oil for common accumulators.
(6) "Hydraulic oil pressure pumps" are pumps to provide hydraulic oil for equipment, e.g. fuel injection devices, exhaust valve driving gears or control valves, through common accumulators.
(7) "Functional blocks" are blocks used to classify by function all items making up whole systems into the groups of systems, sub-systems, components, assemblies and parts.
(8) "Reliability block diagrams" are logical figures showing the relationship between functional blocks on an analytic level.
(9) "Normal operation" of main propulsion machinery means those operations at normal out-put conditions, using governors and

all safety devices.

(10) "High-pressure" piping means piping in the down-stream of fuel oil pressure pumps or hydraulic oil pressure pumps.

2.1.3 Drawings and Data*

1 Drawings and data to be submitted are generally as follows:

(1) Drawings and data for approval

Drawings and data specified in **Table 9.2.1(a)**

(2) Drawings and data for reference

Drawings and data specified in **Table 9.2.1(b)**

2 The drawings and data for the purpose of inspection and testing specified in **-1** (the items represented by the mark ○ in **Table 9.2.1(a)** and **Table 9.2.1(b)**, hereinafter indicated in the same way throughout this Chapter) are to be submitted in accordance with **2.1.4-1** by the engine manufacturer producing engines with the drawings and data whose approval of use has been obtained in accordance with **2.1.1-2** (hereinafter referred to as "licensee" in this Chapter). Such drawings and data, however, may be submitted by the licensor in accordance with **2.1.4-2**.

Table 9.2.1(a) Drawings and Data for Approval

	Items	For inspection and testing
(1)	Engine particulars (in the format designated by the Society)	○
(2)	Material specifications of main parts with information on non-destructive testing and pressure testing as applicable to the material	○
(3)	Bedplate and crankcase of welded design, with welding details and welding instructions(1)	○
(4)	Thrust bearing bedplate of welded design, with welding details and welding instructions(1)	○
(5)	Frame/framebox/gearbox of welded design, with welding details and instructions(1)	○
(6)	Crankshaft, assembly and details	○
(7)	Thrust shaft or intermediate shaft (if integral with engine)	○
(8)	Shaft coupling bolts	○
(9)	Connecting rod bearings (four-stroke design)	—
(10)	Bolts and studs for connecting rods (four-stroke design)	○
(11)	Schematic layout or other equivalent drawings and data on the reciprocating internal combustion engine of the following **(a)** to **(g)** (details of the system so far as supplied by the licensee such as: main dimensions, operating media and maximum working pressures). (a) Starting air system (b) Fuel oil system (c) Lubricating oil system (d) Cooling water system (e) Hydraulic system (f) Hydraulic system (for valve lift) (g) Engine control and safety system	○
(12)	High pressure oil pipes for driving exhaust valves with its shielding	—
(13)	Shielding of high pressure fuel pipes, assembly (all engines)	○
(14)	High pressure parts for fuel oil injection system The documentation to contain specifications for pressures, pipe dimensions and materials.	○
(15)	Arrangement and details of the crankcase explosion relief valve (only for engines of a cylinder diameter of 200 *mm* or more or a crankcase volume of 0.6 m^3 or more)	○
(16)	Oil mist detection and/or alternative alarm arrangements	○
(17)	Connecting rod with cap (four-stroke design)	○
(18)	Arrangement of foundation (for main engines only)	○

	Items	For inspection and testing
(19)	The drawings, data, etc. required by **2.1.4**.	○
(20)	The following drawings and data for exhaust driven turbochargers: (a) Category *A* turbochargers (upon request) i) Sectional assembly (including principal dimensions and names of components) ii) Containment test report iii) Test procedures (b) Category *B* turbochargers i) Sectional assembly (including principal dimensions and materials of housing components for containment evaluation.) ii) Documentation of containment in the event of the disc fracture iii) Documentation of following operational data and limitations ・Maximum permissible operating speed (*rpm*) ・Maximum permissible exhaust gas temperature at the turbine inlet ・Minimum lubrication oil inlet pressure ・Maximum permissible vibration levels (self- and externally generated vibrations) ・Alarm level for exhaust gas temperature at the turbine inlet (levels are also to be indicated on engine control system diagrams) ・Lubrication oil inlet pressure low alarm set point (levels are also to be indicated on engine control system diagrams) ・Lubrication oil outlet temperature high alarm set point (levels are also to be indicated on engine control system diagrams) iv) Diagram of lubrication oil systems (diagrams included in piping arrangements fitted to engines may be accepted instead) v) Test report of type test (only for type tests) vi) Test procedure (only for type tests) (c) Category *C* turbochargers i) Drawings listed in **(b)** above ii) Drawings of the housing and rotating parts (including details of blade fixing) iii) Material specifications (including mechanical properties and chemical composition) of the parts mentioned in **ii)** above iv) Welding details and welding procedures for the parts mentioned in **ii)** above, if made of welded construction	–
(21)	Other drawings and data deemed necessary by the Society	○

Note:

(1) For approval of materials and weld procedure specification, the weld procedure specification is to include details of pre- and post-weld heat treatments, weld consumables and fit-up conditions.

Table 9.2.1(b) Drawings and Data for Reference

	Items	For inspection and testing
(1)	A list containing all drawings and data submitted (including relevant drawing numbers and revision status)	○
(2)	Bolts and studs for main bearings	○
(3)	Connecting rod bearings (two-stroke design)	–
(4)	Bolts and studs for cylinder heads and exhaust valve (two-stroke design)	○
(5)	Bolts and studs for connecting rods (two-stroke design)	○
(6)	Tie rods	○
(7)	Piston pins	–
(8)	Construction of accumulators for hydraulic oil and fuel oil	○
(9)	Cylinder head fixing bolts and valve box fixing bolts	–
(10)	Rocker valve gears	–
(11)	Cylinder head	○
(12)	Cylinder block, engine block	○
(13)	Cylinder liner	○
(14)	Counterweights (if not integral with crankshaft), including fastening	○
(15)	Connecting rod with cap (two-stroke design)	○
(16)	Crosshead	○
(17)	Piston rod	○
(18)	Piston, assembly, including identification (e.g. drawing number) of components	○
(19)	Piston head	○
(20)	Camshaft drive, assembly, including identification (e.g. drawing number) of components	○
(21)	Flywheel	○
(22)	Fuel oil injection pump	○
(23)	Shielding and insulation of exhaust pipes and other parts of high temperature which may be impinged as a result of a fuel system failure, assembly	○
(24)	Construction and arrangement of dampers	○
(25)	Construction and arrangement of detuners, balancers or compensators, bracings as well as all calculation sheets related to engine balancing and engine vibration prevention	–
(26)	For electronically controlled engines, assembly drawings or arrangements of the following **(a)** to **(d)**: (a) Control valves (b) High-pressure pumps (c) Drive for high pressure pumps (d) Valve bodies, if applicable	○
(27)	Operation and service manuals(1)	○
(28)	Engine control system diagram (including the monitoring, safety and alarm systems)	–
(29)	Test program resulting from FMEA (for engine control system) in cases of engines that rely on hydraulic, pneumatic or electronic control of fuel injection and/or valves	○
(30)	Production specifications for castings and welding (sequence)	○
(31)	Certification of an approval of use for environmental tests, control components(2)	○
(32)	Quality requirements for engine production	○
(33)	Location of measures preventing oil from spraying out from joints in flammable oil piping (if fitted)	–
(34)	The following drawings and data for exhaust driven turbochargers (only for category *C* turbochargers): (a) Documentation of the safe torque transmission when the disc is connected to the shaft by an interference	–

	Items	For inspection and testing
	fit (b) Information on expected lifespan (creep, low cycle fatigue and high cycle fatigue are to be considered) (c) Operation and maintenance manuals	
(35)	Other drawings and data deemed necessary by the Society	○

Notes:

(1) Operation and service manuals are to contain maintenance requirements (servicing and repair) including details of any special tools and gauges that are to be used with their fitting/settings together with any test requirements on completion of maintenance.

(2) Drawings and data modified for a specific application are to be submitted to the Society for information or approval, as applicable

2.1.4 Approval of Reciprocating Internal Combustion Engines*

1 Reciprocating internal combustion engines are to be approved in accordance with the following **(1)** to **(6)**:

(1) Development of documents and data for engine production

(a) Prior to the start of the reciprocating internal combustion engine approval process in accordance with the following **(c)** and subsequent sub-paragraphs of this paragraph, a design approval is to be obtained as specified separately by the Society.

(b) Each type of reciprocating internal combustion engine is to be provided with a certificate of approval of use obtained by the licensor in accordance with **2.1.1-2**. For the first engine of a type or for those with no service records, the process of an approval of use and the approval process for production by the licensee may be performed simultaneously.

(c) The licensor is to review the drawings and data of the reciprocating internal combustion engine whose approval of use has been obtained for the application and develop, if necessary, application specific drawings and data for production of reciprocating internal combustion engines for the use of the licensee in developing the reciprocating internal combustion engine specific production drawings and data for the purpose of inspection and testing specified in **2.1.3-1**.

(d) If substantive modifications to the drawings and data of the reciprocating internal combustion engine whose approval of use has been obtained have been made in the drawings and data of reciprocating internal combustion engines to be produced, the affected drawings and data are to be resubmitted to the Society as specified separately by the Society.

(2) Drawings and data for the inspection and testing of reciprocating internal combustion engines

(a) The licensee is to develop the drawings and data for the inspection and testing specified in **2.1.3-1** and a comparison list of these drawings and data to the drawings and data of the reciprocating internal combustion engine whose approval of use has been obtained by the licensor and submit these drawings and the comparison list to the Society.

(b) As for the drawings and data for the inspection and testing specified in **2.1.3-1**, if there are differences in the technical content on the licensee's production drawings and data of the reciprocating internal combustion engine compared to the drawings and data of the reciprocating internal combustion engine whose approval of use has been obtained by the licensor, the licensee is to submit "Confirmation of the licensor's acceptance of licensee's modifications" approved by the licensor and signed by the licensee and licensor. If the licensor acceptance is not confirmed, the reciprocating internal combustion engine manufactured by the licensee is to be regarded as a different engine type and is **2.1.1-2** is to apply to the reciprocating internal combustion engine.

(c) In applying **(b)** above, modifications applied by the licensee are to be provided with appropriate quality requirements.

(d) The Society returns the drawings and data specified in **(a)** and **(b)** above to the licensee with confirmation that the design has been approved.

(e) The licensee or its subcontractors are to prepare to be able to provide the drawings and data specified in **(a)** and **(b)** above so that the Surveyor can use the information for inspection purposes during manufacture and testing of the reciprocating internal combustion engine and its components.

(3) Additional drawings and data

In addition to the drawings and data for inspection and testing specified in **2.1.3-1**, the licensee is to be able to provide to the Surveyor performing the test specified in **2.6.1, Part D of the Rules for the Survey and Construction of Steel Ships** upon request the relevant detail drawings, production quality control specifications and acceptance criteria. These drawings and data are for supplemental purposes to the survey only.

(4) Licensee approval

(a) The Society assesses conformity of production with the Society's requirements for production facilities comprising manufacturing facilities and processes, machining tools, quality assurance, testing facilities, etc. as specified separately by the Society.

(b) Satisfactory conformance with **(a)** above results in the issue of a document showing the licensee has been approved by the Society.

(5) Engine assembly and testing

The licensee is to assemble and test the reciprocating internal combustion engine according to the Society's technical rules each of the reciprocating internal combustion engine assembly and testing procedure is to be witnessed by the Surveyor unless the manufacturer of the reciprocating internal combustion engine is one approved in accordance with the **Rules for Approval of Manufacturers and Service Suppliers** and use of a mass production system is agreed between the manufacturer and the Society.

(6) Issue of certificates of reciprocating internal combustion engines and components

(a) The attending Surveyors, at the licensee/subcontractors, will issue product certificates as necessary for components manufactured upon satisfactory inspections and tests.

(b) An engine certificate is issued by the Surveyor upon satisfactory completion of assembly and tests specified in **(5)** above.

2 In applying **-1** above, for those cases when a licensor - licensee agreement does not apply, a "licensor" is to be understood as the following **(1)** or **(2)**:

(1) The entity that has the design rights for the reciprocating internal combustion engine type; or

(2) The entity that is delegated by the entity having the design rights of **(1)** above to modify the design.

3 Components of licensor's design which are covered by the certificate of approval of use of the relevant engine type are regarded as approved whether manufactured by the reciprocating internal combustion engine manufacturer or sub-supplied.

4 For components of subcontractor's design, necessary approvals are to be obtained by the relevant suppliers (e.g. exhaust gas turbochargers, charge air coolers, etc.).

2.1.5 Materials, Construction and Strength*

1 Materials intended for the principal components of reciprocating internal combustion engines and their non-destructive test are to conform to the requirements specified in **2.2.1, Part D of the Rules for the Survey and Construction of Steel Ships**.

2 Where the principal components of reciprocating internal combustion engines are of welded construction, they are to comply with the requirements specified in **Chapter 11, Part D of the Rules for the Survey and Construction of Steel Ships**.

3 Reciprocating internal combustion engines are to be designed to have construction and strength adequate for the service for which they are intended, the working conditions to which they are subjected and the environmental conditions on board. Crankshafts other than those for emergency generator engines are to comply with the requirements specified in **2.3, Part D of the Rules for the Survey and Construction of Steel Ships**.

4 Installation of reciprocating internal combustion engines in ships is to be in accordance with the following **(1)** to **(4)**.

(1) Engines are to be installed on steel seat plates of sufficient strength and rigidity laid across the bottom girders.

(2) Where engines having large unbalanced inertia forces or moments or having large exciting forces due to the piston side thrust are installed, the seat plates for installation are to be of sufficient length and are to be connected to each other on both sides or incorporated into one construction.

(3) Where the temperature of the seat plates of engines may rise high in normal operation to affect creep property of FRP girders in way of the seat plates, adequate insulation is to be provided between the seat plates and the girders.

(4) Where engines and their seat plates are installed onto FRP girders, consideration is to be given to avoid excessive deformation due to clamping forces of bolts and the weight of engines.

5 Crankpin bearings of 4 stroke-cycle engines are to be designed and constructed to keep a fair contact pressure upon the contact face of the bearing caps and not to cause an excessive stress on the crankpin bolts, against the alternating load to be acting on the connecting rod.

6 The ambient reference conditions for the purpose of determining the power of reciprocating internal combustion engines intended for main propulsion machinery, electric generators or auxiliary machinery are to be as follows:

Total barometric pressure: 0.1 *MPa*

Air temperature: 45°C

Relative humidity: 60%

Seawater temperature: 32°C (at charge air intercooler inlet)

7 Essential components are to be so arranged that normal operation of main propulsion machinery is capable of being sustained or restored even though one of these components becomes inoperable, except in cases where special consideration and approval is given by the Society to the reliability of single arrangements. Single components provided for cylinders, which do not require a spare, may be acceptable in cases where any failed parts can be isolated.

2.2 Safety Devices

2.2.1 Speed Governors and Overspeed Protective Devices

1 For crafts in which reciprocating internal combustion engines are used as main propulsion machinery (excluding electric propulsion crafts), each reciprocating internal combustion engine is to be provided with a speed governor so adjusted to prevent the engine speed from being exceeded by more than 15 % of the maximum continuous revolutions.

2 In addition to this speed governor, each reciprocating internal combustion engine as specified in **1** above that has a continuous maximum output of 220 *kW* or above, and which can be declutched or drives a controllable pitch propeller, is to be provided with a separate overspeed protective device. The overspeed protective device and its driving gear are to be independent from the governor required in **-1**, and so adjusted to automatically stop the engine when the speed exceeds more than 20 % of the maximum continuous revolutions.

3 Where reciprocating internal combustion engines are used as the main propulsion machinery of an electric propulsion craft, driving generators used to supply electrical power exclusively to propulsion motors, the engines are to be provided with governers specified in **5.1.2-2, Part H of the Rules for the Survey and Construction of Steel Ships**.

4 Reciprocating internal combustion engines used to drive generators other than those mentioned in **-3** are to be provided with the governors specified in **2.4.1-5, Part D of the Rules for the Survey and Construction of Steel Ships**.

5 In addition to the normal governor, each reciprocating internal combustion engine used as the main propulsion machinery of an electric propulsion craft and reciprocating internal combustion engines used to drive a generator(excluding that of emergency use) with a maximum continuous output of 220 *kW* or over are to be provided with a separate overspeed protective device. In this case, the overspeed protective device and its driving gear are to be independent from that of the governor required in **-3** and **-4**, and so adjusted to automatically stop the engine when the speed exceeds by more than 15 % of the maximum continuous revolutions.

2.2.2 Protection against Crankcase Explosion

Engines are to comply with the following requirements to protect from crankcase explosion:

(1) **2.2.2-4**, **-5** and **-6, Part D of the Rules for the Survey and Construction of Steel Ships**

(2) **2.4.3, Part D of the Rules for the Survey and Construction of Steel Ships**

2.2.3 Relief Valves for Cylinders

Each cylinder of a reciprocating internal combustion engines having a bore exceeding 230 *mm* is to be provided with a relief valve adjusted to be activated at not more than 40% above the maximum combustion pressure at the maximum continuous output, and so arranged that when discharged no damage to operators can occur. The relief valves may be replaced by effective warning devices for overpressure in each cylinder.

2.2.4 Emergency Stopping Device

At least two independent means of stopping the engines (excluding emergency generator engines) quickly from the control station under any operating conditions are to be provided. Not less than one of these means are to be operated by hand. Duplication of the actuator fitted to the engine may not be required.

2.3 Associated Installations

2.3.1 Exhaust Driven Turbochargers

Exhaust driven turbochargers are to comply with the requirements given in **2.5.1, Part D of the Rules for the Survey and Construction of Steel Ships**.

2.3.2 Starting Arrangements

1 The starting air mains are to be in accordance with **2.5.3-1, Part D of the Rules for the Survey and Construction of Steel Ships**.

2 Where main propulsion engines are arranged for starting by compressed air, starting air reservoirs are to be provided. These reservoirs are to be connected ready for use. In this case, the total capacity of the starting air reservoirs is to be sufficient to provide, without replenishment, not less than the number of consecutive starts as specified in **(1)** to **(3)** below. Where the arrangements of the main propulsion engines and shafting systems are other than shown below, the required number of starts is to be as deemed appropriate by the Society. When other consumers such as auxiliary machinery starting systems, control systems, whistles, etc. are to be connected to starting air reservoirs, their air consumption is also to be taken into account.

(1) For direct reversible engines

$Z=12C$

where:

Z: Total number of starts

C: Constant determined by the arrangement of main propulsion engines and shafting systems, where the following values are to be referred to as the standard;

$C = 1.0$ For single screw craft, where one engine is coupled with the shaft either directly or through reduction gear

$C = 1.5$ For twin screw craft, where two engines are coupled with the shafts either directly or through reduction gears, or for single screw craft, where two engines are coupled with the shaft through a declutchable coupling provided between engines and reduction gears

$C = 1.9$ For triple screw craft, where three engines are coupled with the shafts either directly or through reduction gears

$C = 2.0$ For single screw craft, where one engine is coupled with the shaft without declutchable coupling between engine and reduction gear

$C = 2.3$ For quadruple screw craft, where four engines are coupled with the shafts either directly or through reduction gears. For twin screw craft, where four engines are coupled with the shafts through declutchable coupling provided between engines and reduction gears

$C = 3.0$ For twin screw craft, where four engines are coupled with the shafts without declutchable coupling between engines and reduction gears

(2) For non-reversible type engines using a separate reversing gear, controllable pitch propellers or waterjet propulsion systems, 1/2 of the total number of starts specified in **(1)** above may be accepted.

(3) For electric propulsion craft:

$Z=6+3(k-1)$

where:

Z: Total number of starts

k: Number of engines and it is not necessary for the value of k to exceed 3.

3 The capacities of the reservoirs specified in **-2** above are to be about the same.

4 Starting air reservoirs and starting air systems are also to comply with **8.12**.

5 Internal combustion engines which are arranged for electrical starting are to comply with the following **(1)** to **(3)**:

(1) Two separate batteries are to be fitted to starting arrangements for main propulsion machinery. Arrangements are to be such that the batteries cannot be connected in parallel, and each battery is to be capable of starting the main propulsion machinery under the cold and ready-to-start condition. The combined capacity of the batteries is to be sufficient (without recharging) to provide the number of consecutive starts specified in **-2** above within 30 *minutes*.

(2) Electric starting arrangements for internal combustion engines driving generators and auxiliary machinery are to have two separate batteries but may be supplied by separate circuits from the batteries for main propulsion machinery. In the case of single auxiliary engines, only one battery needs to be fitted. The capacity of each set of batteries is to be sufficient for at least three starts for each engine.

(3) Starting batteries are to be used for starting and engine self-monitoring purposes only. Provisions are to be made to continuously maintain stored energy at all times.

2.3.3 Fuel Oil Arrangements

The high pressure fuel oil injection pipes are to be effectively shielded and secured to prevent the fuel or fuel mist from reaching a source of ignition on the engine or its surroundings. Visible and audible alarming device which are to be activated when leaked fuel oil within the sheath is detected. And fuel oil leakage within the sheath is to be drained through drainage system of engine. Where flexible hoses are used for shielding purposes, they are to be of an approved type.

2.3.4 Lubricating Oil Arrangements

1 The lubricating oil arrangements of reciprocating internal combustion engines (excluding emergency generator engines) with maximum continuous output exceeding 37 *kW* are to be provided with alarm devices which give visible and audible alarms in the event of failure of lubricating oil supply or appreciable reduction in lubricating oil pressure, and also with devices to stop the engine automatically by low pressure after the function of alarms.

2 The lubricating oil arrangements are to be provided with lubricating oil sampling connections at proper locations.

3 The lubricating oil arrangements for rotor shafts of exhaust gas turbo blowers are to be designed so that the lubricating oil may not be drawn into charging air.

4 Lubricating oil drain pipes from the engine crankcase sump to the sump tank are to be submerged at their outlet ends. These drain pipes of two or more engine units are not to be inter-connected.

2.3.5 Cooling Arrangements

1 Cooling arrangements of reciprocating internal combustion engines (excluding emergency generator engines) with maximum continuous output exceeding 37 *kW* are to be provided with alarm devices which give visible and audible alarms when water temperature becomes abnormally high.

2 Drain cocks are to be fitted to water jackets and water pipe lines at their lowermost position.

2.3.6 Control Valves for Electronically-controlled Engines which are used as the Main Propulsion Machinery

1 Control valves are to be capable of retaining their expected ability to function properly for a period of time set by manufacturers.

2 Control valves are to be independently provided for each function (e.g. fuel injection, exhaust valve driving).

3 Means are to be provided to prevent fuel oil from continuously flowing into cylinders due to control valve failure.

2.3.7 Accumulators and Common Accumulators for Electronically-controlled Engines which are used as the Main Propulsion Machinery

1 Accumulators and common accumulators are to comply with the requirements in **Chapter 10, Part D of the Rules for the Survey and Construction of Steel Ships**. However, notwithstanding this requirement, material and non-destructive tests as well as surface inspections and dimension inspections are to be in accordance with **Table D2.2, Part D of the Rules for the Survey and Construction of Steel Ships** and hydrostatic tests are to be in accordance with **Table D2.6, Part D of the Rules for the Survey and Construction of Steel Ships**.

2 Accumulators are to be capable of retaining their expected ability to function properly for a period of time set by manufacturers.

3 In principle, at least two common accumulators are to be provided. However, in cases where results of fatigue analysis upon fluctuating stress are submitted and approved by the Society, a single arrangement may be acceptable.

2.3.8 Fuel Oil Piping Systems and Hydraulic Oil Piping Systems for Electronically-controlled Engines which are used as the Main Propulsion Machinery

1 At least two fuel oil pressure pumps and hydraulic oil pressure pumps are to be provided for their respective lines and are to be capable of supplying a sufficient amount of oil at the maximum continuous output of main propulsion machinery. In such cases, even though a single one of these pumps may become inoperable, the remaining pumps are to be capable of supplying a sufficient amount of fuel under normal service conditions. In cases where one or more of these pumps are provided as a stand-by pump, the pumps are to always be connected and ready for use.

2 Piping arrangements from fuel oil pressure pumps to the fuel injection devices and from hydraulic oil pressure pumps to exhaust valve driving gears are to be protected with jacketed piping systems or oil tight enclosures, to prevent any spread of oil from igniting.

3 Two common piping arrangements from fuel oil pressure pumps or a hydraulic oil pressure pumps to common accumulators, from one common accumulator to another common accumulator and from common accumulators to those positions where distribution to cylinders are to be respectively provided. In cases where results of fatigue analysis upon fluctuating stress are submitted and approved by the Society, a single arrangement may be acceptable.

4 Valves or cocks provided on piping connected to equipment, e.g. accumulators or pumps, are to be located as close to such

equipment as practicable.

5 In high-pressure piping, high-pressure alarms are to be provided. Relief valves are also to be provided at proper positions, so as to lead any released oil to lower-pressure sides.

6 In cases where pressure gauges using bourdon-tubes are provided in high-pressure piping, such gauges are to be ones that comply with recognized industrial standards, e.g. *JIS*, and be vibration-proof and heat-resistant types.

2.3.9 Electronic Control Systems for Electronically-controlled Engines which are used as the Main Propulsion Machinery

1 Systems are to be so arranged that the function of an entire system is capable of being sustained or restored in cases where there is a single failure in any equipment part or circuit.

2 Controllers for systems are to comply with the following:

(1) At least two main controllers which are integrated to control every function, e.g. fuel injection, exhaust valve drive, cylinder lubrication and supercharge, are to be provided.

(2) Notwithstanding the requirement in **(1)** above, a single main controller may be acceptable, in cases where normal operation of main propulsion machinery is available by using control systems independent from main controllers.

3 At least two sensors essential for the operation of main propulsion machinery, e.g. for the following uses, are to be independently provided. In cases where normal operation of main propulsion machinery is available without any feedback from such sensors, single arrangements may be acceptable.

(1) Number of revolutions

(2) Crank angles

(3) Fuel pressure in common accumulators

4 Power for control systems is to be supplied from two independent sources, one of which is to be supplied from a battery, and through two independent circuits.

5 Power for driving solenoid valves is to be supplied from two independent sources, and through two independent circuits.

6 Electronic-control systems of main propulsion machinery which comply with the requirements given in **-1** through **-5** above are regarded as the same as those which comply with the following requirements.

(1) **18.2.4-5(1), Part D of the Rules for the Survey and Construction of Steel Ships**.

(2) **18.3.2-3(3), Part D of the Rules for the Survey and Construction of Steel Ships**.

2.3.10 Failure Mode Effect Analysis for Electronically-controlled Engines which are used as the Main Propulsion Machinery

Failure Mode Effect Analysis (FMEA) is to be carried out, for electronic control systems, in order to confirm that any one equipment or circuits in such systems which lose function may not cause any malfunction or deterioration in other equipment or circuits, in accordance with the following:

(1) Systems are to be divided into functional blocks and drawn out in reliability block diagrams in which such functional blocks are systematically organized.

(2) Analytic levels are to be sufficient up to the extent of those functional blocks regarding sub-systems and components.

(3) FMEA results are to be created in table form as shown in **Table 9.2.1** or be of equivalent forms thereto.

(4) If FMEA results show that corrective action is demanded, then FMEA is to be carried out again after the corrective action to confirm the effectiveness of the corrective action.

(5) For failure modes, every possible failure from minor to catastrophic is to be considered.

Table 9.2.1 Failure Mode Effect Analysis Table for Electronically-controlled Engines which are used as the Main Propulsion Machinery

Systems				Elements									
ID Number	Component	Sub-system	Operating mode	Failure mode	Failure cause	Failure detection Means	Alarm / Notification Means	Effect of failure			Failure severity	Corrective action	Remarks
								On component	On sub-system	On system			

Examples of Operating Mode: back-up operations, fuel cost priority operations, NOx reduction operations, etc.

Examples of Failure Mode: piston pin stuck, connecting rod broken, lubricating oil leaked out, etc. (Failed parts are to be shown.)

Failure Severity:

(a) Catastrophic: loss of complete function, explosion, loss of life (Design change is to be compulsory.)

(b) Major: loss or deterioration of part of the ability to function properly (Possible design change is to be investigated.)

(c) Minor: negligible affect on ability to function properly (Design change may not be required.)

Chapter 3 GAS TURBINES

3.1 General

3.1.1 Scope

The requirements in this Chapter apply to open cycle gas turbines (i.e., thermodynamic cycle in which the working fluid enters the gas turbine from the atmosphere and is discharged into the atmosphere) used as main propulsion machinery, or used to drive generators and auxiliaries (hereinafter referred to in this Chapter as all auxiliaries excluding auxiliary machinery for specific use, etc.).

3.1.2 Terminology

The terminology used in this Chapter is as specified in the following **(1)** to **(5)**:

(1) "Gas generator" is an assembly of gas turbine components that produces heated pressurized gas to a process or to a power turbine.

(2) "Power turbine" is a turbine which is driven by the gases from a gas generator, producing power output from the gas turbine through an independent shaft.

(3) "Combustion chamber" is a component of a gas turbine in which fuel (heat source) reacts with the working fluid to increase its temperature.

(4) "Enclosure" is barriers, used to protect personnel, protect equipment from the environment, contain fires and possibly provide sound attenuation.

(5) "Principal components" of gas turbines are those listed in the following **(a)** to **(h)**:

(a) Discs (or rotors), stationary blades and moving blades of the turbine

(b) Discs, stationary blades and moving blades of the compressor

(c) Turbine and compressor casings

(d) Combustion chambers

(e) Turbine output shafts

(f) Connecting bolts for main turbine components

(g) Shaft couplings and bolts

(h) Pipes, valves and fittings attached to a gas turbine classified in **Chapter 12, Part D of the Rules for the Survey and Construction of Steel Ships** as either Group I or II

3.1.3 Drawings and Data*

Drawings and data to be submitted are generally as follows:

(1) Drawings and data for approval

(a) Discs (and/or rotors) of the turbine and compressor

(b) Combustion chambers

(c) Details of the fixing of moving and stationary blades

(d) Shaft couplings and bolts

(e) Piping arrangements fitted to the turbine (including fuel, lubricating oil, cooling water, pneumatic and hydraulic systems, and information on materials, sizes and working pressures of pipes)

(f) Pressure vessels and heat exchangers (classified as Group I and Group II as defined in **10.1.3, Part D of the Rules for the Survey and Construction of Steel Ships**) attached to the turbine

(g) Details of turbine installation

(h) Particulars (type and product number of the turbine, power and number of revolutions per minute of the turbine and compressors at maximum continuous rating, temperatures and pressure at turbine inlet and outlet, pressure losses in inlet air and exhaust gas arrangements, ambient condition intended for operation, fuel oil and lubricating oil to be used)

(i) Material specifications of principal components

(j) Critical speeds of turbine rotors and compressors

(k) Number of moving blades in each stage

(l) Number and arrangements of stationary blades

(m) Lists of safety devices, including those specified in 3.3.5.

(n) In the case of a gas turbine without service records for Society-classed ships or the modification of specifications of a gas turbine with such service records, the following **i)** and **ii)**:

i) Welding details of principal components

ii) Maintenance instructions

(2) Drawings and data for reference

(a) A list containing all drawings and data submitted (with relevant drawing numbers and revision status)

(b) Sectional assembly

(c) Moving blades and stationary blades

(d) General arrangement

(e) Starting arrangement

(f) Inlet air and exhaust gas arrangements

(g) Diagram of engine control systems

(h) Documents containing strength considerations made for principal components

(i) Calculation sheets for vibration of turbine blades

(j) Documentation on the failure mode and effect analysis

(k) In the case of a gas turbine without service records for Society-classed ships or modification specifications of a gas turbine with such service records, the following **i)** and **ii)**:

i) Operation instructions for fuel oil control systems

ii) Illustrative drawing of cooling method for each part of turbine

(l) Other drawings and data deemed necessary by the Society

3.2 Materials, Construction and Strength

3.2.1 Materials

1 Materials intended for the principal components of gas turbines (excluding those driving emergency generators) and their non-destructive tests are to be in accordance with the requirements specified in 4.2.1-1 and 4.2.1-2, Part D of the Rules for the Survey and Construction of Steel Ships.

2 Materials used for high temperature parts are to have properties suitable against corrosion, thermal stress, creep and relaxation in order to maintain intended performance and achieve the intended service life. In cases where the base material is coated, for example, with corrosion-resistant surfacing, the coating material is to have properties such that it is hard to detach from the base material the strength of the base material is not impaired.

3.2.2 Construction and Installations

1 Gas turbines are to be so designed that no excessive vibration and surging, etc. are induced within the operating speed range.

2 Each part of gas turbines is to be so constructed that no detrimental deformations are caused by its thermal expansions.

3 Where the principal components of gas turbines are of welded construction, they are to comply with the requirements in Chapter 11, Part D of the Rules for the Survey and Construction of Steel Ships.

4 Gas turbines used as main propulsion machinery are to be so designed that they can restart immediately when the electrical power supply is resumed after any stoppage resulting from a temporary failure of the main source of electrical power.

5 Gas turbines are to be installed so that the hull construction is not thermally affected and no excessive structural constraints are caused by thermal expansion.

6 Gas turbines are to be installed so that any turbine or compressor blade loss or any failure of other principal components does not endanger persons and machinery in the vicinity of the gas turbine. In addition, gas turbines are to be constructed to contain, as far as possible, turbine or compressor blades and any blade debris in the event of blade loss.

3.3 Safety Devices

3.3.1 Governors and Overspeed Protective Devices

1 Gas turbines (excluding those driving emergency generators) are to be provided with an overspeed protective device. This device is to be so adjusted that the output shaft speed may not exceed the maximum continuous speed by more than 15 % and is to have the functions specified in **3.2.2-2**.

2 Gas turbines are to be provided with a speed governor independent of the overspeed protective device specified in **-1** above. The speed governor is to be capable of controlling the speed of the unloaded gas turbine without bringing the overspeed protective device into action.

3 The governors of gas turbines used to drive generators are to comply with the requirements in **4.3.1-4, Part D of the Rules for the Survey and Construction of Steel Ships**. However, when gas turbines used as main propulsion machinery in electric propulsion ships are used to drive generators to supply electric power exclusively to propulsion motors, the requirements in **5.1.2-2, Part H of the Rules for the Survey and Construction of Steel Ships** are to be applied.

3.3.2 Shut-down Devices

1 Gas turbines (excluding those driving emergency generators) are to be provided with at least two independent means of quickly stopping the gas turbine under any operating conditions by shutting off the fuel which are to be provided at the control station. At least one of these means is to be hand trip gear for shutting off the fuel in an emergency. A common actuator may be used for these means.

2 Unless the FMEA proves that the adverse effects due to failures occurring are within acceptable ranges, the shut-down functions for gas turbines are to be provided in accordance with **Table 9.3.1**.

3 Gas turbines (excluding those driving emergency generators) are to be provided with a quick closing device (shut-down device) which automatically shuts off the fuel supply to the turbines at least in the cases of the following **(1)** to **(7)**. In addition, means are to be provided so that alarms are operated at the control station by the activation of these shut-down devices.

(1) Over speed

(2) Unacceptable lubricating oil pressure drop (for gas turbines other than the main gas turbines, only in the case where forced lubrication is adopted.)

(3) Failure of the lubricating oil system

(4) Failure in automatic starting

(5) Loss of flame during operation

(6) Excessive vibrations

(7) Excessive high temperature of gas at the turbine inlet or outlet

4 In addition to the requirements specified in **-3** above, gas turbines used as main propulsion machinery are to be provided with a quick closing device (shut-down device) which automatically shuts off the fuel supply to the turbines in at least the following **(1)** to **(3)** cases. In addition, means are to be provided so that alarms are operated at the control station by the activation of these shut-down devices.

(1) Excessive axial displacement of each rotor (except for gas turbines with roller bearings)

(2) Unacceptable lubricating oil pressure drop of reduction gear

(3) Excessive high vacuum pressure at the compressor inlet

3.3.3 Alarms

Gas turbines (excluding those driving emergency generators) are to be provided with alarm devices as required by **Table 9.3.1**. The addition or omission of alarm devices, however, may be accepted taking into account the results of failure mode and effects analysis (FMEA).

3.3.4 Fire Detection and Extinction Systems in Enclosures

Where gas generators and the high pressure oil pipes of gas turbines are surrounded by an enclosure, the enclosure is to be provided with fire detection systems and a fire extinguishing system which complies with the requirements of **Part 11**.

3.3.5 Additional Safety Devices

Gas turbines may be required to be provided with additional safety devices as required in order to safeguard against hazardous conditions arising in the event of malfunctions in the gas turbine installation. Such hazardous conditions are to be verified by the manufacturer in accordance with the failure mode and effects analysis (FMEA).

Table 9.3.1 Emergency Shutdown and Alarm Settings(1)

Monitoring parameter	Alarm	Emergency Shutdown	
		Gas turbines used as main propulsion machinery	Gas turbines other than those used as main propulsion machinery
Turbine speed	H	X	X
Lubricating oil pressure	L(2)	X	X(3)
Failure of the lubricating oil system	○(4)	X	X
Lubricating oil pressure of reduction gear	L(2)	X	
Differential pressure across lubricating oil filter	H		
Lubricating oil temperature	H		
Oil fuel supply pressure	L		
Oil fuel temperature	H		
Cooling medium temperature	H		
Bearing temperature	H		
Flame and ignition failure	○	X	X
Automatic starting failure	○	X	X
Vibration	H(2)	X	X
Axial displacement of rotor	H	X	
Exhaust gas temperature at the turbine inlet	H(2)	X	X
Exhaust gas temperature at the turbine outlet	H(2)	X	X
Vacuum pressure at the compressor inlet	H(2)	X	
Loss of control system	○		

Notes:

(1) "H" and "L" mean "high" and "low". "○" means abnormal condition occurred.

(2) Alarms are to be activated at the suitable setting points prior to arriving the critical condition for the activation of shut-down devices in the case where such shutdown is required.

(3) Only in the case where forced lubrication is adopted.

(4) Alarms are to be audible and visual.

3.4 Associated Installations

3.4.1 Air Inlet Systems

Air inlet systems are to be so constructed and arranged that any intrusion of harmful particles and water into compressors can be minimized. In addition, means are to be provided to minimize the detrimental effects caused by any salt deposits in the suction air, and if necessary, by any icing of the air intake.

3.4.2 Starting Arrangements*

1 Starting devices are to be so arranged that the firing operation is discontinued and the main fuel valve is closed within a pre-determined time in cases where ignition fails. In addition, gas turbines are to be provided with automatic or interlocked means for the following **(1)** or **(2)** before ignition commences (on starting) or recommences so as to prevent abnormal combustion or ignition trouble.

(1) Clearing all parts of the main gas turbine of the accumulation of liquid fuel; or

(2) Purging gaseous fuel

2 Where compressed air is used for starting, the starting arrangement is to comply with **8.12**, in addition to the following **(1)** to **(5)**:

(1) In order to protect starting air mains against the effects of backfiring and internal explosion in the starting air pipes (including explosion arising from improper functioning of starting valves), means are to be provided in accordance with the following **(a)** to **(e)**:

(a) An isolation non-return valve or equivalent is to be fitted at the starting air supply connection to each gas turbine.

(b) A rupture disc or flame arrester is to be fitted in way of the supply inlet to the starting air manifold.

(c) In cases where an flame arrester is provided in accordance with **(b)** above, a rupture disc is to be fitted at an appropriate position on the starting air manifold as an emergency means for pressure relief.

(d) For rupture discs which cannot be readily replaced, a mechanism of blocking up the exhaust way is to be provided for the purpose of quick restart of the gas turbine. This blocking mechanism is to be fitted with a means of indicating whether it is blocking or not.

(e) An effective arrangement to prevent the accumulation of oils in the starting air manifold or to prevent the excessive temperature rise in the starting air manifold is to be provided.

(2) The arrangement for the air starting of main propulsion machinery is to be provided with at least two starting air reservoirs which may be used independently. The total capacity of the air reservoirs is to be sufficient to provide, without their being replenished, the number of consecutive starts of main propulsion machinery not less than the following **(a)** and **(b)**. Where the arrangements of the main propulsion machinery and shafting systems are other than those shown below, the required number of starts is to be as deemed appropriate by the Society. When other consumers such as auxiliary machinery starting systems, control systems, whistles, etc. are to be connected to the starting air reservoirs, their air consumption is also to be taken into account.

(a) Ships other than electric propulsion ships

$Z = 6C$

where

Z: Total number of starts of gas turbines

C: Constant determined by the arrangement of gas turbines and shafting systems, where the following values are to be referred to as the standard

$C = 1.0$: Single screw ships, where one gas turbine is either coupled with the shaft directly or through reduction gears.

$C = 1.5$: Twin screw ships, where two gas turbines are either coupled with the shafts directly or through reduction gear, and for single screw ships, where two gas turbines are coupled with the shaft through declutchable coupling provided between gas turbines and reduction gear.

$C = 2.0$: Single screw ships, where two gas turbines are coupled with one shaft without any declutchable coupling between gas turbines and reduction gear.

(b) Electric propulsion ships

$Z = 6 + 3\ (k\text{-}1)$

where

Z: Total number of starts of gas turbines

k: Number of engines (In the case of more than three gas turbines, the value of k to be used need not exceed three.)

(3) The capacities of the reservoirs specified in **(2)** above are to be about the same.

3 Gas turbines which are arranged for electrical starting are to comply with the following **(1)** to **(3)**:

(1) Two separate batteries are to be fitted to the starting arrangement for main propulsion machinery. The arrangement is to be such that the batteries cannot be connected in parallel, and each battery is to be capable of starting the main propulsion machinery under cold and ready-to-start conditions. The combined capacity of the batteries is to be sufficient (without recharging) to provide the number of consecutive starts specified in **-2** above within 30 *minutes*.

(2) Electric starting arrangements for gas turbines driving generators and auxiliary machinery are to have two separate batteries,

but may be supplied by separate circuits from the batteries for main propulsion machinery. In the case of a single gas turbine, only one battery need be fitted. The capacity of each set of batteries is to be sufficient for at least three starts for each gas turbine.

(3) The starting batteries are to be used for starting and the gas turbine's own monitoring purposes only. Provisions are to be made to continuously maintain the stored energy at all times.

4 Gas turbines which are arranged for hydraulic starting are to comply with the following **(1)** and **(2)**:

(1) Starting arrangements for main propulsion machinery are to be provided with two sets of hydraulic systems.

(2) The capacity of the hydraulic power pack is to be sufficient (without recharging) to provide the number of consecutive starts specified in **-2** above within 30 *minutes*.

3.4.3 Ignition Arrangements

1 Each ignition arrangement is to consist of two or more systems independent of each other.

2 Cables of an electric ignition device are to be arranged so that satisfactory electrical insulation is ensured and the cables are not likely to be damaged and do not to come in contact with fuel oil and other flammable oils including their pipes and tanks.

3 Ignition distributors are to be of an explosion-proof construction or are to be provided with proper shielding. No coils for any ignition device are to be situated in areas where explosive gases may accumulate.

3.4.4 Fuel Oil Arrangements

1 Sufficient consideration is to be given to the prevention of any clogging of fuel manifolds and fuel nozzles due to solids contained in the fuel and to the prevention of any corrosion of turbine blades and other parts due to corrosive substances such as salts.

2 The fuel control system is to comply with the following requirements.

(1) The fuel control system is to be capable of adjusting the fuel supply to the burners so as to maintain the exhaust gas temperature within the pre-determined range throughout the normal operation.

(2) The fuel control system is to be capable of ensuring stable combustion throughout the operation range where the fuel supply is adjustable.

(3) The fuel control system is to be capable of maintaining the minimum speed of the turbines without stopping the gas generator in the case of sudden load fluctuations.

(4) In dual-fuel applications, provision is to be made for automatic isolation of both primary and standby fuel supplies in the event of a fire.

3.4.5 Lubricating Oil Arrangements

1 Gas turbines used as main propulsion machinery are to be provided with an effective emergency supply of lubricating oil which comes into service automatically and has sufficient amount to ensure adequate lubrication until the turbine is brought to rest after a shutdown of the fuel oil supply in the event of a failure of the lubricating oil supplying system. For this purpose, a gravity tank or from an auxiliary lubricating oil pump driven by the turbine may be used.

2 An oil sampling valve is to be provided at a proper location.

3.4.6 Automatic Temperature Controls

The gas turbine services specified in the following **(1)** to **(3)** are to be fitted with automatic temperature controls so as to maintain steady state conditions throughout the normal operating range of the main gas turbine.

(1) Lubricating oil supply

(2) Oil fuel supply (or automatic control of oil fuel viscosity as alternative)

(3) Exhaust gas

3.4.7 Cooling Arrangements

Gas turbines are to be provided with cooling arrangements as required, and arrangements are to be provided so that the design temperature is not exceeded.

Chapter 4 POWER TRANSMISSION SYSTEMS

4.1 General

4.1.1 Scope

The requirements of this Chapter apply to power transmission systems which transmit power from main propulsion machinery and prime movers driving generators and auxiliaries (excluding auxiliary machinery for specific use etc., hereinafter the same in this Chapter).

4.1.2 Drawings and Data

Drawings and data to be submitted are generally as follows:

(1) Drawings and data for approval

(a) Transmitted power and number of revolutions per minute of each pinion at the maximum continuous output

(b) Particulars of each gear (number of teeth, module, pitch circle diameters, pressure angles, helix angles, face widths, center distances, tool tip radius, backlash, addendum modification, amount of profile and tooth trace modification, finishing method of tooth flank, expected finishing accuracy of gear)

(c) Welding methods of principal components (including tests and inspection)

(d) Gears

(e) Gear shafts

(f) Couplings

(g) Construction of main parts such as clutches and flexible shafts

(h) Specifications for materials used in power transmission parts (chemical compositions, heat treatment methods, mechanical properties and their test methods)

(2) Drawings and data for reference

(a) Sectional assembly

(b) Necessary data for strength calculation of principal components of the power transmission systems.

(c) Other data deemed necessary by the Society

4.1.3 Materials, Construction and Strength

1 Materials intended for the principal components of power transmission system and their non-destructive tests are to conform to the requirements specified in **5.2.1-1** and **5.2.1-2, Part D of the Rules for the Survey and Construction of Steel Ships**.

2 Power transmission systems are to have the design and construction adequate for the purposes and working conditions, and are to have sufficient strength against the torque to be transmitted and against the astern pull.

3 Where the principal components of power transmission system are of welded construction, they are to comply with the requirements in **Chapter 11, Part D of the Rules for the Survey and Construction of Steel Ships**.

4.1.4 General Construction of Gearings

1 Where a gear rim is shrunk on the boss, the rim is to be so thick as to ensure sufficient strength and is to have enough shrinkage allowance against transmitted power. Where shrinkage fit is made after tooth cutting, the construction is to be such as to fully guarantee the accuracy of gearing, or final tooth finishing is to be carried out after the shrinkage fit.

2 Where gears are of welded construction, they are to have sufficient regidity and are to be stress-relieved before tooth cutting.

3 Gears are not to have harmful unbalanced weight.

4 The strength of gearing system is to comply with the requirements in **5.3** and **5.4, Part D of the Rules for the Survey and Construction of Steel Ships**.

5 Gear casings are to have sufficient regidity, and their construction is to be such that all possible facilities are provided for inspection and maintenance.

6 In the case where heavy articles are intended to be fitted on extended part of the pinion shaft, the construction of pinions is to be such that the whirling moves of pinions and deviation of shaft centre may be minimized.

4.1.5 General Construction of Power Transmission Systems other than Gearings (e.g. highly elastic flexible couplings, clutches, etc.)

1 The power transmission systems other than the gearings are to be of those approved by the Society in their constructions and materials, functioning safely and reliably and having sufficient strength against transmitted power.

2 The construction of electro-magnetic slip couplings is to conform to the requirements in **2.4, Part H, of the Rules for the Survey and Construction of Steel Ships** as well as to the discretion of the Society.

3 Where the clutch of power transmission systems for main propulsion is operated with a hydraulic or pneumatic system, a stand-by pump or compressor connected ready for use or any other appropriate unit is to be provided, thereby to ensure that a ship can keep the navigable speed.

4.1.6 Lubricating Oil Arrangements

1 Gearing systems are to be provided with strainers, if practicable, with magnets in the lublicating arrangement.

2 The lubricating oil arrangements of power transmission systems with the driving units above 37 *kW* are to be provided with alarm devices which give visible and audible alarms in the event of failure of supply of lubricating oil appreciable reduction of lubricating oil pressure.

Chapter 5 SHAFTINGS, PROPELLERS, WATERJET PROPULSION SYSTEMS AND TORSIONAL VIBRATION OF SHAFTINGS

5.1 Shaftings

5.1.1 Scope

The requirements of this Chapter apply to propulsion shafting (excluding any part of waterjet propulsion system and propeller) and power transmission system which transmit power from prime mover driving generators and auxiliaries (excluding auxiliary machinery for specific use etc., hereinafter the same in this section). The torsional vibration of shaftings are to comply with the requirements specified in **5.4**.

5.1.2 Drawings and Data

Drawings and data to be submitted are generally as follows:

(1) Drawings for approval (including specifications of material)
- (a) Shafting arrangement
- (b) Thrust shaft
- (c) Intermediate shaft
- (d) Stern tube shaft
- (e) Propeller shaft
- (f) Stern tube
- (g) Stern tube bearing; this drawing may be included in the drawings and data specified in **6.1.2(1)(l), Part D of the Rules for the Survey and Construction of Steel Ships** in the case of propeller shafts Kind 1*C*.
- (h) Stern tube sealing device; this drawing may be included in the drawings and data specified in **6.1.2(1)(l), Part D of the Rules for the Survey and Construction of Steel Ships** in the case of propeller shafts Kind 1*C*.
- (i) Shaft bracket bearing
- (j) Shaft couplings and coupling bolts
- (k) Shafts which transmit power to generators or auxiliaries
- (l) In the case of propeller shafts Kind 1*C*, the drawings and data specified in **6.1.2(1)(l), Part D of the Rules for the Survey and Construction of Steel Ships**

(2) Data for reference
- (a) Data necessary for the calculations of shafting strength specified in this section
- (b) Data deemed necessary by the Society

5.1.3 Materials, Construction and Strength

1 Materials intended for the principal components of shafting and their non-destructive test are to conform to the requirements specified in **6.2.1-1**, **6.2.1-2** and **6.2.1-3, Part D of the Rules for the Survey and Construction of Steel Ships**.

2 The dimensions of shafts and coupling bolts are to comply with the requirements specified in **6.2.2**, **6.2.3**, **6.2.4**, **6.2.5**, **6.2.6** and **6.2.12, Part D of the Rules for the Survey and Construction of Steel Ships**.

5.1.4 Corrosion Protection of Propeller Shafts and Stern Tube Shafts

Corrosion protection of propeller shafts and stern tube shafts are to comply with requirements in **6.2.7, Part D of the Rules for the Survey and Construction of Steel Ships**.

5.1.5 Propeller Shaft Sleeves and Stern Tube Shaft Sleeves

1 The sleeves to be fitted to propeller shafts or a stern tube shafts are to comply with the requirements in **6.2.8(1), Part D of the Rules for the Survey and Construction of Steel Ships**.

2 Sleeves are to be of bronze or equivalent thereto and to be free from porosity and other defects.

3 Sleeves are to be fitted to the shafts by a method free from stress concentration such as shrinkage fit, etc.

5.1.6 Fixing of Propellers to Shafts

1 Where propellers are force fitted on the propeller shafts, the fixing part is to be of sufficient strength against torque to be

transmitted.

2 Where a key is provided to fix part, ample fillets are to be provided at the corners of keyway. The key is to have a true fit in the keyway. The fore end of keyway on the propeller shaft is to be rounded smoothly for avoiding any excessive stress concentration.

3 Where propellers are fitted to propeller shaft flanges with bolts, the following **(1)** and **(2)** are to comply with.

(1) The bolts and pins are to be of sufficient strength.

(2) The thickness of the aft propeller shaft flange at the pitch circle is to comply with **6.2.9-4, Part D of the Rules for the Survey and Construction of Steel Ships**.

5.1.7 Stern Tube Bearings and Shaft Bracket Bearings

The aftermost stern tube bearing or shaft bracket bearing which supports the weight of propeller is to comply with **6.2.10-1, Part D of the Rules for the Survey and Construction of Steel Ships**.

5.1.8 Stern Tube Sealing Devices

Stern tube sealing devices other than gland packing type water sealing devices are to be of the type approved by the Society in their materials, construction and arrangement.

5.1.9 Propeller Shaft Kind 1*C*

The propeller shaft Kind 1*C* is to comply with the requirements specified in **6.2.11, Part D of the Rules for the Survey and Construction of Steel Ships**.

5.2 Propeller

5.2.1 Scope

The requirements of this Chapter apply to screw propellers.

5.2.2 Drawings and Data

Drawings and data to be submitted are generally as follows:

(1) Drawings

(a) Propeller

(b) Hydraulic oil piping diagram of controllable pitch propeller indicating pipe materials, pipe sizes and service pressure

(c) Blade fixing bolts of controllable pitch propeller

(2) Data

(a) Particulars of propeller (maximum continuous output and number of maximum continuous revolutions per minute of main propulsion machinery, details of blade profile, diameter, pitch, developed area, propeller boss ratio, rake or rake angle, number of blades, mass, moment of inertia, material specifications, etc.)

(b) Calculation sheet of propeller pull-up length (where the propeller is fitted onto a propeller shaft without key)

5.2.3 Materials, Construction and Strength

1 Materials of propellers and blade fixing bolts of controllable pitch propellers and their non-destructive tests are to conform to the requirements specified in **7.1.3-1** and **7.1.3-2, Part D of the Rules for the Survey and Construction of Steel Ships**.

2 The thickness of the propeller blades are to comply with the requirements specified in **7.2.1, Part D of the Rules for the Survey and Construction of Steel Ships**.

3 Notwithstanding the requirement in **-2**, the blade thickness for propellers fitted onto propeller shafts with a shaft rake of 5 degrees or more and for rudder propellers may be reduced to the value given by the following formula.

$$t = \sqrt{\frac{2K_1 H}{K_2 Z N_0 \ell}}$$

Where:

t : Thickness of blades (excluding the fillet of blade root (cm))

H : Maximum continuous output of main propulsion machinery (kW)

Z : Number of blades

N_0 : Number of maximum continuous revolutions (rpm) divided by 100

ℓ : Width of blade at radius in question (cm)

K_1 : Coefficient given by the following formula at radius in question

$$K_1 = \frac{30.3}{\sqrt{1 + k_1\left(\frac{P'}{D}\right)^2}}\left(k_2\frac{D}{P} + k_3\frac{P'}{D}\right)$$

D: Diameter of propeller (m)

k_1, k_2 and k_3: Values given in **Table 9.5.1**

P': Pitch at radius in question (m)

P: Pitch at radius of $0.7R$ (m), (R = Radius of propeller (m))

K_2: Coefficient given by the following formula

$$K_2 = K - \left(k_4\frac{E}{t_0} + k_5\right)\frac{D^2N_0^2}{1000}$$

k_4 and k_5: Values given in **Table 9.5.1**

E : Rake at tip of the blade (Measuring from face side base line, and taking positive value for backward rake) (cm)

t_0 : Imaginary thickness of blade at propeller shaft centreline ($t_0$may be obtained by producing the each side line which connects the blade tip thickness with the thickness at $0.25R$, or $0.35R$ for controllable pitch propeller, in the projection of blade section along maximum blade thickness line.) (cm)

K : Value depending upon the type of the propeller material given in **Table 9.5.2**

Table 9.5.1 Values of k_1, k_2, k_3, k_4 and k_5

Radial position	k_1	k_2	k_3	k_4	k_5
$0.25R$	1.62	0.386	0.239	1.92	1.71
$0.35R$	0.827	0.308	0.131	1.79	1.56
$0.6R$	0.281	0.113	0.022	1.24	1.09

Table 9.5.2 Values of K

Material		K
Copper alloy castings	*KHBsC*1	1.15
	*KHBsC*2	
	*KAlBC*3	1.3
	*KAlBC*4	1.15
Stainless steel forgings for propellers	*KSCSP*1, *KSCSP*2, *KSCSP*3	1.0
	*KSCSP*4	0.9

Notes:

(1) For the blades of materials different from those specified in the above table, the value of K is to be as deemed appropriate by the Society.

(2) For propellers having a diameter of 2.5 *metres* or less, the value of K may be taken as the value in the above Table multiplied by the following factor:

$2 - 0.4D$ for $2.5 \geq D > 2.0$

1.2 for $2.0 \geq D$

5.2.4 Controllable Pitch Propellers

1 The thickness of the controllable pitch propeller blades is to be in accordance with the requirements specified in **5.2.3-2** and **-3**.

2 The blade fixing bolts and the flanges for fixing the blades of controllable pitch propellers are to comply with the requirements specified in **7.2.2-2** through **7.2.2-7, Part D of the Rules for the Survey and Construction of Steel Ships**.

3 Where pitch control gears are operated by hydraulic oil pump, a standby oil pump so connected as to be ready for use or other suitable device is to be provided, thereby to ensure that the ship can keep the navigable speed.

5.2.5 Force Fitting of Propellers

1 Where a propeller is force fitted on the propeller shaft without a key, the lower and upper limits of pull-up length are to comply with the requirements specified in **7.3.1-1, Part D of the Rules for the Survey and Construction of Steel Ships**.

2 Where a propeller is force fitted on the propeller shaft with a key, the strength of the fitted parts are to be such that they are sufficient for the torque to be transmitted.

3 Where a propeller is force fitted on the propeller shaft, the edge at the fore end of the tapered hole of the propeller boss is to be appropriately rounded off.

4 Propeller bosses are not to be heated locally to a high temperature at time of forcing on or drawing out.

5.3 Waterjet Propulsion Systems

5.3.1 Scope

Waterjet propulsion systems are to conform to requirements in this Section, according to their design, to in additional to the requirements in 5.1.4 through 5.1.8.

5.3.2 Terminology

The terms used in this section are defined as follows:

(1) Waterjet propulsion system is a system, including **(2)** to **(7)**, that receives water through an inlet duct and discharges it through a nozzle at increased velocity to produce propulsive thrust without recourse to a screw propeller.

(2) Impeller is a rotating assembly provided with blades to give energy to the water.

(3) Main shaft is a shaft that transmits power to the impeller blades.

(4) Water intake duct is the portion that leads the water drawn from the water intake to the impeller inlet.

(5) Nozzle is the portion that injects the rectified water from the impeller.

(6) Deflecter is the device serving as a rudder by leading the water injected from the nozzle either to port or to starboard.

(7) Reversers are the devices to thrust the ship to go astern by reversing the flow direction of the water injected from the nozzle.

5.3.3 Drawings and Data

Drawings and data to be submitted are generally as follows:

(1) Drawings and data for approval

- (a) General arrangement and sectional assembly (showing the materials, and dimensions of the principle components including the water intake duct)
- (b) Shafting arrangement (showing the arrangements, shapes and constructions of the main propulsion machinery, reduction gears, clutches, couplings, main shafts, bearings, thrust bearings, sealing devices and impellers)
- (c) Details of water intake duct
- (d) Construction of impeller (showing the detailed blade profiles, the maximum diameter of the impeller from the centre of the main shaft, number of blades and material specifications)
- (e) Details of bearings, thrust bearings and forward sealing devices of the main shaft
- (f) Details of deflecters
- (g) Details of reversers
- (h) Diagram of hydraulic piping system
- (i) Calculation sheets of torsional vibration of main shaft

(2) Drawings and data for reference

- (a) Calculation sheets of bending natural frequency when bending vibration due to self-weight is expected
- (b) Strength calculation sheets for deflecters and reversers
- (c) Others deemed necessary by the Society

5.3.4 General*

1 The materials of parts of the waterjet propulsion system are suitable for respective uses intended, and the following essential components are to comply with the requirements in **Part K of the Rules for the Survey and Construction of Steel Ships**:

(1) Main shaft

(2) Shaft coupling and coupling bolts

(3) Impeller

(4) Water intake duct, nozzle and impeller casing which are composing a part of shell plating

2 The construction and the strength of waterjet propulsion system are to be in accordance with deemed appropriate by the Society.

5.4 Torsional Vibration of Shaftings

5.4.1 Scope

The requirements of this Chapter apply to power transmission systems and shafting for propulsion (excluding a part of waterjet propulsion system and propeller), shafting transmitting power from the main engine to generators, crank shaft of reciprocating internal combustion engines used for main propulsion and shafting of generating systems using reciprocating internal combustion engine.

5.4.2 General

1 Torsional vibration calculation sheets are to be submitted for main propulsion shaftings and shaftings for generators (excluding those for emergency generators). However in such a case where the shafting systems are of the same type with sufficient practical experience and can be deduced with satisfactory accuracy that no critical vibration would exist within the service speed range, the submission of the torsional vibration calculation sheets may be omitted.

2 Where considered necessary by the Society, measurements to confirm correctness of the estimated value by the calculation are to be carried out.

3 The torsional vibration stresses and torques on the shaftings are to comply with the allowable limit specified in **8.2, Part D of the Rules for the Survey and Construction of Steel Ships**.

4 In the case where the torsional vibration stresses or torques exceed the allowable limit τ_1 specified in **8.2, Part D of the Rules for the Survey and Construction of Steel Ships**, the barred speed ranges are to be imposed in accordance with **8.3, Part D of the Rules for the Survey and Construction of Steel Ships**.

Chapter 6 BOILERS, THERMAL OIL HEATERS, INCINERATORS AND PRESSURE VESSELS

6.1 Boilers

6.1.1 Drawings and Data

Drawings and data to be submitted are generally as follows:

(1) Drawings (with materials and scantlings)
- (a) General arrangement of boiler
- (b) Details of shells and headers (including the internal fittings)
- (c) Details of seats for boiler fittings and nozzles
- (d) Arrangement and details of boiler tubes
- (e) Arrangement and details of tubes of superheater and reheater
- (f) Details of internal desuperheater
- (g) Arrangement and details of tubes of economizer or exhaust gas economizer
- (h) Details of air preheater
- (i) Arrangement and details of boiler fittings
- (j) Arrangement of safety valves (with principal particulars)
- (k) Other drawings considered necessary by the Society

(2) Data
- (a) Particulars of boiler (design pressure, design temperature, maximum evaporation, heating surface, etc.)
- (b) Welding specifications (with welding procedures, welding consumables and welding conditions)
- (c) Other data considered necessary by the Society

6.1.2 General

1 The boilers shown in the following **(1)** to **(3)** are to be designed to have construction and strength adequate for the intended service and the surrounding conditions in ships.

(1) Steam boilers with design pressure not exceeding 0.1 *MPa* and heating surface not exceeding 1 m^2

(2) Hot water boilers with design pressure not exceeding 0.1 *MPa* and heating surface not exceeding 8 m^2

(3) Electric water heaters

2 The boilers other than **-1** are to comply with **9.2** through **9.9, Part D of the Rules for the Survey and Construction of Steel Ships**.

3 Notwithstanding the requirement in **-2**, small boilers with design pressure not exceeding 0.35 *MPa* may be required to comply with **9.11, Part D of the Rules for the Survey and Construction of Steel Ships**.

6.2 Thermal Oil Heaters

6.2.1 General

1 Thermal oil heaters heated by flame or combustion gas are to comply with **6.1** (in this case the term "boiler" is to be read as "thermal oil heater") as well as the following **-2** and **-3**.

2 Safety devices, etc. of thermal oil heaters heated by flame are to comply with **9.12.2, Part D of the Rules for the Survey and Construction of Steel Ships**.

3 Safety devices, etc. of thermal oil heaters heated by combustion gas are to comply with **9.12.3, Part D of the Rules for the Survey and Construction of Steel Ships**.

6.3 Incinerators

6.3.1 Drawings and Data

Drawings and data to be submitted are generally as follows:

(1) Drawings
  (a) General arrangement of incinerator
  (b) Arrangement of incinerator fittings
  (c) Other drawings considered necessary by the Society

(2) Data
  (a) Particulars
  (b) Instruction manual of safety devices
  (c) Operation manual of incinerator
  (d) Other data considered necessary by the Society

6.3.2 General

Incinerators are to comply with **9.13, Part D of the Rules for the Survey and Construction of Steel Ships**.

6.4 Pressure Vessels

6.4.1 Drawings and Data

Drawings and data to be submitted are generally as follows.

(1) Drawings (with type and dimensions of materials specified)
  (a) General arrangement
  (b) Details of shells
  (c) Arrangement of pressure relief devices
  (d) Details of seats for fittings and nozzles
  (e) Other drawings considered necessary by the Society

(2) Data
  (a) Principal particulars
  (b) Welding specifications (with welding procedures, welding consumables and welding conditions)
  (c) Other data considered necessary by the Society

6.4.2 General

Pressure vessels are to comply with the requirements specified in **Chapter 10, Part D of the Rules for the Survey and Construction of Steel Ships**.

Chapter 7 PIPES, VALVES, PIPE FITTINGS AND AUXILIARIES

7.1 General

7.1.1 Design Pressure and Design Temperature

1 Design pressure is the maximum working pressure of a medium inside pipe and is not to be less than the following pressures given in **(1)** to **(3)**:

(1) For piping systems fitted with a relief valve or other overpressure protective device, the pressure based on the set pressure of the relief valve or over pressure protective device. However, for steam piping systems connected to a boiler or piping systems fitted to a pressure vessel, the design pressure of the boiler shell (nominal pressure if the boiler has a superheater) or design pressure for the shell of a pressure vessel.

(2) For piping on the discharge side of the pumps, the pressure based on the delivery pressure of the pump with the valve on the discharge side closed running the pump at rated speed. However, for pumps having relief valve or overpressure protective device, the pressure based on its set pressure.

(3) For blow-off pipings of boilers, the pressure is not less than 1.25 times the pressure of the boiler drum.

2 Design Temperature is the highest working temperature of the medium inside pipes at the designed condition.

3 Pipes are classified to comply with the requirements specified in **12.1.3, Part D of the Rules for the Survey and Construction of Steel Ships** according to the type of medium, design pressure and design temperature.

7.1.2 Materials*

1 Materials used for auxiliary machinery are to be adequate for their service conditions. The materials used for essential parts of auxiliary machinery are to comply with the standards deemed appropriate by the Society.

2 Materials for pipes are to comply with the requirements specified in **12.1.4-2, Part D of the Rules for the Survey and Construction of Steel Ships**.

However materials which comply with a standard deemed appropriate by the Society may be accepted for pipes with both a design pressure less than 1*MPa* and a design temperature of 230°C or less.

3 Materials for valves or cocks (hereinafter referred to as "valves" in this Chapter) and pipe fittings are to comply with the requirements specified in **12.1.4-3, Part D of the Rules for the Survey and Construction of Steel Ships**.

However materials which comply with a standard deemed appropriate by the Society may be accepted for the following **(1)** and **(2)**.

(1) Valves and pipe fittings used for pipes with a nominal diameter less than 100 *mm*.

(2) Valves and pipe fittings with both a design pressure less than 3*MPa* and a design temperature of 230°C or less.

4 Notwithstanding the requirements **-2** and **-3**, materials for pipes, valves and pipe fittings are to comply with the requirements of the service limitations for materials specified in **12.1.5, Part D of the Rules for the Survey and Construction of Steel Ships**.

5 Special materials such as rubber hoses, plastic pipes (including vinyl pipes) complying with **Annex 12.1.6, Part D of the Rules for the Survey and Construction of Steel Ships**, aluminium alloys, etc., (notwithstanding **-3** above) may be used in cases where approved by the Society in accordance with requirements specified otherwise after taking into account their safety against fire and flooding as well as their service conditions.

7.2 Thickness of Pipes

Thickness of pipes is to comply with the requirements specified in **12.2, Part D of the Rules for the Survey and Construction of Steel Ships**.

7.3 Construction of Valves and Pipe Fittings

Construction of valves and pipe fittings is to comply with the requirements specified in **12.3, Part D of the Rules for the Survey and Construction of Steel Ships**.

7.4 Connection and Forming of Piping System

Connection and forming of piping system is to comply with the requirements specified in **12.4, Part D of the Rules for the Survey and Construction of Steel Ships**.

7.5 Construction of Auxiliary Machinery and Storage Tanks*

Construction of auxiliary machinery and storage tanks is to comply with the requirements specified in **12.5, Part D of the Rules for the Survey and Construction of Steel Ships**. In case where storage tanks for fuel oil are manufactured with the material other than steel plating, however, minimum thickness of plating is to be deemed appropriate by the Society.

Chapter 8 PIPING SYSTEMS

8.1 General

8.1.1 Piping

Piping systems are to comply with the requirements specified in **13.2, Part D of the Rules for the Survey and Construction of Steel Ships**.

8.2 Sea Suction Valves and Overboard Discharge Valves

8.2.1 Location and Construction

1 Sea inlet and overboard discharge pipes are to be connected to the valves or cocks which are fitted in accordance with the requirements in **-3** and **-4**.

2 The locations of overboard discharges subjected to pressure by the pump are not to be such that water can be discharged into life boats and liferafts at fixed launching positions including those under launching device when they are launched, unless special provision is made for preventing any discharge of water into them.

3 Sea suction valves and overboard discharge valves or cocks fitted to the ship's side, sea chests forming a part of the ship's structure or distance pieces attached to the shell plating are to be located at easily accessible positions.

4 Valves or cocks prescribed in **-3** are to be fitted in accordance with the following **(1)** to **(3)**:

(1) Valves or cocks are to be fitted to doublings which are welded to the shell plating or sea chest by using stud bolts not piercing the shell plating and sea chest.

(2) Valves or cocks are to be fitted by bolts to distance pieces attached to the shell plating. In this case, the distance piece is to be of rigid construction and as short as practicable.

(3) Where valves or cocks are fitted to the nonmetallic shell plating such as FRP, the fitting method is to be such that deemed appropriate by the Society.

5 The valve spindles of sea suction valves are to be extended above the lower platform where they are easily operable. Power-operated sea suction valves are to be arranged also for manual operation. Sea suction valves are to be provided with indicators to show whether they are open or closed.

6 Overboard discharge valves and cocks are to be fitted with spigots passing through the shell plating and a protection rings specified in **-7(1)**, but the spigots on the valves or cocks may be omitted if these fittings are attached to pads or distance pieces which themselves form spigots in way of the shell plating and protecting rings. Overboard discharge valves and cocks are to be provided with indicators to show whether they are open or closed.

7 Blow-off valves or cocks of boilers and evaporators are to comply with the following requirements in **(1)** and **(2)**.

(1) Blow-off valves or cocks of boilers and evaporators are to be fitted in easily operable positions and to be provided with protection rings on the outside of the shell plating to prevent corrosion.

(2) Cock handles are not to be capable of being removed unless the cocks are shut, and, if valves are fitted, the hand wheels are to be suitably retained on the spindle.

8.2.2 Sea Chests

Sea chests are to be of substantial construction not to blank off the suction due to air-locking.

8.2.3 Gratings of Sea Suctions

1 Gratings are to be fitted at the sea inlets. The net area through grating is not to be less than twice the total inlet area of sea suction valves.

2 Provision is to be made for cleaning the gratings specified in **-1** by use of low pressure steam, compressed air, etc.

8.3 Scuppers and Sanitary Discharges

1 Scuppers piping sufficient in number and size to provided effective drainage are to be provided on all decks. However the Society may permit the means of drainage to be dispensed with in any particular compartment of any ship or class of ship if it is satisfied that by reason of size or internal subdivision of those spaces the safety of the ship is not thereby impaired.

2 Scuppers and sanitary discharges are to comply with the requirements specified in **13.4.1-2**, **13.4.1-3**, **13.4.1-5**, **13.4.1-6** and **13.4.2, Part D of the Rules for the Survey and Construction of Steel Ships**.

8.4 Bilge and Ballast Pipings

1 Bilge and ballast pipings are to comply with the requirements specified in **13.5, Part D of the Rules for the Survey and Construction of Steel Ships**.

2 For multihull crafts, the breadth of the hull "*B*" used for calculating minimum required diameter of bilge main may be the breadth of a hull at or below the design waterline (*m*).

3 For multihull crafts with individual bilge pumps for each hull, such bilge piping are to comply with the requirements in **-1** and **-2** above. Also the total capacity "*Q*" of the bilge pumps for each hull is not to be less than 2.4 times the required capacity of the pump specified in **-1** and **-2** above.

4 Notwithstanding the requirements given in **-1** and **-3** above, where approved by the Society in consideration of the area of the machinery spaces, at least two required bilge suctions may be arranged near the center line of the hull. In this case, at least one of them is to be connected to direct bilge piping and others may be connected to branch bilge piping.

8.5 Air Pipes

Air pipes for tanks, cofferdams and similar spaces are to comply with the requirements specified in **13.6, Part D of the Rules for the Survey and Construction of Steel Ships**.

8.6 Overflow Pipes

8.6.1 General

1 Where tanks which can be pumped up come under either one of the following categories, overflow pipes are to be provided:

(1) Where total sectional area of air pipes to tanks which can be pumped up is less than 1.25 times total sectional area of filling pipes.

(2) Where there is any opening below the open ends of air pipes fitted to the tanks; and

(3) Fuel oil settling tanks and fuel oil service tanks.

2 Overflow pipes other than those to tanks for fuel oil, lubricating oil and other flammable oils are to be led to the open air, or alternatively, to proper positions where the overflows can be disposed of.

3 Overflow pipes are to be arranged to be self-draining.

8.6.2 Sizes of Overflow Pipes

The aggregated sectional area of overflow pipes which come under **8.6.1-1** is to be not less than 1.25 times the aggregated sectional area of filling pipes.

8.6.3 Overflow Pipes to Fuel Oil, Lubricating Oil and Other Flammable Oil tanks

Overflow pipes to tanks for fuel oil, lubricating oil and other flammable oil are to comply with the requirements specified in **13.7.3, Part D of the Rules for the Survey and Construction of Steel Ships**.

8.6.4 Preventive Means of Counter-flow of Overflow

1 Adequate means are to be provided on overflow pipes so that in the event of any one of the tanks being bilged, the other tanks cannot be flooded from the sea through the overflow pipes.

2 Overflow pipes discharging through the ship's sides are to extend above the load line, and are to be provided with non-return valves fitted on the ship's sides. Where the overflow pipes do not extend above the freeboard deck, additional effective means are

to be provided to prevent the sea water from passing inboard.

8.7 Sounding Pipes

8.7.1 General

1 All the tanks, cofferdams and similar spaces are to be provided with a sounding pipe or a liquid level indicator. These devices are to be capable of checking the liquid level in such spaces at readily accessible positions at all times.

2 Name plates are to be affixed to the upper ends of sounding pipes.

8.7.2 Upper Ends of Sounding Pipes

1 Sounding pipes are to be led to positions above the bulkhead deck which are at all times readily accessible, and are to be provided with effective closing means at their upper ends. The sounding pipes, however, may be led to readily accessible positions from the platform of the machinery space provided that the following closing means are provided according to the kinds of tanks.

(1) Sounding pipes to tanks for fuel oil;

(a) Self-closing blanking devices on the termination of sounding pipes

(b) Small diameter control cock located below the blanking device for the purpose of ascertaining that oil fuel is not present before opening the blanking device

(c) Means to ensure that any spillage of fuel oil through the control cock involves no ignition hazard

(2) Sounding pipes to tanks for lubricating oil and other lammable oils;

Sluice valves or cocks with self closing means

(3) Sounding pipes to tanks other than mentioned in **(1)**, **(2)** and cofferdams;

Sluice valves, cocks or screw caps attached to the pipes by chain

2 The upper ends of sounding pipes to tanks for fuel oil, lubricating oil and other flammable oils are not to terminate in accommodation spaces and adjacent to the electrical equipment, boilers and other heated surfaces.

8.7.3 Construction of Sounding Pipes

Construction of Sounding Pipes is to comply with the requirements specified in **13.8.3, Part D of the Rules for the Survey and Construction of Steel Ships**.

8.7.4 Construction of Liquid Level Indicators

1 A liquid level indicator which is specified in **8.7.1-1** above is to be of the type approved by the Society. However, when a liquid level indicator conforms to a standard deemed appropriate by the Society or when it is provided with a certificate deemed appropriate by the Society, the requirements do not apply.

2 Glass gauges used for tanks carrying fuel oils, lubricating oils and other flammable oils are to comply with the following requirements **(1)** and **(2)**:

(1) The glasses used for oil level indicators are to be of flat shape, of heat resisting quality, and adequately protected from mechanical damage.

(2) The valves or cocks at the lower ends of glass gauges are to be provided with self-closing means.

8.8 Fuel Oil Systems

8.8.1 General

1 Fuel oil in the oil tanks is not to be heated to the temperature within 10°C below the flash point of the fuel oil, unless considered appropriate by the Society.

2 The compartments in which fuel oil burning systems, fuel oil settling and service tanks, fuel oil purifiers, etc., are located are to be readily accessible and well ventilated.

3 The fuel oil system in the main propulsion machinery room and boiler room are to be carefully considered to make maintenance and inspection easy. Due care is to be paid against oil leakage so that it may not result in fire accidents and that it may be detected easily in case of leakage. All valves or cocks are to be capable of being operated from above the platform.

4 Valves, cocks and other fittings fitted on fuel oil tanks are to be located in safe positions so as to be protected from external damage.

5 Stop valves or cocks are to be fitted on both suction and delivery sides of fuel oil pumps.

6 Where pressure relief valves are provided on the delivery side of the fuel oil pumps, arrangements are to be made so that the discharged oil may be led to the suction side of the pump.

7 Valves and pipe fittings with a design temperature above 60°C and a design pressure above 1 *MPa* are to be suitable for a pressure of not less than 1.6 *MPa*. Valves and pipe fittings used for fuel oil transfer piping lines, fuel oil suction piping lines and other low pressure fuel oil piping lines are to be suitable for a pressure of not less than 0.5 *MPa*.

8 Union joints used for connection of fuel oil injection pipes of reciprocating internal combustion engines or the pipes of burning systems of boilers are to be of rigid construction and to have metal contact capable of providing sufficient oil tightness.

9 Fuel oil pipelines including fuel oil tanks are to be segregated from ballast pipelines.

8.8.2 Fuel Oil Filling Pipes

Fuel oil filling pipes are to comply with the requirements specified in **13.9.2, Part D of the Rules for the Survey and Construction of Steel Ships**.

8.8.3 Valves for Tank Suction Pipes

Valves for tank suction pipes are to comply with the requirements specified in **4.2.2(3)(d), Part R of the Rules for the Survey and Construction of Steel Ships**.

8.8.4 Fuel Oil Transfer Pumps

1 In ships where power pumps are used for pumping up to the settling and service tanks, at least two independent power fuel oil transfer pumps are to be provided, and these pumps are to be connected ready for use. Where any suitable independent power driven fuel oil pump for other purposes is available as a fuel oil transfer pump, this pump may be used as a fuel oil transfer pump.

2 For multihull crafts, notwithstanding **-1** above, interconnecting pipe lines for fuel oil transfer pumps may be dispensed with providing that, even in the case of one engine inoperative, the craft can maintain her navigable speed.

8.8.5 Drip Trays and Drainage System

Drip trays and drainage system is to comply with the requirements specified in **13.9.4, Part D of the Rules for the Survey and Construction of Steel Ships**.

8.8.6 Fuel Oil Heaters

Fuel oil heaters are to comply with the requirements specified in **13.9.5, Part D of the Rules for the Survey and Construction of Steel Ships**.

8.8.7 Fuel Oil Systems for Reciprocating Internal Combustion Engines

1 Number and capacity of fuel oil supply pumps for the main propulsion machinery are to comply with the following requirements **(1)** or **(2)**:

(1) Two sets of main fuel oil supply pumps are to be provided with sufficient total capacity enough to maintain the supply of the fuel oil at the maximum continuous output of the main propulsion machinery, and each of which has sufficient capacity to obtain navigable speed of the craft.

(2) Where two or more main propulsion machinery are provided, such system that each of main propulsion machinery has an exclusive main fuel oil supply pump may be accepted providing that it is possible to give a navigable speed even if one of them is out of use.

2 Reciprocating internal combustion engines for driving electrical generators and auxiliary machinery for which duplication is required are to be provided with two fuel oil supply pumps of sufficient total capacity to maintain the supply of oil at the maximum continuous output of the engine and each of which has sufficient capacity to obtain navigable speed of the craft. However, such a system that each engine is provided with an exclusive fuel oil supply pump may be accepted.

3 Fuel oil filters are to be provided on fuel oil supply piping lines for reciprocating internal combustion engines. The filters for reciprocating internal combustion engines used as main propulsion machinery are to be capable of being cleaned without stopping the supply of filtered oil. The fuel oil filters are to be provided with valves or cocks for depressurizing before being opened.

4 Where low grade oil is used as fuel oil, suitable fuel oil heating devices and fuel oil purifying devices are to be provided.

8.8.8 Burning Systems for Boilers

1 Essential auxiliary boilers and other boilers to supply steam for fuel oil heating necessary for the operation of the main propulsion machinery or cargo heating that is required continuously are to be provided with two units of burning pumps and fuel oil heaters of sufficient total capacity to maintain the supply of oil at the maximum evaporation rate of the boiler, and each of which

has sufficient capacity to obtain navigable speed of the craft. However, where alternative means are available to ensure the normal navigation and cargo heating with the burning system being out of operation, only one unit of burning system will be accepted.

2 Where fuel oil is supplied to the burners by gravity, fuel oil filters capable of being cleaned without stopping the supply of filtered oil are to be provided.

3 Where the removal of residual fuel oil in burners is conducted by means of steam or air, means are to be taken to prevent the mixing of oil into steam or air.

8.9 Lubricating Oil Systems and Hydraulic Oil Systems

8.9.1 General

1 The compartment in which lubricating oil tanks, lubricating oil purifiers and hydraulic oil tanks are located are to be readily accessible and well ventilated.

2 Lubricating oil system and hydraulic oil system in the main propulsion machinery room and boiler room are to be carefully considered to make maintenance and inspection easy. Due care is to be paid against oil leakage so that it may not result in fire accidents and that it may be detected easily in case of leakage. All valves or cocks are to be capable of being operated from above the platform.

3 Valves, cocks and other fittings fitted on lubricating oil tanks and hydraulic oil tanks are to be located in safe positions so as to be protected from external damage.

4 Valves for lubricating oil tank suction pipes are to comply with the requirements specified in **4.2.2(3)(d), Part R of the Rules for the Survey and Construction of Steel Ships** (in this case the term "fuel oil" is to be read as "lubricating oil").

5 Drip trays and drainage arrangement of lubricating oil systems and hydraulic oil systems are to comply with the requirements specified in **13.9.4-1** and **13.9.4-4, Part D of the Rules for the Survey and Construction of Steel Ships** (in these case the term "fuel oil" is to be read as "lubricating oil" or "hydraulic oil").

6 Lubricating oil heaters are to comply with the requirements specified in **13.9.5, Part D of the Rules for the Survey and Construction of Steel Ships** (in this case the term "fuel oil" is to be read as "lubricating oil").

8.9.2 Lubricating Oil Pumps

1 Number and capacity of lubricating oil pumps for main propulsion machinery, propulsion shaftings and power transmission systems are to comply with the following requirements **(1)** or **(2)** :

(1) Two sets of lubricating oil pumps are to be provided with sufficient total capacity enough to maintain the supply of the oil at the maximum continuous output of the main propulsion machinery, and each of which has sufficient capacity to obtain navigable speed of the craft.

(2) Where two or more main propulsion machinery, propulsion shaftings and their power transmission systems are provided, such system that each of them has an exclusive lubricating oil pump may be accepted, providing that it is possible to give a navigable speed even if one of them is out of use.

2 Reciprocating internal combustion engines for driving electrical generators and auxiliary machinery for which duplication is required are to be provided with two lubricating oil pumps of sufficient total capacity to maintain the supply of oil at the maximum continuous output of the engine, and each of which has sufficient capacity to obtain navigable speed of the craft. However, such a system that each engine is provided with an exclusive lubricating oil pump may be accepted.

8.9.3 Stop Valves between Engine and Sump Tank

For ships of 100 *meters* and above in length, where a double bottom is used as a lubricating oil sump tank, a stop valve which can be easily operated from the engine room floor or suitable counterflow prevention device is to be provided.

8.9.4 Lubricating Filters

1 Where a forced lubrication system (including gravity supply from head tank) is adopted for lubrication of machinery installations, lubricating oil filters are to be provided.

2 The filters used for the lubricating oil systems of the main propulsion machinery, power transmission of propulsion shafting and controllable pitch propeller system are to be capable of being cleaned without stopping the supply of filtered oil.

8.10 Thermal Oil Systems

Thermal oil systems are to comply with the requirements specified in **13.11, Part D of the Rules for the Survey and Construction of Steel Ships**.

8.11 Cooling Systems

8.11.1 Cooling Pumps

1 Number and capacity of cooling pumps for the main propulsion machinery are to comply with the following requirements **(1)** or **(2)**:

(1) Two sets of main cooling pumps are to be provided with sufficient total capacity enough to maintain the supply of water (oil) at the maximum continuous output of the main propulsion machinery, and each of which has sufficient capacity to obtain navigable speed of the craft.

(2) Where two or more main propulsion machinery are provided, such system that each of them has an exclusive cooling pump may be accepted providing that it is possible to give a navigable speed even if one of them is out of use.

2 Reciprocating internal combustion engines for driving electrical generators and auxiliary machinery for which duplication is required are to be provided with two cooling pumps of sufficient total capacity to maintain the supply of water (oil) at the maximum continuous output of the engine, and each of which has sufficient capacity to obtain navigable speed of the craft. However, such a system that each engine is provided with an exclusive cooling pump may be accepted.

8.11.2 Suction of Sea Water

Arrangement is to be provided to introduce cooling sea water from sea suction valves fitted on two or more sea chests or sea suctions. For multihull crafts, however, such a system that each hull has single sea chest respectively may be accepted providing that it is possible to give a navigable speed even if one of the engine in any hull is out of use.

8.11.3 Cooling Systems for Reciprocating Internal Combustion Engines

Where sea water is used for the direct cooling of the propulsion machinery, or reciprocating internal combustion engines driving electrical generators or auxiliary machinery for which duplication is required, strainers which are arranged to be capable of being cleaned without stopping the supply of filtered cooling water to the respective engines are to be provided between the sea suction valve and the cooling sea water pump.

8.12 Pneumatic Piping Systems

Pneumatic piping systems are to comply with the requirements specified in **13.13.1**, **13.13.2**, **13.13.3** and **13.13.5, Part D of the Rules for the Survey and Construction of Steel Ships**.

8.13 Steam Piping Systems and Condensate Systems

Steam piping systems and condensate systems are to comply with the requirements specified in **13.14, Part D of the Rules for the Survey and Construction of Steel Ships**.

8.14 Feed Water Systems for Boilers

8.14.1 Feed Water Pumps and Piping

1 Every auxiliary boiler (including steam generating systems, hereinafter in **8.14.1**) which provides services essential for the safety of the ship, or which could be rendered dangerous by the failure of its feed water supply, is to be provided with two separate feed water systems, each including a stop valve, a non-return valve and a feed pump.

Total capacity of feed water pumps are to be sufficient for maximum evaporation and capacity of one feed water pump is to be sufficient to obtain navigable speed of the craft.

However, a single penetration of the steam drum is acceptable.

2 Boiler feed water pipes are not to be led through tanks which contain oil, nor are oil pipes to be led through boiler feed water tanks.

8.15 Exhaust Gas Piping Arrangement

1 Exhaust gas piping arrangement is to comply with the requirements specified in **13.16, Part D of the Rules for the Survey and Construction of Steel Ships**.

2 Exhaust gas piping is to be arranged with consideration of heat influence to hull plates.

3 Open ends of exhaust gas piping are to be arranged so that exhaust gas is prevented to flow into air intakes of reciprocating internal combustion engines, gas turbines, etc.

Chapter 9 STEERING GEARS

9.1 General

9.1.1 Scope

1 The requirements in this Chapter apply to power-driven steering gears.

2 Electrical equipment and cables used for steering gears are to conform to the requirements of **Chapter 10** in addition to those specified in this Chapter.

3 Manual steering gears will be considered by the Society in each case.

9.1.2 Drawings and Data

Drawings and data to be submitted are generally to be as follows:

(1) Drawings:

(a) General arrangements of the steering gear

(b) Details of tiller, etc.

(c) Assembly and details of power units

(d) Assembly and details of rudder actuators

(e) Piping diagram of hydraulic pipes

(f) Arrangements of control systems and diagram of hydraulic and electrical systems (including alarm devices and automatic steering gear)

(g) Arrangements and diagram of an alternative source of power

(h) Diagram of a rudder angle indicator

(i) Other drawings considered necessary by the Society

(2) Data:

(a) Particulars

(b) Operating instructions (including drawings showing the change-over procedure for power units and control systems, drawings showing the sequence of automatic supply of power from an alternative source of power; and the type, particulars and an assembly of the power source in the case that the alternative source of power is an independent source of power and information about hydraulic fluid quality.)

(c) Manuals for countermeasures to be taken at the time of a single failure of the power actuating system

(d) Calculation sheet of rudder torque to be used in strength calculation

(e) Calculation sheet of the strength of essential parts

(f) Other data considered necessary by the Society

9.1.3 Display of Operating Instructions

Simple operating instructions with a block diagram showing the change-over procedures for power units and control systems are to be permanently displayed on the navigating bridge and in the steering gear compartment for ships equipped with power-operated steering gears.

9.2 Performance and Arrangement of Steering Gears

9.2.1 Number of Steering Gears

Number of steering gears is to comply with the requirements specified in **15.2.1, Part D of the Rules for the Survey and Construction of Steel Ships**.

9.2.2 Performance of Main Steering Gear

Performance of main steering gear is to comply with the requirements specified in **15.2.2, Part D of the Rules for the Survey and Construction of Steel Ships**.

9.2.3 Performance of Auxiliary Steering Gear

Performance of auxiliary steering gear is to comply with the requirements specified in **15.2.3, Part D of the Rules for the Survey and Construction of Steel Ships**.

9.2.4 Piping

1 Hydraulic piping system is to comply with the requirements specified in **15.2.4-1** to **15.2.4-4, Part D of the Rules for the Survey and Construction of Steel Ships**.

2 A fixed storage tank having sufficient capacity to recharge at least one power actuating system including reservoir is to be provided, where the main steering gear is operated by hydraulic power.

9.2.5 Re-start and Power-failure Alarm of Power Units

Re-Start and power-failure alarm of power units are to comply with the requirements specified in **15.2.5, Part D of the Rules for the Survey and Construction of Steel Ships**.

9.2.6 Electrical Installations for Electric and Electrohydraulic Steering Gear

1 Electrical installations for electric and electrohydraulic steering gear are to comply with the requirements specified in **15.2.7-2**, **15.2.7-3**, **15.2.7-4**, **15.2.7-6**, **15.2.7-8** and **15.2.7-9, Part D of the Rules for the Survey and Construction of Steel Ships**.

2 Short circuit protection is to be provided for the circuit of electrical installations for electric and electrohydraulic steering gears.

9.2.7 Position of Steering Gears

Position of steering gears is to comply with the requirements specified in **15.2.8, Part D of the Rules for the Survey and Construction of Steel Ships**.

9.2.8 Rudder Angle Indictor

Rudder angle indictor is to comply with the requirements specified in **15.2.10, Part D of the Rules for the Survey and Construction of Steel Ships**.

9.3 Controls

Controls are to comply with the requirements specified in **15.3.1** and **15.3.2, Part D of the Rules for the Survey and Construction of Steel Ships**.

9.4 Materials, Constructions and Strength of Steering Gears

Materials, constructions and strength of steering gears controls are to comply with the requirements specified in **15.4, Part D of the Rules for the Survey and Construction of Steel Ships**. In this case, rudder torque "T_R" is to be such that defined as follows:

$$T_R = AV^2c\left(42.9 - 116.1\frac{a}{c}\right)$$

T_R : Rudder torque to be used in strength calculation (Nm)

A : Area of rudder plate (m^2)

V : Craft's speed (kt)

a : Distance from forward edge of rudder to the centreline of rudder stock (m) (measured at the same position as "c" below)

c : Breadth of rudder (m) (measured at centre of area of rudder plate)

Chapter 10 WINDLASSES AND MOORING WINCHES

10.1 General

10.1.1 Scope

The requirements in this Chapter apply to windlasses and mooring winches.

10.2 Windlasses

10.2.1 General

Unless otherwise specified in this chapter, windlasses are to be in accordance with requirements in **Chapter 16, Part D of the Rules for the Survey and Construction of Steel Ships**.

10.2.2 Drawings and Data*

The following drawings and data showing design specifications, standards of compliance, engineering analyses and details of construction, are, in principle, to be submitted.

(1) Drawings and data for approval:
- (a) Windlass design specifications
- (b) Windlass arrangement plan
- (c) Dimensions, materials and welding details of torque-transmitting components and load-bearing components
- (d) Drawings and data concerning hydraulic systems
- (e) Control, monitoring and instrumentation arrangements
- (f) Procedures for shop tests
- (g) Other drawings and data considered necessary by the Society

(2) Drawing and data for reference:
- (a) Calculated strength for torque-transmitting components and load-bearing components
- (b) General arrangements and sectional assembly drawings of chain cable stoppers and documents which demonstrate the chain cable stoppers are in accordance with requirements specified in **16.2.4-2(6), Part D of the Rules for the Survey and Construction of Steel Ships** (in cases where chain cable stoppers are fitted)
- (c) Load calculations of prime movers (in cases where the load test specified in **16.2.5-1(3), Part D of the Rules for the Survey and Construction of Steel Ships** is not carried out)
- (d) Calculation sheets for cable lifter brake capacities (in cases where the cable lifter brake capacity test specified in **16.2.5-1(4), Part D of the Rules for the Survey and Construction of Steel Ships** is not carried out)
- (e) Operation and maintenance procedures
- (f) Other drawings and data considered necessary by the Society

10.3 Mooring Winches

10.3.1 Structure, etc.

1 Mooring winches are to comply with the Japanese Industrial Standards or other recognized standards deemed appropriate by the Society.

2 Mooring winches and their beds and other accessory facilities are to be installed effectively and securely onto the deck.

Chapter 11 REFRIGERATING EQUIPMENT

11.1 General

11.1.1 Scope

The requirements in this chapter apply to the refrigerating machinery using the primary refrigerants listed below and forming the refrigerating cycle used for refrigeration, air conditioning, etc., as well as to the controlled atmosphere systems for the cargo holds. However, the refrigerating machinery with compressors of 7.5 *kW* or less and the refrigerating machinery using the primary refrigerants other than those listed below are to be as deemed appropriate by the Society.

*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*407*H* : *R*32/*R*125/*R*134*a* (32.5/15/52.5 *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*449*A*: *R*32/*R*125/*R*1234*yf*/*R*134*a* (24.3/24.7/25.7/25.3 *wt*%) CH_2F_2 / CHF_2CF_3 / $CF_3CF{=}CH_2$/CH_2FCF_3

*R*507*A*: *R*125/*R*143*a* (50/50 *wt*%) CHF_2CF_3 / CH_3CF_3

11.1.2 Drawings and Data

Drawings and data to be submitted for approval are generally as follows:

(1) Drawings (with materials, scantlings, kinds, design pressure, design temperature, etc. of the pipes, valves, etc.)
  (a) Piping diagrams of refrigerating systems for provision chamber and air conditioning installations
  (b) Drawings of pressure vessels exposed to a pressure of the primary refrigerant
  (c) Other drawings considered necessary by the Society

(2) Data
  (a) The particulars of refrigerating machinery
  (b) Other drawings considered necessary by the Society

11.2 Design of Refrigerating Machinery

Design of refrigerating machinery is to comply with the requirements specified in **17.2, Part D of the Rules for the Survey and Construction of Steel Ships**.

Chapter 12 AUTOMATIC AND REMOTE CONTROL

12.1 General

12.1.1 Scope*

1 The requirements in this Chapter apply to the systems of automatic or remote control which are used to control the following machinery and equipment.

(1) Main propulsion machinery (in this Chapter, propulsion generating set in electric propulsion ships are excluded),

(2) Controllable pitch propeller

(3) Steam generating set

(4) Electric generating set (in this Chapter, propulsion generating set in electric propulsion ships are included)

(5) Auxiliary machinery associated with machinery and equipment listed in **(1)** to **(4)**

(6) Fuel oil systems

(7) Bilge systems

(8) Deck machinery

2 Where considered necessary by the Society, the requirements in this Chapter are correspondingly applied to the systems of automatic or remote control which are used for controlling machinery and equipment not listed in **-1(1)** to **(8)**.

3 Computer based systems are to be in accordance with **Part X of the Rules for the Survey and Construction of Steel Ships** in addition to those specified in **-1** and **-2** above and throughout the rest of this chapter.

12.1.2 Terminology

Terms used in this Chapter are defined as the requirements specified in **18.1.2, Part D of the Rules for the Survey and Construction of Steel Ships**.

12.1.3 Drawings and Data*

Drawings and data to be submitted are generally, as follows.

(1) Drawings and data for approval

(a) Drawings and data concerning automation

i) List of measuring points

ii) List of alarm points

iii) Control devices and safety devices

1) List of controlled objects and controlled variables

2) Kinds of control energy sources (self-actuated, pneumatic, electric, etc.)

3) List of conditions for emergency stopping, speed reduction (automatic or demand for reduction), etc.

(b) The following drawings and data for the automatic control devices and remote control devices for main propulsion machinery or controllable pitch propellers

i) Operating instructions of main propulsion machinery such as starting and stopping, change-over of direction of revolution, increase and decreased of output, etc.

ii) Arrangements of safety devices (including those attached to engines) and pilot lamps

iii) Controlling diagrams

(c) Following drawings and data for the automatic control devices and remote control devices for boilers

i) Operating instructions of sequential control, feed water control, pressure control, combustion control and safety devices

ii) 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, alarm panels and control stands at respective control stations

(f) Other drawings and data deemed necessary by the Society.

(2) Drawings and data for reference

Other drawings and data deemed necessary by the Society.

12.2 System Design

System design is to comply with the requirements specified in **18.2, Part D of the Rules for the Survey and Construction of Steel Ships**.

12.3 Automatic and Remote Control of Main Propulsion Machinery or Controllable Pitch Propellers

Automatic and remote control of main propulsion machinery or controllable pitch propellers is to comply with the requirements specified in **18.3, Part D of the Rules for the Survey and Construction of Steel Ships**.

12.4 Automatic and Remote Control of Boilers

Automatic and remote control of boilers is to comply with the requirements specified in **18.4, Part D of the Rules for the Survey and Construction of Steel Ships**.

12.5 Automatic and Remote Control of Electric Generating Sets

Automatic and remote control of electric generating sets is to comply with the requirements specified in **18.5, Part D of the Rules for the Survey and Construction of Steel Ships**.

12.6 Automatic and Remote Control of Auxiliary Machinery

Automatic and remote control of auxiliary machinery is to comply with the requirements specified in **18.6, Part D of the Rules for the Survey and Construction of Steel Ships**.

Chapter 13 SPARE PARTS, TOOLS AND INSTRUMENTS

13.1 General

13.1.1 Scope

1 The requirements in this chapter apply to spare parts, tools and instruments for the following machinery installations.

(1) Reciprocating internal combustion engines used as main propulsion machinery

(2) Reciprocating internal combustion engines driving generators or auxiliary machinery essential for main propulsion

(3) Boilers and thermal oil installations

(4) Pumps

2 Since the requirements for spare parts and tools vary depending on regulations of registered country, purpose of ships engaged, kinds of machinery installations, navigation route and others, the requirements in this Chapter may not be applicable in all cases. However, as a rule, spare parts and tools specified in this Chapter are to be provided in engine room, boiler room or any other convenient places in a ship.

3 The spare parts, tools and instruments for machinery installations not specified in this Chapter are to be as deemed appropriate by the Society.

13.2 Spare Parts, Tools and Instruments

13.2.1 Spare Parts

1 The following parts are to be provided as the spare parts for a reciprocating internal combustion engine used as main propulsion machinery.

(1) Exhaust valves, complete with casings, seats, springs and other fittings for one cylinder: 1 set

(2) Air inlet valves, complete with casings, seats, springs and other fittings for one cylinder: 1 set

(3) Fuel valves, complete with casings, springs and other fittings for one engine: 1 set

*Note: Engines with three or more fuel valves per cylinder: two fuel valves complete per cylinder, and other fuel valves excluding casings.

(4) Bottom end bearings or shells of connecting rod of each size and type fitted, complete with shims, bolts and nuts: 1 set

(5) Top end bearings or shells of connecting rod of each size and type fitted, complete with shims, bolts and nuts: 1 set

(6) Piston rings for one cylinder: 1 set

(7) Fuel injection pump complete, or, when replacement at sea is practicable, a complete set of working parts for one pump (plunger, sleeve, valves, springs, etc.): 1 set

(8) High pressure fuel pipe of each size and shape fitted, complete with couplings: 1 set

2 The following parts are to be provided as the spare parts for a reciprocating internal combustion engine driving a generator or auxiliary machinery essential for main propulsion.

(1) Exhaust valves, complete with casings, seats, springs and other fittings for one cylinder: 1 set

(2) Air inlet valves, complete with casings, seats, springs and other fittings for one cylinder: 1 set

(3) Fuel valves, complete with casings, springs and other fittings for one engine: 1 set

*Note: Engines with three or more fuel valves per cylinder: two fuel valves complete per cylinder, and other fuel valves excluding casings.

(4) Bottom end bearings or shells of connecting rod of each size and type fitted, complete with shims, bolts and nuts: 1 set

(5) Top end bearings or shells of connecting rod of each size and type fitted, complete with shims, bolts and nuts: 1 set

(6) Piston rings for one cylinder: 1 set

(7) Fuel injection pump complete, or, when replacement at sea is practicable, a complete set of working parts for one pump (plunger, sleeve, valves, springs, etc.): 1 set

(8) High pressure fuel pipe of each size and shape fitted, complete with couplings: 1 set

(9) Special gaskets and packings of each size and type fitted, for cylinder cover and cylinder liner for one cylinder: 1 set

3 The following parts are provided as the spare parts for an essential auxiliary boiler, a boiler to supply steam for fuel oil heating necessary for operation of main propulsion machinery or cargo heating required continuously, and a thermal oil installation for essential use. However, no spare parts are required, provided that stand-by means which are ensured to keep the normal service condition of a ship or heating of cargoes are provided, in case of failure of boilers or thermal oil installations.

(1) Safety valve spring of each size including superheater safety valve springs: 1 set

(2) Oil burner nozzles, complete for one boiler: 1 set

(3) Round type water gauge glasses including packings: 6 sets

(4) Flat type water gauge glasses: 1 set

(5) Flat type water gauge frame: 1 set

4 The following parts are provided as the spare parts for a piston pump which is classified as auxiliary machinery essential for main propulsion or which is used as a bilge pump.

(1) Valves with seats and springs of each size fitted: 1 set

(2) Piston rings of each type and size for one piston: 1 set

5 The following parts are to be provided as the spare parts for electronically-controlled engines used as main propulsion machinery.

(1) Control valves: 1 of each type

(2) Accumulator diaphragms: 2 of each type

(3) Sensors provided for each cylinder (Spare parts may be omitted in cases where normal operation of main propulsion machinery is available without these sensors.): 1 of each type

6 The spare parts for the machinery installations specified in **-1** to **-5** are those required for each one set of the machinery installations. In the case where the craft is installed with two or more sets of the machinery installations of the same type for the same service, only one set of spare parts for the machinery installations may be acceptable.

However, the number of water gauge glasses of round type and flat type is required to be the number specified in **-3** for each boiler, and the number of flat type water gauge frames is required to be one for each two boilers.

7 Notwithstanding the requirement specified in **-6** no spare parts are required for the machinery installations specified in following **(1)** to **(4)**.

(1) The machinery installations whose number exceeds the Rule required number and each capacity is adequate under the normal service condition of the ship.

(2) The pumps classified as auxiliary machinery essential for main propulsion, which have stand-by pumps of adequate capacity under normal service condition of the ship

(3) Main engines for such ships in which at least two sets of main engines are installed.

(4) Engines driving main generator in such craft in which at least two sets of main generators are installed.

13.2.2 Tools and Instruments

The following tools and instruments for each one ship are to be provided.

(1) Tube stoppers or plugs of each size for boilers required spare parts in the requirement in **13.2.1-3**, including those for superheater tubes and economizer tubes: 4 sets

(2) Water tester (Two salinometers will be acceptable.): 1 set

(3) Special tools and instruments for maintenance of repair work or the machinery installations: 1 set

Part 10 ELECTRICAL INSTALLATIONS

Chapter 1 GENERAL

1.1 General

1.1.1 Scope

The requirements in this part apply to the electrical equipment and wirings for craft (hereinafter referred to as the "electrical installations").

1.1.2 Equivalency

Electrical installations which do not fully comply with the requirements of this part may be accepted, provided that there are unavoidable but justifiable reasons precluding the due compliance with the requirements of this part and that the electrical installations are deemed by the Society to be equivalent to those specified in this part.

1.1.3 Electrical Installations with Novel Design Features

For electrical installations manufactured or installed with novel design features the Society may impose appropriate requirements of this part to the extent practically applicable with additional requirements made on design and test procedures other than those specified in this part and accept such installation if they are proved to fit the intended service and are capable of maintaining craft's propulsion and securing the safety of life and the craft to the satisfaction of the Society.

1.1.4 Terminology

Terms used in this part are defined in **Chapter 2, Part 1**, and additionally in **1.1.5, Part H of the Rules for the Survey and Construction of Steel Ships**.

1.1.5 Drawing and Data*

The drawings and data to be submitted are as follows.

(1) Drawings

(a) Sectional assembly of generators, motors and electromagnetic slipcouplings for electric propulsion equipment including complete rating, main dimensions, main materials used and weights

(b) Key diagram and explanation of electric propulsion control gears

(c) Sectional assembly of generators (main, auxiliary and emergency) of 100 *kW* (or 100 *kVA*) and over, including complete rating, main dimensions, main materials used and weights

(d) Arrangement plan (including specifications of main parts such as circuit breakers, fuses, instruments and cables) and circuit diagrams of main switchboard and emergency switchboard

(e) Plans of the arrangement of electrical equipment and of cable installation

(f) Diagrams of the wiring system including normal working current, rated current, prospective short-circuit current in the circuits, line drop of voltages, type of cables, cable sizes, rating and setting of circuit breakers, rating of fuses and switches, and breaking capacity of circuit breakers and fuses

(g) Sectional assembly drawings of windlass electric motors rated 100 *kW* and over, including their ratings, main dimensions, main materials used and weights

(2) Data

(a) Explanation of electric propulsion system

(b) Investigation table of electrical power

(c) List of particulars of high voltage electrical equipment (including test voltage for dielectric strength)

(d) The following data in cases of ships where harmonic filters are installed on the main busbars of electrical distribution systems, except in cases where the filters are installed for single application frequency devices such as pump motors.

i) Total Harmonic Distortion (THD) calculation report

ii) Harmonic filter operation guide

1.1.6 Ambient Conditions

Ambient conditions are to be in compliance with **1.1.7, Part H of the Rules for the Survey and Construction of Steel Ships**.

1.2 Testing

1.2.1 Shop Tests*

1 Electrical equipment specified below is to be tested in accordance with the respective requirements in **Chapter 2, Part H of the Rules for the Survey and Construction of Steel Ships** at the manufacturer's works or at other works which provide with the adequate apparatus for testing and inspections.

(1) Rotating machines for propulsion and their control equipment

(2) Craft service generators of not less than 50 *kVA*

(3) Switchboards with input power of not less than 50 *kVA*

(4) Motors of not less than 50 *kW* for auxiliary machinery specified in **1.1.6-1(1)** to **(3), Part D of the Rules for the Survey and Construction of Steel Ships**, and their control gears

(5) Transformers of single phase not less than 30 *kVA* and three phase not less than 50 *kVA* excluding those for special services such as one for a Suez Canal Search Light

(6) Semiconductor converters for power of not less than 50 *kW* and their respective accessories that are used for supplying power to the electrical equipment specified in **(1)** to **(3)** above

(7) Other electrical equipment as deemed necessary by the Society

2 For the electrical equipment manufactured by mass production system, test procedures suited to their production methods, despite of the requirements in **-1**, may be applied subject to the approval of the Society.

3 Cables for power, lighting and internal communications and semiconductor converters for power of not less than 50 *kW* used for supplying power to the electrical equipment specified in **-1(4)** are to be subjected to type test for each type of product. However, in cases where it is inadequate to deal with them under the requirements for type tests (e.g. those used only for specific ships or purposes with little possibility of continued use, or items for which the acquisition of individual test/inspection certificates is desired), tests and inspections of individual products may be accepted in place of type tests when requested by application.

4 Electrical equipment and cables having a certificate considered acceptable to the Society may be exempted partially and wholly from the tests and inspections.

1.2.2 On Board Tests

After the electrical equipment and cables have been installed on board the craft, they are to be tested and inspected in accordance with the requirements in **2.11**.

1.2.3 Additional Tests and Inspections

The Society may require, when it deems necessary, other tests and inspections than those specified in this part.

Chapter 2 ELECTRICAL INSTALLATIONS AND SYSTEM DESIGN

2.1 General

2.1.1 Scope

This chapter specifies the requirements for electrical equipment and cables, and system design relating to electricity.

2.1.2 Voltage and Frequency*

1 System voltage is not, as a rule, to exceed:

(1) 1,000 *V* for generators, power equipment, and heating and cooking equipment connected to fixed wiring

(2) 250 *V* for lighting, heaters in cabins and public rooms, equipment other than those specified in **(1)**

(3) 15,000 *V a.c.* and 1,500 *V d.c.* installations for electric propulsion

(4) 15,000 *V a.c.* for *a.c.* generators and *a.c.* power equipment meeting the requirements in **2.17, Part H of the Rules for the Survey and Construction of Steel Ships**

2 A frequency of 60 *Hz* is recognized as a standard for all alternating current systems.

3 Electrical equipment is to be designed and manufactured that it is capable of operating satisfactorily under the normally occurring voltage and frequency fluctuations. Unless otherwise specified, electrical equipment is to operate satisfactorily under the fluctuations in voltage and frequency as given in **Table 10.2.1**. Any special system *e.g.* electronic circuits, whose function cannot operate satisfactorily within the limits given in the table is to be supplied by suitable means, *e.g.* through stabilized supply. **Table 10.2.1** is not to apply to electrical equipment of the battery system.

4 In cases where *a.c.* generators are driven at rated speeds, giving rated voltages and rated symmetrical loads, the Total Harmonic Distortion (*THD*) of distribution systems connected such generators is not to exceed values of 5%. However, in cases where specially approved by the Society, the Total Harmonic Distortion (*THD*) may exceed the requirement values.

Table 10.2.1 Voltage and Frequency Fluctuations

	Fluctuations	
Type of fluctuations	Permanent	Transient
Voltage	6%, -10%	±20% (1.5*sec.*)
Frequency	±5%	±10% (5*sec.*)

Note :

Numerical values (excluding time) in the table signify percentages for the rated values.

2.1.3 Construction, Materials, Installations, etc.*

1 Electric machinery parts subject to mechanical strength are to be of defect-free sound material. Their proper fits and clearances are to be consistent with the best marine practice and experience.

2 All electrical equipment is to be so constructed and installed as not to cause injury when handled and touched in the normal manner.

3 Insulating materials and insulated windings are to be resistant to moisture, sea air and oil vapour.

4 Bolts, nuts, pins, screws, terminals, studs, springs and such other small parts are to be made of corrosion resistant material or to be suitably protected against corrosion.

5 All nuts and screws used in connection with current-carrying parts and working parts are to be effectively locked.

6 Electrical equipment is to be accessibly placed in well-ventilated and adequately lighted spaces where it is not exposed to risk of mechanical injury or damage arising from water, steam or oil. Where it is unavoidable to be exposed to such risks, the equipment is to be so constructed as to meet the conditions of the locations.

7 No electrical installations are to be installed in spaces where explosive gases are liable to accumulate or in compartments assigned principally to accumulator batteries, in paint lockers, in acetylene stores or in similar spaces unless the following requirements **(1)** to **(4)** are satisfied:

(1) Electrical equipment essential for operational purposes

(2) Electrical equipment of a type which will not ignite the mixtures concerned

(3) Electrical equipment appropriate to the spaces concerned

(4) Electrical equipment which is appropriately certified for safe usage in dusts, vapours or gases likely to be encountered

8 Electrical equipment and cables are to be placed at such a safe distance from the magnetic compasses or are to be so screened that the interfering external magnetic field is controlled to negligible extent even when circuits are switched on and off.

9 Electrical equipment allowed in paint stores and adjacent areas are to comply with the requirements in **2.1.3-11, Part H of the Rules for the Survey and Construction of Steel Ships**.

2.1.4 Earthing*

1 Non-current-carrying exposed metal parts of electrical equipment which are not intended to be live but which are liable under fault conditions to become live are to be effectively earthed except the following :

(1) They are supplied at a voltage not exceeding 55 *V d.c.* or 55 *V a.c.* root mean square between conductors. However, auto-transformers are not to be used for the purpose of achieving this voltage.

(2) They are supplied at a voltage not exceeding 250 *V* by safety isolating transformers supplying only one consuming device.

(3) They are constructed in accordance with the principle of double isolation.

2 Additional safety means are to be provided for portable electrical apparatus for use in confined or exceptionally damp spaces where particular risks due to conductivity may exist.

3 Where earthing connections are necessary, the earthing conductors are to be of copper or other approved materials, and are to be properly protected against damage, and, where necessary, erosion. The size of the earthing conductors is to be deemed appropriate by the Society according to the cross sectional area of the current carrying conductors and installation of the earthing lines.

4 In case where aluminium superstructures are secured to the steel hull of the craft including insulation to prevent galvanic corrosion between these materials, a separate bonding connection is to be provided between the superstructure and the hull which is to be made in such a manner that galvanic corrosion is avoided and points of connection may be readily inspected.

5 For ships whose main structure is made of non-metallic materials the following additional requirements in **(1)** to **(5)** are also to be met.

(1) All metal parts of the craft are to be earthed to the sea water, in so far as possible in consideration of galvanic corrosion between dissimilar metals.

The earthing of isolated components inside the structure is not generally necessary, except in fuel tanks.

(2) Each pressure refuelling point is to be provided with a means of earthing the fuelling equipment to the ship.

(3) Metallic pipes capable of generating electrostatic discharges, due to the flow of liquids and gases are to be bonded so as to be electrically continuous throughout their length and are to be adequately earthed.

(4) Secondary conductors provided for the equalisation of static discharges, bonding of equipment, etc. are to have a minimum cross section of 5 mm^2 in copper or equivalent surge carrying capacity in aluminium.

(5) The electrical resistance between bonded objects and the basic structure is not to exceed 0.05Ω The bonding path is to have sufficient cross-sectional area to carry the maximum current likely to be imposed on it without excessive voltage drop.

2.2 System Design - General

2.2.1 Distribution Systems*

1 The following distribution systems are considered as a standard:

(1) Two-wire direct current

(2) Three-wire direct current (three-wire insulated system or three-wire mid-wire earthed system)

(3) Two-wire, single-phase alternating current

(4) Three-wire, three-phase alternating current

(5) Four-wire, three-phase alternating current

2 Notwithstanding the requirement in **-1**, a hull return distribution system may be used for the following system.

(1) Impressed current cathodic protection systems for external hull protection

(2) Limited and locally earthed systems, provided that any possible resulting current does not flow directly through any dangerous spaces

(3) Insulation monitoring systems provided the circulation current does not exceed 30 *mA* under any circumstances

2.2.2 Insulation Monitoring System*

When a distribution system, whether primary or secondary, for power, heating or lighting, with no connection to earth is used, a device capable of continuously monitoring the insulation level to earth and of giving an audible or visual indication of abnormally low insulation values is to be provided. For craft with a gross tonnage less than 500 *tons*, insulation monitoring system may be replaced with earth indicating lamps.

2.2.3 Unbalance of Loads

1 Unbalance of loads between an outer conductor and the middle wire at the switchboards, section boards and distribution boards is not to exceed 15% of the full load current as far as possible.

2 Unbalance of loads on each phase at the switchboards, section boards and distribution boards is not to exceed 15% of the full load current as far as possible.

2.2.4 Diversity Factor

1 Circuits supplying two or more final-subcircuits are to be rated in accordance with the total connected load subject, where justifiable, to the application of a diversity factor.

2 The diversity factor specified in **-1** may be applied to the calculation of the cross sectional area of conductors and ratings of switchgears (including circuit breakers and switches) and fuses.

2.2.5 Feeder Circuits

1 Motors for essential services requiring dual arrangement are to be supplied by individual circuits without the use of common feeders, protective devices and controlgears.

2 Auxiliaries in the machinery spaces, cargo gears and ventilating fans are to be independently supplied from switchboards or distribution boards.

3 Ventilating fans for the cargo holds and those for the accommodation spaces are not to be supplied from the common feeder circuits.

4 Lighting circuits and motor circuits are to be arranged to be supplied independently from the switchboards.

5 A final sub-circuit of rating exceeding 16 *A* is not to supply more than one appliance.

2.2.6 Motor Circuits

A separate final sub-circuit is to be provided, as a rule, for every motor for essential service and for every motor of rating at 1 *kW* or more.

2.2.7 Lighting Circuits

1 Final sub-circuits used for lighting circuits are to be supplied separately from those for heating and power except in cases where such sub-circuits are used for cabin fans and electrical appliances for domestic use.

2 The number of lighting points supplied by final sub-circuit of rating 16 *A* or less is not to exceed:

(1) 10 for the circuits up to 55 *V*

(2) 14 for the circuits from 56 *V* up to 120 *V*

(3) 24 for the circuits from 121 *V* up to 250 *V*

In cases where the number of lighting points and total load current are invariable, a number of points greater than those specified above may be connected to final sub-circuits provided that the aggregate load currents do not exceed 80% of the ratings of protective devices in such circuits.

3 In final sub-circuits of ratings not exceeding 10 *A* for panel lighting and electric signs, in cases where lampholders are closely grouped, the number of points supplied is unrestricted.

4 In spaces where the main engine or boilers are provided, lighting is to be supplied from at least two circuits and to be so arranged that failure of any one circuit will not leave these spaces in darkness. One of the circuits may be reserve lighting circuit or emergency lighting circuit.

2.2.8 Circuits for Internal Communication Systems and Navigational Aids

1 Essential internal communication and signal systems and navigational aids are to have completely self-sustaining independent circuits for ensuring the perfect maintenance of their functions as far as possible.

2 Cables for communication systems are to be so arranged that no induced interference would be caused.

3 No switch is to be provided for feeder circuits of general alarm devices, except for operating switch. Where circuit breaker is used, a suitable means is to be taken to prevent the breaker from being kept in the "*off*" position.

2.2.9 Circuits for Radio Installations

Feeder circuits for radio installations and the lighting in the control station of radio installations are to be arranged in accordance with the requirements of relevant national regulations.

2.2.10 Circuits for Electric Heating and Cooking Equipment

1 Each item of electric heating and cooking equipment is to be connected to a separate final sub-circuit except that up to 10 small electric heaters of aggregate current rating not exceeding 16 *A* may be connected to single final sub-circuit.

2 Electric heating and cooking equipment are to be controlled by the multipole linked switches mounted in the vicinity of the equipment. However, small electric heaters connected to a final sub-circuit of rating not exceeding 16 *A* may be controlled by a single-pole switch.

2.2.11 Circuits for Shore Connection*

1 Where arrangements are made for the supply of electricity from a source on shore, a connection box is to be installed in a suitable position. In case where shore connection cables can be drawn into a switchboard easily and put into service safely, or, where a shore connection receptacle with a permanently fixed cable is installed and put into service safely, the connection box may be omitted provided the protective devices and checking devices specified in **-2** are equipped on the switchboard.

2 The connection box is to contain terminals to facilitate a satisfactory connection and a circuit-breaker or an isolating switch with fuses. A means is to be provided for checking the phase sequence (for three-phase alternating current) or the polarity (for direct current).

3 In case where power is supplied from the three-wire neutral earthed system, an earth terminal is to be provided for connecting the hull to an appropriate earth in addition to those specified in **-2**.

4 At the connection box a notice is to be provided giving information on the system of supply and nominal voltage (and frequency if *a.c.*) of the system and the procedure for carrying out the connection.

5 Cables between the connection box and the switchboard are to be permanently fixed and a pilot lamp for source and a switch or a circuit-breaker are to be provided on the switchboard.

2.2.12 Disconnecting Switches of Circuits*

1 Power circuits and lighting circuits terminating in cargo holds are to be provided with multipole linked switches situated outside these spaces. Provision is to be made for locking in the "*off*" position of the switches or switch boxes for these lighting circuits.

2 Feeder circuits for the electrical equipment installed in hazardous areas are to be provided with multipole linked isolation switches in a safe space. In addition, the isolation switches are to be clearly labelled to identify the electrical equipment to be connected with.

2.2.13 Remote Stopping of Ventilating Fans and Pumps*

1 Remote stopping of ventilating fans and pumps is to comply with the requirements in **5.2.1-2** and **5.2.2-2** through **-4**, **Part R of the Rules for the Survey and Construction of Steel Ships**.

2 In case where fuses are used to protect a remote stopping circuit specified in **5.2.1-2** and **5.2.2-2** through **-4**, **Part R of the Rules for the Survey and Construction of Steel Ships** and is only closed when it operates, consideration is to be given against the fuse element failure.

2.3 System Design - Protection

2.3.1 General

Electrical installations of ships are to be protected against accidental overcurrents including short-circuit. The protective devices are to be capable of continuously serving other circuits as far as possible by breaking a fault circuit and eliminating damage to the system and hazard of fire.

2.3.2 Protection against Overload

1 The overcurrent trip characteristics of circuit-breakers and the fusing characteristics of fuses are to be chosen suitably taking into consideration the thermal capacity of electrical equipment and cables to be protected thereby. Fuses above 200 *A* are not to be

used for overload protection.

2 The ratings or appropriate setting of the overload protection device for each circuit are to be permanently indicated at the location of the protection device, and the current-carrying capacity of each circuit is to be indicated.

3 The overload relays of circuit-breakers for generators and overload protections, except moulded-case circuit breakers, are to be capable of adjusting their current setting and time-delay characteristics.

2.3.3 Protection against Short-circuit

1 The breaking capacity of every protective device is to be not less than the maximum value of the short-circuit current which can flow at the point of installation at the instant of constant separation.

2 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. On alternating current this maximum value corresponds to the peak value allowing for maximum asymmetry.

3 In case where the rated breaking capacity and/or rated making capacity of short-circuit protection are/is not in compliance with the requirements in **-1** and **-2**, fuses or circuit-breakers having the breaking capacity not less than the prospective short-circuit current are to be provided at the power source side of the foregoing short-circuit protection. Circuit-breakers for the generator are not to be used for this purpose. The circuit-breakers connected to the load side are not to be excessively damaged and are to be capable of further service in the following cases :

(1) When the short-circuit current is broken by the back-up circuit-breaker or fuse.

(2) When the circuit-breaker connected to the load side is closed on the short-circuit current while the back-up circuit-breaker or fuse breaks the current.

2.3.4 Protection of Circuits

1 Each pole and phase of all insulated circuits except neutral and equalizer circuits are to be provided with short-circuit protection.

2 All circuits liable to be overloaded are to be provided with overload protection as indicated below:

(1) Two-wire *d.c.* or single-phase *a.c.* system : at least one line or phase

(2) Three-wire *d.c.* system : both outer lines

(3) Three-phase, three-wire system : at least two phases

(4) Three-phase, four-wire system : each phase

3 A fuse, a non-linked switch or a non-linked circuit-breaker is not to be inserted in an earthed conductor and a neutral line.

2.3.5 Protection of Generators*

1 Generators are to be protected against short-circuit and overcurrent by a multipole circuit-breaker arranged to open simultaneously all insulated poles, or in the case of generators less than 50 *kW* not arranged to run in parallel, may be protected by a multipole-linked switch with fuse or a circuit-breaker in each insulated pole. The overload protection is to be suitable to the thermal capacity of generators.

2 For *d.c.* generators arranged to operate in parallel, in addition to the requirement in **-1**, an instantaneous reverse-current protection, operating at a fixed value of reverse-current within the limits of 2% to 15% of the rated current of the generator, is to be provided. This requirement, however, does not apply to the reverse-current generated from load side, *e.g.* cargo winch motors, etc.

3 For *a.c.* generators arranged to operate in parallel, in addition to the requirement in **-1**, a reverse-power protection, with time delay, selected and set within the limits of 2% to 15% of the full load to a value fixed in accordance with the characteristics of the prime mover, is to be provided.

2.3.6 Protection of Essential Services

Where generators are operated in parallel and essential machinery is electrically driven, arrangements are to be made to disconnect automatically the excess non-essential loads when the generators are overloaded. If required, this preference tripping may be carried out in one or more stages.

2.3.7 Protection of Feeder Circuits*

1 Supply circuits to section boards, distribution boards, grouped starters and the similar are to be protected against overload and short-circuit by multi-pole circuit-breakers or fuses. In case where the fuses are used, an isolating switch is to be provided at the power source side of the fuses.

2 Each insulated pole of the final sub-circuits is to be protected against short-circuit and overload by a circuit-breaker or

fuse. In case where fuses are used, an isolating switch is, as a rule, to be provided at the power source side of the fuses. And for the protection of supply circuits of the steering gears, the requirements in **15.2.7, Part D of the Rules for the Survey and Construction of Steel Ships** are to apply.

3 Circuits which supply motors fitted with overload protection may be provided with short-circuit protection only.

4 In case where fuses are used to protect three-phase a.c. motor circuits, consideration is to be given to protection against single phasing.

5 In case where condensers for phase advance are used, overvoltage protective devices are to be installed as required.

2.3.8 Protection of Power and Lighting Transformers

1 The primary circuits of power and lighting transformers are to be protected against short-circuit and overcurrent by multipole circuit-breakers or fuses.

2 When transformers are arranged to operate in parallel, a means of isolation is to be provided on the secondary circuits.

2.3.9 Protection of Electric Motors

1 Motors of rating exceeding 0.5 *kW* and all motors for essential services, except the motors for steering gears, are to be protected individually against overload. The overload protection for motors for the steering gears is to comply with the requirements in **15.2.7, Part D of the Rules for the Survey and Construction of Steel Ships**.

2 The protective devices are to have a delay characteristics to enable the motor to start.

3 For motors for intermittent services, the current setting and the delay are to be chosen in relation to the load factor of the motor.

2.3.10 Protection of Lighting

Lighting circuits are to be protected against short-circuit and overload.

2.3.11 Protection of Meters, Pilot Lamps and Control Circuits

1 Protection is to be provided for voltmeters, voltage coils of measuring instruments, earth indicating devices and pilot lamps together with their connecting leads by means of fuses fitted to each insulating pole. A pilot lamp installed as an integral part of another item of equipment need not be individually protected, provided that any damage of pilot lamp circuit does not cause failures on the supply to essential equipment.

2 Insulated wires for control and instrument circuits directly led from busbars and generator mains are to be protected by fuses at the nearest location to the connecting points. Insulated wires between the fuses and the connecting points are not to be bunched together with wires for other circuits.

3 Fuses in circuits such as those of automatic voltage regulators where loss of voltage might have serious consequences may be omitted. If omitted, a proper means is to be provided to prevent risk of fire in the unprotected part of the installation.

2.3.12 Protection of Batteries

Accumulator batteries other than engine starting batteries are to be protected against overload and short-circuit with devices placed as near as practicable to the batteries. Emergency batteries supplying essential services may have short-circuit protection only.

2.4 Electrical Equipment and Cables - General

2.4.1 Rotating Machines

Rotating machines are to comply with the requirements in **2.4, Part H of the Rules for the Survey and Construction of Steel Ships**.

2.4.2 Transformers for Power and Lighting

Transformers for power and lighting are to comply with the requirements in **2.10, Part H of the Rules for the Survey and Construction of Steel Ships**.

2.4.3 Circuit-breakers

Circuit-breakers are to comply with the requirements in **2.6.1, Part H of the Rules for the Survey and Construction of Steel Ships**.

2.4.4 Fuses

Fuses are to comply with the requirements in **2.6.2, Part H of Rules for the Survey and Construction of Steel Ships**.

2.4.5 Electromagnetic Contactors

Electromagnetic contactors are to comply with the requirements in **2.6.3, Part H of the Rules for the Survey and Construction of Steel Ships**.

2.4.6 Semiconductor Converters for Power

Semiconductor converters for power are to comply with the requirements in **2.12, Part H of the Rules for the Survey and Construction of Steel Ships**.

2.4.7 Lighting Fittings and Wiring Accessories

Lighting fittings and wiring accessories are respectively to comply with the requirements in **2.13** and **2.14, Part H of the Rules for the Survey and Construction of Steel Ships**.

2.4.8 Heating and Cooking Equipment

Heating and cooking equipment is to comply with the requirements in **4.4.1, Part R of the Rules for the Survey and Construction of Steel Ships**.

2.5 Switchboards, Section Boards and Distribution Boards

2.5.1 Location*

Switchboards are to be installed in dry places away from the vicinity of steam, water and oil pipes as possible.

2.5.2 Safety Precautions to Operators*

1 Switchboards are to be so arranged as to give easy access to each component without danger to personnel.

2 The sides and the rear and, where necessary, the front of switchboards are to be suitably guarded.

3 For voltage between poles, or to earth, exceeding 55 *V d.c.* or 55 *V a.c.* root mean square, switchboards are to be of dead front type.

4 Insulated handrails are to be provided on the front and the rear faces of switchboards, and where necessary, insulated mats or gratings are to be provided on the floor of passageway.

5 Sufficient space for operation is to be provided in front of switchboards. Where necessary, space at the rear of switchboards is provided to permit operation and maintenance of disconnecting switches, switches, fuses and other parts, the passageway is to be more than 0.5 *m* in width.

6 Section boards and distribution boards are to have suitable protective enclosures depending on their location. If they are installed in such a location that they are readily accessible for persons other than those responsible operators, proper protection is to be arranged so that safety can be ensured in normal operation.

2.5.3 Construction and Materials*

1 Busbars, circuit-breakers and other electrical appliances of main switchboards are to be so arranged that essential electrical equipment required to be installed in duplicate will not become unserviceable simultaneously by a single fault.

2 In cases where main sources of electrical power are necessary for ship propulsion, main switchboards are to comply with the following requirements or are to be equivalent in performance thereto:

(1) Generator switchboards are to be provided for each generator, and those switchboards adjoining each other are to be partitioned by the walls of steel or flame-retardant material.

(2) Main busbars are to be subdivided into at least two parts which are to be normally connected by circuit breakers or other approved means. So far as it is practicable, any connection of generating sets and other duplicated equipment are to be equally divided among such parts.

3 Cable entries of switchboards are to be so constructed that no ingress of water into the switchboard is permitted along the cables.

4 In case where the supply circuits having different voltages are installed in the same space of a switchboard, a section board or a distribution board, all appliances are to be so arranged that the cables of different rated voltages can be laid without coming to contact with each other within the board.

5 The enclosures are to be of robust construction and their materials used are to be incombustible and non-hygroscopic.

6 Insulating materials are to be durable, flame-retardant and non-hygroscopic.

7 Wiring materials are to conform to the following requirements.

(1) Insulated wires for switchboards are to be flame-retardant and non-hygroscopic which have appropriate maximum permissible

conductor temperatures of not less than 75 °C.

(2) Ducts and straps for wiring are to be of flame-retardant materials.

(3) Insulated wires for control and instrument circuits are not to be bunched together with wires for main circuits and not to be in the same duct. However, if the rated voltages and maximum permissible temperatures of conductors are the same each other and no injurious effects are imposed by the main circuits, this requirement may not be applied.

8 Except where an isolation switch is provided, circuit breakers are to be such that repairing and replacing can be made without disconnecting them from the busbar connections and switching off the power source.

2.5.4 Busbars

Busbars and connecting conductors are to comply with the requirements in **2.5.4, Part H of the Rules for the Survey and Construction of Steel Ships**.

2.5.5 Equalizer

1 The current rating of equalizer connections and equalizer switches is not to be less than a half of the rated full load current of the generator.

2 The current rating of equalizer busbars is not to be less than a half of the rated full-load current of the largest generator in the group.

2.5.6 Measuring Instruments for *d.c.* Generators

Ship's service *d.c.* generator panels are at least to be provided with the instruments as given in **Table 10.2.3**.

2.5.7 Measuring Instruments for *a.c.* Generators

Ship's service *a.c.* generator panels are at least to be provided with the instruments as given in **Table 10.2.4**.

Table 10.2.3 Instruments for ***d.c.*** Generator Panel

Operation	Instrument	Number required	
		2-wire system	3-wire system
Not parallel	Ammeter	1 for each generator (positive pole)	*2 for each generator (positive and negative poles)
	Voltmeter	1 for each generator	1 for eachgenerator (voltage measurement between positive and negative poles or between positive or negative pole and neutral poles)
Parallel	Ammeter	1 for each generator (positive pole)	*2 for each generator (in case of compound winding, between equalizer and armature, and in case of shunt winding, for positive and negative poles)
	Voltmeter	2 (busbar and each generator)	2 (voltage measurement between busbar and positive and negative poles of each generator, or between positive pole and neutral pole)

Notes:

1. When employed neutral line earthed system, a zero centre ammeter for the earth line is to be added to the number marked with * in the above table.
2. One of the voltmeters is to be capable of measuring shore supply voltage.
3. Where a control panel is provided for automatic control of generators, the instruments in the above table may be installed on the control panel, except that, if the control panel is installed outside engine room, the minimum number of instruments required to carry out single or parallel operation of generators is to be mounted of the switchboard.
4. In case where there are two or more generators which are not operated in parallel, one ammeter and one voltmeter may be permitted provided that one portable voltmeter and one portable ammeter are located on board.

Table 10.2.4 Instruments for ***a.c.*** Generator Panel

Operation	Instrument	Number required
Not parallel	Ammeter	1 for each generator (current measurement of each phase)
	Voltmeter	1 for each generator (current measurement of each line voltage)
	Wattmeter	1 for each generator (it may be omitted for *50kVA* or less)
	Frequency meter	1 (frequency measurement of each generator)
	*Ammeter	1 for exciting circuit of each generator
Parallel	Ammeter	1 for each generator (current measurement of each phase)
	Voltmeter	2 (measurement of busbar's voltage and each line voltage of generators)
	Wattmeter	1 for each generator
	Frequency meter	2 (frequency measurement of each generator and busbar)
	Synchroscope and synchronizing lamps	1 set each In case where an automatic synchroscope is provided, either one of these may be omitted
	*Ammeter	1 for exciting circuit of each generator

Notes:

1. In the above table, the ammeter marked with * is to be provided where necessary only.
2. One of the voltmeters is to be capable of measuring shore supply voltage.
3. Where a control panel is provided for automatic control of generators, the instruments given in the above table may be installed on the control panel, except that, if the control panel is installed outside engine room, the minimum number of instruments required to carry out single or parallel operation of generators is to be mounted on the switchboard.
4. In case where there are two or more generators which are not operated in parallel, one ammeter and one voltmeter may be permitted provided that one portable voltmeter and one portable ammeter are located on board.

2.5.8 Instrument Scales

1 The upper limit of the scale of every voltmeter is to be approximately 120% of the normal voltage of the circuit.

2 The upper limit of the scale of every ammeter is to be approximately 130% of the normal rating of the circuit.

3 Ammeters for use with *d.c.* generators and wattmeters for use with *a.c.* generators which may operate in parallel are to be capable of indicating reverse current or reverse power up to 15% respectively.

2.5.9 Transformers for Instruments

The secondary windings of transformers for instruments are to be earthed.

2.6 Controlgears for Motors

2.6.1 Controlgears for Motors

1 Controlgears for motors are to be durably constructed and provided with efficient means of starting, stopping, reversing and speed controlling of motors together with essential safety devices.

2 Controlgears for motors are to be provided with protective enclosures suitable for their location and to allow safe operation for the personnel.

3 All wearing parts of controlgears are to be readily replaceable and accessible for inspection and maintenance.

4 Motors above 0.5 *kW* are to be provided with the controlgears complying with the requirements in **-1**, **-2** and **-3** and in the following:

(1) A means is to be provided to prevent undesired restarting after stoppage due to low voltage or complete loss of voltage. This requirement does not apply to motors, continuous availability of which is essential to the safety of the craft and to motors with automatic operation.

(2) A primary means of isolation is to be provided so that all voltages may be cut off from the motor, except where a means of isolation (that provided at the switchboard, the section board, the distribution board, etc.) is adjacent to the motor.

(3) A means for automatic disconnection of the power supply is to be provided in the event of excess current due to mechanical overloading of the motor. This requirement does not apply to motors for steering gears.

5 In case where the primary means of isolation is remote from the motor, either of the following means or the equivalent is to be provided:

(1) An additional means of isolation fitted adjacent to the motor is to be provided.

(2) Provision is made for locking the primary means of isolation in the "*off*" position.

6 When fuses are used to protect three-phase a.c. motor circuits, consideration is to be given to protect against single phasing.

7 Running indicators and overload alarms for motors for steering gears are to comply with the requirements in **15.2.7, Part D of the Rules for the Survey and Construction of Steel Ships**.

2.7 Cables

2.7.1 General

Cables are to comply with one of *IEC* standards listed in the following **(1)** to **(7)** or equivalent thereto. However, cables such as flexible cables, fibre-optic cables, etc. used for special purposes may be accepted provided they comply with relevant standards deemed appropriate by the Society or any equivalent thereto. Installation of cables is to comply with the requirements in this **2.7**.

(1) *IEC* 60092-350:2020

(2) *IEC* 60092-352:2005

(3) *IEC* 60092-353:2016

(4) *IEC* 60092-354:2020

(5) *IEC* 60092-360:2014

(6) *IEC* 60092-370:2019

(7) *IEC* 60092-376:2017

2.7.2 Installation of Cables

1 Cables are to have a construction as to meet the conditions of the locations. Cables fitted in spaces where they are likely to suffer from mechanical damages are to be suitably protected by means of, *e.g.*, effective metal casings.

2 Cable runs are to be, as far as possible, straight and accessible.

3 The installation of cables across expansion joints in the craft's structure is to be avoided as far as possible. Where such installation is unavoidable, a loop of cable of length proportional to the expansion of the joint is to be provided. The internal radius of the loop is to be at least 12 times the external diameter of the cable.

4 Where a duplicate supply is required, the two cables are to follow different routes which are to be as far apart as practicable.

5 Cables having insulating materials with different maximum-rated conductor temperatures are not to be bunched together, or, where such bunching is unavoidable, the cables are to be operated so that no cable may reach a temperature higher than that permitted for the lowest temperature-rated cable in the group.

6 Cables having a protective covering which may damage the covering of other cables are not to be bunched together with those other cables.

7 When installing cables, the minimum inside radius of bend is to be in accordance with the following:

(1) Armoured rubber insulated and *PVC* insulated cables: $6d$

(2) Unarmoured rubber insulated and *PVC* insulated cables:

$4d$ ($d \leq 25mm$)

$6d$ ($d > 25\ mm$)

(3) Mineral insulated cables: $6d$

(d : overall diameter of the finished cables)

8 Intrinsically safe circuits are to be installed complying with the followings;

(1) The cables for intrinsically safe circuits associated with intrinsically safe type electrical equipment are to be of exclusive use, being installed separately from cables for general circuits.

(2) Intrinsically safe circuits associated with different intrinsically safe type electrical equipment are, as a rule, to be wired individually using different cables. Where it is necessary to use a multi-core cable in common, a cable which has shields by

each core or each pair of cores is to be used, having such shields earthed effectively. However, intrinsically safe circuits associated with category '*ia*' intrinsically safe type electrical equipment is not to be contained in a cable associated with category '*ib*' intrinsically safe type electrical equipment.

9 Metallic coverings of cables are to be effectively earthed at both ends, except that in final sub-circuits earthing may be at the supply end only. This does not necessarily apply to instrumentation cables where single point earthing may be desirable for technical reasons.

10 Effective means are to be taken to ensure that all metallic coverings of cables are made electrically continuous throughout their length.

11 Cables and wires are to be so supported and secured that they may not be injured by chafing or other mechanical damage.

12 Penetration of bulkheads and decks, which are required to have some degree of strength and tightness, is to be so carried out by means of cable glands or boxes as to ensure that the strength and tightness are not impaired.

13 Where cables pass through non-watertight bulkheads or structures, bushings or other suitable means are to be provided in order to avoid damage to cables. If the thickness of the steel is sufficient ($\geq 6mm$) and there is no risk of damage to cables, adequately rounded edges may be accepted as the equivalent of bushing.

14 The choice of the materials for glands and bushings is to be such that there is no risk of corrosion.

15 Penetration through bulkheads and decks, which are to have some degree of fire integrity is to be so effected as to ensure that the fire integrity is not impaired.

2.7.3 Terminals, Joints and Branches of Cables*

1 Cables are to be jointed by terminals. However, in cases where deemed appropriate by the Society, these requirements do not apply. Soldering fluxes containing corrosive substances are not to be used.

2 Terminals are to have sufficient contacting surface and pressure.

3 The length of soldered parts of copper tube terminals and other terminals is not to be less than 1.5 times the diameter of conductors.

4 Cables not having a moisture-resistant insulation (*e.g.*, mineral insulation) are to have their ends effectively sealed against ingress of moisture.

5 Terminals and joints (including branches) of all cables are to be so made as to retain the original electrical, mechanical, flame-retardant and, where necessary, fire-resisting properties of the cable.

6 Terminals and conductors are to be of dimensions adequate for the cable rating.

2.7.4 Precaution against Fire*

All cables for essential services are to be so far as practicable routed clear of machinery spaces of Category *A* and their casings, galleys, laundries and other high fire risk areas.

2.7.5 Cables in Hazardous Areas

Where cables which are installed in hazardous areas introduce the risk of fire or explosion in the event of an electrical fault in such areas, proper protections against such risks are to be provided.

2.8 Accumulator Batteries

2.8.1 General*

1 The requirements in this **2.8** apply to all permanently installed vented types of secondary batteries. However, the requirements specified in **2.8.5-4** are also applicable to valve-regulated sealed types of batteries.

2 Accumulator battery systems consisting of lithium-ion batteries with total capacities of 20 *kWh* or more and associated equipment are to be in accordance with **Annex 2.11.1-2, Part H of the Rules for the Survey and Construction of Steel Ships**.

3 Any usage of types of secondary batteries other than vented types of secondary batteries and the secondary batteries specified in **-2** above is to be required as deemed appropriate by the Society.

4 Accumulator batteries are to be able to suitably perform with respect to their intended services.

2.8.2 Construction

Cells of all batteries are to be so constructed and secured as to prevent spilling of the electrolyte due to craft's motions and to prevent emission of acid or alkaline spray.

2.8.3 Location*

1 Alkaline batteries and lead acid batteries are not to be installed in the same compartment.

2 Large batteries are to be installed in compartment assigned to them only. They may be installed in a box on deck if adequately ventilated and provided with means to prevent ingress of water.

3 Engine starting batteries are to be located as close as practicable to the engine(s) served.

4 Batteries are not to be placed in the living quarters.

2.8.4 Installation Procedures and Protection of Corrosion

1 Batteries are to be arranged to permit ready access for replacing, inspection, testing, replenishing and cleaning.

2 Cells or crates are to be placed on non-absorbent isolating supports. They are to be fitted to prevent any movement due to craft's motions.

3 In case where acid is used as the electrolyte, a tray of acid resisting materials is to be provided below the cells unless the deck below is similarly protected.

4 The interior of the battery compartment including the shelves is to be coated with corrosion-resistant paint.

5 The interior of ventilating ducts and impellers of ventilating fans are to be coated with corrosion-resistant paint unless ducts and fans are made of corrosion-resistant material.

2.8.5 Ventilation*

1 Battery compartments are to be adequately ventilated by an independent ventilating system.

2 In case where natural ventilation is employed, the ventilation ducts are to be run directly from the top of the battery compartment to the open air above, with no part of the ducts more than 45 degrees from the vertical.

3 If natural ventilation is impracticable, mechanical exhaust-ventilation is to be provided. The electric motors for the ventilation fans are not to be placed inside the ducts. Ventilating fans are to be so constructed and to be of such a material as to render sparking impossible in the event of the impeller touching the fan casing.

4 The ventilation arrangements for installation of vented type batteries which have charging power higher than 2 *kW* are to be such that the quantity of air expelled is at least equal to:

$$Q = 110 \times I \times n \ (l/h)$$

I : Maximum current delivered by the charging equipment during gas formation, but not less than 25 % of the maximum obtainable charging current in amperes

n : Number of cells in series

Q : Quantity of air expelled in litres/hour

The ventilation rate for compartments containing valve-regulated sealed type batteries may be reduced to 25 % of that given above.

2.8.6 Electrical Installations*

1 Switches, fuses and other electrical installations liable to cause an arc are not to be installed in battery compartments.

2 Lighting fittings provided within battery compartments are to be suitable for use in explosive atmosphere classified into gas and vapour group IIC, temperature class *T*1 and construction suitable for use in Zone 1 as specified in *IEC* 60079, or equivalent thereto.

3 Cables other than those for batteries and electrical installations specified in **-2** are, as a rule, not to be installed in battery compartments except where installation in other locations is impracticable.

2.8.7 Charging Facilities

1 Suitable charging facilities are to be provided. Battery charging facilities by means of *d.c.* generator and series resister are to be provided with protection against reversal of current when the charging voltage is 20% of the line voltage or higher.

2 For floating service or for any other conditions where the load is connected to the battery while it is on charge, the maximum battery voltage under any conditions of charge is not to exceed the safe value of any connected apparatus. A voltage regulator or other means of voltage control may be provided for this purpose.

2.9 Explosion-protected Electrical Equipment

2.9.1 General

1 Explosion-protected electrical equipment is to comply with the requirements in **2.16, Part H of the Rules for the Survey and Construction of Steel Ships**.

2 Explosion-protected electrical equipment is to be provided with a certificate which is deemed appropriate by the Society.

2.10 High Voltage Electrical Installations

2.10.1 High Voltage Electrical Installations

High voltage electrical installations are to comply with the requirements in **2.17, Part H of the Rules for the Survey and Construction of Steel Ships**.

2.11 Tests after Installation On Board

2.11.1 Insulation Resistance Test

1 Each circuit of power and lighting is to have insulation resistances not less than the values in **Table 10.2.5** between conductors and between each conductor and earth.

2 Insulation resistances of internal communication circuits are to comply with the following requirements **(1)** to **(3)** :

(1) Each circuit of 100 V and above is to have an insulation resistance not less than $1M\Omega$ between conductors and between each conductor and earth.

(2) For circuits below 100 V, the insulation resistance is to be at least $1/3M\Omega$.

(3) During the test for **(1)** and **(2)**, any or all appliances connected thereto may be disconnected from the circuit.

Table 10.2.5 Minimum Insulation Resistance

Rated voltage Un (V)	Minimum test voltage (V)	Minimum insulation resistance ($M\Omega$)
$Un \leq 250$	$2 \times Un$	1
$250 < Un \leq 1{,}000$	500	1
$1{,}000 < Un \leq 7{,}200$	1,000	$Un/1{,}000 + 1$
$7{,}200 < Un$	5,000	$Un/1{,}000 + 1$

Note:

During the above test, any or all electric heaters, small appliances and the like connected thereto may be disconnected from the circuit.

2.11.2 Performance Tests

1 All electrical equipment is to be examined under normal conditions to demonstrate its proper operation with no harmful vibration nor temperature rise.

2 Among the examinations specified in **-1**, the following tests concerning generators and switchboards are to be included.

(1) The operation test of overspeed trip and other safety devices of generators

(2) The voltage regulation test and the parallel operation test of generators

Chapter 3 DESIGN OF INSTALLATIONS

3.1 General

3.1.1 General

This chapter specifies the requirements for the design of installations of main source of electrical power, emergency source of electrical power and other electrical installations on board craft.

3.1.2 Design and Construction

Electrical installations are to comply with the following:

(1) All electrical auxiliary services necessary for maintaining the craft in normal operational and habitable conditions and other electrical services as deemed necessary by the Society will be ensured without recource to the reserve or emergency source of electrical power;

(2) Electrical services essential for safety will be ensured under various emergency conditions; and

(3) The safety of passengers, crew and craft from electrical hazards will be ensured.

3.2 Source of Electrical Power and Lighting Systems

3.2.1 Main Source of Electrical Power in Cargo Craft

1 A main source of electrical power of sufficient capacity to supply all those services specified in **3.1.2(1)** is to be provided.

2 The arrangements of the ship's main source of electrical power are to be such that the services referred to the requirement in **3.1.2(1)** can be maintained regardless of the speed and direction of the propulsion machinery or shafting.

3.2.2 Lighting Systems

1 A main electric lighting system supplied from the main source of electrical power is to be provided in spaces or compartments where crew use and normally work on duty.

2 Reserve lighting providing sufficient illumination necessary for the safety is to be provided at/in the following spaces.

(1) Every muster and embarkation station, and over sides

(2) All alleyways, stairways and exits, personnel lift cars and personnel lift trunks

(3) Machinery spaces and a location of the reserve source of electrical power

(4) Main engine control stations

3.2.3 Reserve Source of Electrical Power

A reserve source of electrical power capable of supplying simultaneously the services listed in the following for 4 *hours* (for continuous 30 *minutes* for intermittent operation services of signals and alarms) is to be provided.

(1) Reserve lighting specified in **3.2.2-2**

(2) Navigation lights and other lights, and sound signals

(3) All internal communication equipment as required in an emergency

(4) Fire detection and alarm systems required by **1.2.4, Part 9** and **3.1, Part 11**

3.3 Navigation Lights, Other Lights, Internal Signals, etc.

3.3.1 Navigation Lights

1 Navigation lights are to be connected separately to the navigation light indicator panel.

2 Each navigation light is to be controlled and protected in each insulated pole by a switch with fuses or a circuit breaker fitted on the navigation light indicator panel.

3 The navigation light indicator panel is to be power supplied by a separate circuit from the main switchboard and the reserve source of electrical power or the lighting distribution panel provided on the navigation bridge (limited to the case where two or more generating sets are provided). However, in craft with a gross tonnage of less than 500 *tonnes*, a single circuit from the charging and

discharging panels supplied by main sources of electrical power (through main switchboards) and reserve sources of electrical power is deemed acceptable.

4 Switches and fuses are not to be provided on the feeder circuits of navigation lights, except the switchboards and indicator panel.

5 The navigation light indicator panel is to be placed in an accessible position on the navigation bridge.

6 In the event of the failure of navigation lights due to blown bulbs, short-circuits, etc., visual and audible alarms are to activate on navigation light indicator panels. Such alarm devices are to be fed from the main sources and reserve sources of power and their feeder circuits are to be independent of the feeder circuits from navigation light indicator panels to navigation lights.

3.3.2 Not under Command Lights, Anchor Lights and Signal Lights

Not under command lights, anchor lights and signal lights are to be power supplied from both main source of electrical power and reserve source of electrical power.

3.3.3 General Emergency Alarm Systems

General emergency alarm systems are to be power supplied from both main source of electrical power and reserve source of electrical power.

3.4 Lightning Conductors

3.4.1 General

Lightning conductors are to be fitted on each mast of ships having non metallic masts or topmasts.

3.4.2 Construction

1 Lightning conductors are to be composed of continuous copper tape or rope having a section not less than 75 mm^2 which is riveted with copper rivets or fastened with copper clamps to a suitable copper spike not less than 12 *mm* in diameter, projecting at least 150 *mm* above the top of the mast. At the lower end, this copper tape or rope is to be securely earthed to the sea water.

2 Lightning conductors are to be run as straight as possible, and sharp bends in the conductors are to be avoided. All clamps used are to be of brass or copper, preferably of the serrated contact type, and effectively locked. No connection is to be dependent on a soldered joint.

3 The resistance of lightning conductor between the mast top and the point on the earth plate or hull is not to exceed 0.02 Ω.

Chapter 4 ADDITIONAL REQUIREMENTS FOR CRAFT CARRYING SPECIAL CARGOES

4.1 Enclosed Cargo Holds for Carrying Motor Vehicles with Fuel in their Tanks for their Own Propulsion and Enclosed Compartments Adjoining the Cargo Holds, etc.

4.1.1 Electrical Installations in Enclosed Cargo Holds, etc.*

1 Electrical installations in enclosed cargo holds, etc., for carrying motor vehicles with fuel in their tanks are to comply with the requirements in this **4.1.1**, in addition to the requirements in other relevant chapters in this part.

2 Electrical installations are to be of a type suitable for use in explosive gas atmosphere concerned.

3 Electrical equipment installed above a height of 450 *mm* from the deck or from each platform for vehicles may be of a type so enclosed and protected as to prevent the escape of sparks as an alternative of the electrical equipment specified in **-2**.

In this case, such electrical equipment are to be installed so that they can be operated only when ventilation system so designed as to provide continuous ventilation of the cargo holds at the rate of at least 10 air changes per hour is in operation whenever motor vehicles are on board. The platforms with openings of sufficient size permitting penetration of petrol gases downwards may not be regarded as the platforms in the application of this requirement.

4 Electrical installations in exhaust ventilation ducts for a cargo hold are to be of a type approved by the Society for use in explosive gas atmosphere concerned.

5 As a rule, no portable electrical appliances are to be located in the cargo holds. Where it is unavoidable to locate the appliances in the holds, they are subject to the approval of Society.

6 Fire detection system, gas detection system and the like which are installed in enclosed cargo holds, etc. are to be of explosion-protected type as deemed appropriate by the Society.

7 All electrical circuits terminating in enclosed cargo holds, etc. are to be provided with multipole linked isolating switches situated outside the cargo holds and accessible only to authorized personnel. Provision is to be made for isolation, for locking in the "*off*" position of the means of control of such circuits. However, this requirement does not apply to safety devices such as fire or gas detectors.

4.1.2 Electrical Equipment in Enclosed Compartments Adjoining Enclosed Cargo Holds

For the electrical equipment in the compartments adjoining cargo holds and having openings such non-gastight door, hatch, scuttle and the like in their bulkheads decks, requirements in **4.1.1** are generally to be applied.

4.2 Special Requirements for Craft Carrying Dangerous Goods

4.2.1 General

Electrical installations for craft carrying dangerous goods are to comply with the requirements in **Chapter 19, Part R of the Rules for the Survey and Construction of Steel Ships** as well as the relevant requirements in this part.

Chapter 5 ADDITIONAL REQUIREMENTS FOR ELECTRIC PROPULSION PLANTS

5.1 General

5.1.1 General

Electrical installations for electric propulsion craft are to comply with the requirements in **Chapter 5, Part H of the Rules for the Survey and Construction of Steel Ships** as well as relevant requirements in this part.

Part 11 FIRE PROTECTION, DETECTION, EXTINCTION AND MEANS OF ESCAPE

Chapter 1 GENERAL

1.1 General

1.1.1 Application*

1 The requirements in this Part apply only to cargo craft which are not engaged in international voyage and are for restricted service.

2 A craft other than the craft specified in **-1** above is to be in accordance with the requirements in Chapter 7 **-** *Fire Safety of IMO Resolution MSC.*97(73) *THE INTERNATIONAL CODE OF SAFETY FOR HIGH SPEED CRAFT*, as may be amended.

3 Accumulator battery systems consisting of lithium-ion batteries with total capacities of 20 *kWh* or more and associated equipment are to also be in accordance with **1.2.3, Annex 2.11.1-2, Part H of the Rules for the Survey and Construction of Steel Ships**.

1.1.2 Basic Principles

The following basic principles underlay the provisions in this Part and are embodied therein as appropriate, having regard to the category and operating conditions of craft and the potential fire hazard involved:

(1) prevention of any fire;

(2) detection of any fire in the space of origin;

(3) containment of any fire in the space of origin;

(4) extinction of any fire in the space of origin;

(5) protection of means of escape and access for fire fighting; and

(6) immediate availability of fire-extinguishing appliances.

1.1.3 General Requirements*

The requirements in this Part are subject to the following general requirements that;

(1) no enclosed sleeping births for passengers and crews are provided unless specially approved by the Society,

(2) in addition to the requirements in this Part, craft which intends to carry dangerous goods is to be complied with the requirements in **Chapter 19, Part R of the Rules for the Survey and Construction of Steel Ships**. However, cargo craft of less than 500 *gross tonnage* or for restricted service need not comply with the requirements in **1.2.2, 1.2.3, 10.2.1-4(4), 10.8.1** and **10.9.1, Part R of the Rules for the Survey and Construction of Steel Ships**.

1.1.4 Equivalency

Alternative construction, equipment, arrangement and materials will be accepted by the Society, provided that the Society is satisfied that such construction, equipment, arrangement and materials are equivalent to those required in this Part.

1.2 Definitions

1.2.1 Application*

The definitions of terms which appear in this Part are to be as specified in this Chapter, unless otherwise specified elsewhere:

1.2.2 Fire-resisting Divisions

Fire-resisting divisions are those divisions formed by bulkheads and decks which comply with the following:

(1) They are to be constructed of non-combustible or fire-restricting materials which by insulation or inherent fire-resisting properties satisfy the requirements of following **(2)** to **(6)**.

(2) They are to be suitably stiffened.

(3) They are to be so constructed as to be capable of preventing the passage of smoke and flame up to the end of the appropriate fire protection time.

(4) Where required, they are to maintain load-carrying capabilities up to the end of the appropriate fire protection time.

(5) They are to have thermal properties such that the average temperature on the unexposed side will not rise more than 139°C above the original temperature, nor will the temperature, at any one point, including any joint, rise more than 180°C above the original temperature during the appropriate fire protection time.

(6) A test of a prototype bulkhead or deck in accordance with the test procedures deemed as appropriate by the Society, are to be required to ensure that it meets the above requirements.

1.2.3 Fire-restricting Materials

Fire-restricting materials are those materials which have the properties specified in **(1)** to **(4)** below, this being ensured in accordance with the test procedures deemed as appropriate by the Society;

(1) they are to have low flame-spread characteristics;

(2) limit heat flux, due regard being paid to the risk of ignition of furniture in the compartment;

(3) limited rate of heat release, due regard being paid to the risk of spread of fire to an adjacent compartment; and

(4) gas and smoke are not to be emitted in quantities that could be dangerous to the occupants of the craft.

1.2.4 Non-combustible Material

Non-combustible material is a material which neither burns nor gives off flammable vapours in sufficient quantity for self-ignition when heated to approximately 750°C, this being ensured in accordance with the test procedures deemed as appropriate by the Society.

1.2.5 Standard Fire Test

A standard fire test is one in which specimens of the relevant bulkheads, decks or other constructions are exposed in a test furnace by specified test method which is considered appropriate by the Society.

1.2.6 Other Equivalent Materials

Where the words “steel or other equivalent materials” occur, other equivalent materials means any non-combustible material which, by itself or due to insulation provided, has structural and integrity properties equivalent to steel at the end of the applicable exposure to the standard fire test (*e.g.*, aluminium alloy with appropriate insulation).

1.2.7 Low Flame-spread

Low flame-spread means that the surface thus described will adequately restrict the spread of flame, this being determined by an established test procedure which is considered appropriate by the Society.

1.2.8 Smoke-tight

Smoke-tight or capable of preventing the passage of smoke means that a division made of non-combustible or fire-restricting materials is capable of preventing the passage of smoke.

1.3 Local Fire

Materials which comply with the requirements in **1.2.3(2)** may be used as surface materials on bulkheads, wall, and ceiling linings including their supporting structure as considered necessary.

Chapter 2 FIRE PROTECTION

2.1 Classification of Space Use

2.1.1 Classification of Space Use*

For the purposes of classification of space use in accordance with fire hazard risks, the following grouping should apply :

(1) Category *A* : Areas of major fire hazard
- Machinery spaces
- Open vehicle spaces
- Spaces containing dangerous goods
- Special category spaces
- Store-rooms containing flammable liquids
- Galley

(2) Category *B* : Areas of moderate fire hazard
- Auxiliary machinery spaces
- Bond stores containing packaged beverages with alcohol content not exceeding 24% by volume
- Crew accommodations
- Service spaces

(3) Category *C* : Areas of minor fire hazard
- Auxiliary machinery spaces having little or no fire risk
- Cargo spaces
- Fuel tank compartments including fuel oil tanks (however, small fuel oil tanks may be deemed as a part of fuel oil piping system subject to the approval of the Society)
- Public spaces
- Tanks, voids and areas of little or no fire risk

(4) Category *D* : Control stations
- Those spaces in which the craft's radio or navigating equipment or the emergency source of power and emergency switchboard are located, or where the fire recording or fire control equipment is centralized, or where other functions essential to the safe operation of the craft such as propulsion control, public address, stabilization systems, etc., are located.

(5) Category *E* : Evacuation stations
- External stairs and open decks used for escape routes
- Muster stations, internal and external
- Open deck spaces and enclosed promenades forming lifeboat and liferaft embarkation and lowering stations
- The craft's side to the waterline in the lightest seagoing condition, superstructure and deckhouse sides situated below and adjacent to the liferaft's and evacuation slide's embarkation areas

(6) Category *F* : Open spaces
- Open spaces locations other than evacuation stations and external escape routes and control stations.

2.1.2 Treatment of Space

1 If a space is divided by partial bulkheads into two (or more) smaller areas such that they form enclosed spaces, then the enclosed spaces are to be surrounded by bulkheads and decks in accordance with **Table 11.2.1**, as applicable. However, if the separating bulkheads of such spaces are at least 30% open, then the spaces may be considered as the same space.

2 Cabinets having a deck area of less than 2 m^2 may be accepted as part of the space they serve, provided they have open ventilation to the space and do not contain any material or equipment that could be a fire risk.

3 Where a space has the special characteristics of two or more space groupings, the structural fire protection time of the divisions are to be the highest for the space groupings concerned.

2.1.3 Insulation of Deck or Bulkhead

1 To prevent heat transmission at intersections and terminal points, the insulation of the deck or bulkhead is to be carried past the intersection or terminal point for a distance of at least 450 *mm* in the case of steel or aluminium structures (refer to **Fig.11.2.1** and **Fig.11.2.2**).

2 If a space is divided by a deck or bulkhead and the fire insulation required for each space is different, the insulation with the higher structural fire protection time is to continue on the deck or bulkhead with the insulation of the lesser structural fire protection time for a distance of at least 450 *mm* beyond the boundary between the spaces.

3 Where the lower part of the fire insulation has to be cut for drainage, the construction is to be in accordance with the structural details shown in **Fig.11.2.3**.

Fig. 11.2.1

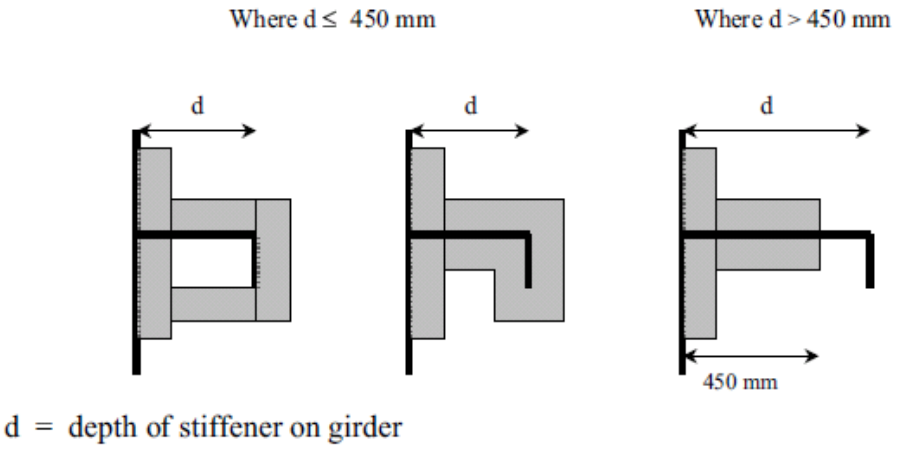


Fig.11.2.2

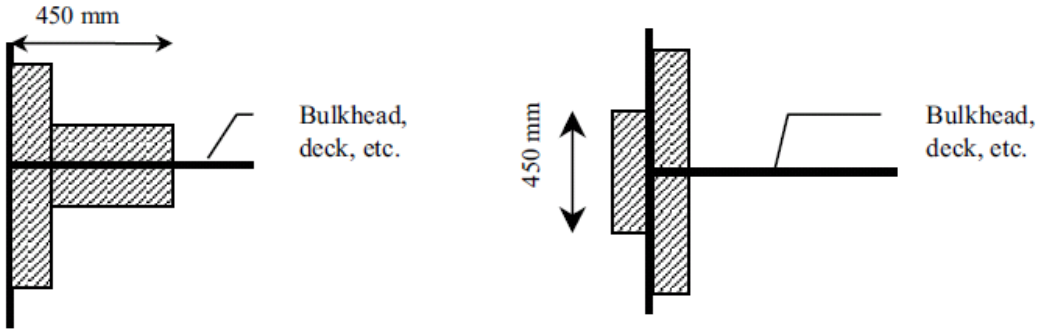
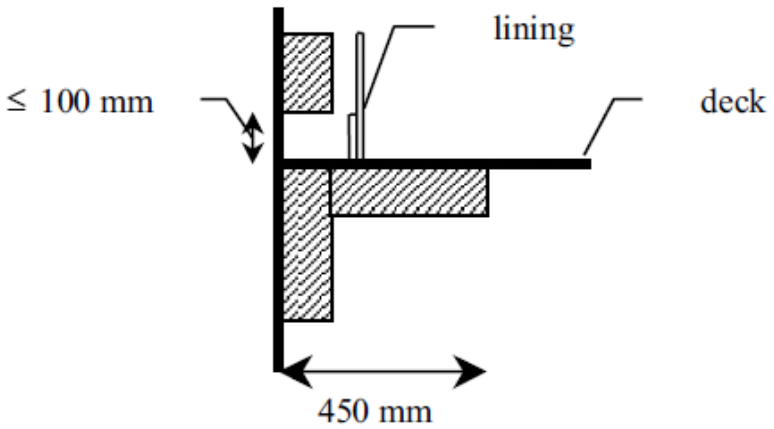


Fig. 11.2.3



2.2 Construction

2.2.1 Construction

1 The hull, superstructure, structural bulkheads, decks, deckhouses and pillars are to be constructed of approved non-combustible materials having adequate structural properties. When the materials other than non-combustible materials are used for these structures, such materials are to be of appropriate fire-restricting materials approved by the Society.

2 The structural fire protection times for separating bulkheads and decks specified in 2.3 in this Chapter are to be in accordance with Table 11.2.1.

3 In using Table 11.2.1, it is to be noted that the title of each category is intended to be typical rather than restricted. For determining the appropriate fire integrity standards to be applied to boundaries between adjacent spaces, where there is doubt as to their classification for the purpose of this section, they are to be treated as spaces within the relevant category having the most stringent boundary requirement.

Table 11.2.1 Structural Fire Protection Times for Separating Bulkheads and Decks

Separating Bulkheads and Decks

Categories	A	B	C	D	E	F
Category *A*: Areas of major fire hazard	60 (1)(2) / 60 (1)(2)	30 / 60 (1)	(3) / 60 (1)(6)	(3) / 60 (1)	(3) / 60 (1)	— / 60 (1)(5)
Category *B*: Areas of moderate fire hazard		— / —	— / —	— / —	— / —	— / —
Category *C*: Areas of minor fire hazard			— / —	— / —	— / —	— / —
Category *D*: Control station				— / —	— / —	— / —
Category *E*: Evacuation stations and escape routes					— / —	— / —
Category *F*: Open spaces						— / —

Notes:

The figures on either side of the diagonal line represent the required structural fire protection time for the protection system on the relevant side of the division.

(1) The upper side of the decks within spaces protected by fixed fire-extinguishing systems need not be insulated.

(2) Where adjacent spaces are in the same alphabetical category and a note (2) appears, a bulkhead or deck between such spaces need not be fitted if deemed unnecessary by the Society. For example, a bulkhead need not be required between two store-rooms. A bulkhead is, however, required between a machinery space and a special category space even though both spaces are in the same category.

(3) No structural fire protection requirements, however, smoke-tight non-combustible or fire-restricting material is required.

(4) Control stations which are also auxiliary machinery spaces are to be provided with 30*min*. structural fire protection.

(5) Fire-resisting divisions need not comply with **1.2.2(5)** of this Part.

(6) Fire-resisting divisions adjacent to void spaces need not comply with **1.2.2(5)** of this Part.

「-」 There are no special requirements for material or integrity of boundaries where only a dash appears in the table.

2.3 Fire-resisting Divisions

2.3.1 Protection of Areas of Major Fire Hazard*

1 Areas of major fire hazard are to be enclosed by fire-resisting divisions complying with the requirements of **1.2.2** except where the omission of any such division would not affect the safety of the craft. These requirements need not apply to those parts of the structure in contact with water at least 300*mm* below the craft's waterline in the lightweight condition in displacement mode, but due regard is to be given to the effect of temperature of hull in contact with water and heat transfer from any uninsulated structure in contact with water to insulated structure above the water.

2 Fire-resisting bulkheads and decks are to be constructed to resist exposure to the standard fire test for a period of 60 *min*. for areas of major fire hazards.

3 Main load-carrying structures within major and moderate fire hazard areas are to be arranged to distribute load such that there will be no collapse of the construction of the hull and superstructure when it is exposed to fire for the appropriate fire protection time. The load-carrying structure is to also comply with the requirements of **2.3.1-4** and **2.3.1-5**.

4 If the structures specified in **2.3.1-3** are made of aluminium alloy their installation is to be such that the temperature of the core does not rise more than 200°C above the ambient temperature for a period of 60 *min*.

5 If the structures specified in **2.3.1-3** are made of combustible material, their insulation is to be such that their temperatures will not rise to a level where deterioration of the construction will occur during the exposure to the composite standard fire test which is considered appropriate by the Society to such an extent that the load-carrying capability will be impaired.

6 The construction of all doors, and door frames in fire-resisting divisions, with the means of securing them when closed, is to provide resistance to fire as well as to the passage of smoke and flame equivalent to that of the bulkheads in which they are situated. Watertight doors of steel need not insulated. Also, where a fire-resisting division is penetrated by pipes, ducts, controls, electrical cables or for other purposes, arrangements and necessary testing are to be made to ensure that the fire-resisting integrity of the division is not impaired. Where machinery shafts penetrate fire-resisting watertight divisions, arrangements are to be made to ensure that the required watertight and fire-resisting integrity of the division is not impaired.

2.4 Restricted Use of Combustible Materials

2.4.1 Application

The requirements in **2.4.2** and **2.4.3** are to apply only to passenger craft, unless otherwise specified elsewhere.

2.4.2 Separating Divisions

1 All separating divisions, ceilings or linings if not a fire-resisting division, are to be of non-combustible or fire-restricting materials.

2 Where insulation is installed in areas in which it could come into contact with any flammable fluids or their vapours, its surface is to be impermeable to such flammable fluids or vapours. The exposed surfaces of vapour barriers and adhesives used in conjunction with insulation materials are to have low flame spread characteristics. The fire insulation in such spaces may be covered by metal sheets (not perforated) or by vapour proof glass cloth sealed at joints.

2.4.3 Furniture and Furnishings

Furniture and furnishings in public spaces and crew accommodation are to comply with the following standards :

(1) all case furniture e.g., decks, wardrobes, dressing tables, bureaux and dressers is constructed entirely of approved non-combustible or fire-restricting materials, except that a combustible veneer with a calorific value not exceeding 45 MJ/m^2

may be used on the exposed surface of such articles;

(2) all other furniture such as chairs, sofas, tables, is constructed with frames of non-combustible or fire-restricting materials;

(3) all draperies, curtains and other suspended textile materials have qualities of resistance to the propagation of flame in accordance with standards which is considered appropriate by the Society;

(4) all upholstered furniture has qualities of resistance to the ignition and propagation of flame in accordance with standards which is considered appropriate by the Society;

(5) all bedding components comply with the standards which is considered appropriated by the Society; and

(6) all deck finish materials comply with the standards which is considered appropriate by the Society.

2.4.4 Surface Materials

1 The following surfaces are to, as a minimum standard be constructed of materials having low flame-spread characteristics. However this requirement does not apply to partitions, windows and sidescuttles made of glass which are deemed to be non-combustible.

(1) exposed surfaces in corridors and stairway enclosures, and of bulkheads, wall and ceiling linings in all accommodation and service spaces and control stations;

(2) concealed or inaccessible spaces in accommodation, service spaces and control stations.

2 Any thermal and acoustic insulation material, if not in compliance with the requirements for fire-resisting divisions or fire-restricting materials, are to be of non-combustible material.

3 Materials used in the craft, when exposed to fire, are not to emit smoke or toxic gases in quantities that could be dangerous to humans as determined in tests of a standard which is considered appropriate by the Society.

4 Void compartments, where low density combustible materials are used to provide buoyancy, are to be protected from adjacent fire hazard areas by fire-resisting divisions, in accordance with **Table 11.2.1**. Also, the space and closures to it is to be gastight but it is to be ventilated to atmosphere.

5 In compartments where smoking is allowed, suitable non-combustible ash containers are to be provided. In compartments where smoking is not allowed, adequate notices are to be displayed.

Chapter 3 FIRE DETECTION AND EXTINCTION

3.1 Fire Detection Systems

3.1.1 Fixed Fire Detection and Fire Alarm Systems

1 Areas of major fire hazard are to be provided with an approved automatic smoke detection system and manually operated call points to indicate at the control station the location of outbreak of a fire in all normal operating conditions of the installations.

2 In case where deemed necessary by the Society, main propulsion machinery rooms are to in addition have detectors sensing other than smoke and be supervised by TV cameras monitored from the operating compartment.

3 Manually operated call points are to be installed throughout the accommodation spaces, service spaces and, where necessary, control stations. One manually operated call point is to be located at each exit from these spaces and from areas of major fire hazard. Control stations not normally occupied (e.g., emergency generator rooms) need not be provided with manually operated call points.

4 Fixed fire detection and fire alarm systems with manually operated call points are to comply with the installation requirements and the design requirements specified in **Chapter 7, Part R of the Rules for the Survey and Construction of Steel Ships** in addition to the requirements specified in this chapter.

3.1.2 Fixed Fire Detection and Fire Alarm Systems for Unattended Machinery Spaces

A fixed fire detection and fire alarm systems for periodically unattended machinery spaces are to comply with the following requirements in addition to the requirements in **3.1.1-4** above.

(1) The fire detection system is to be so designed and the detectors so positioned as to detect rapidly the onset of fire in any part of those spaces and under any normal conditions of operation of the machinery and variations of ventilation as required by the possible range of ambient temperatures. Except in spaces of restricted height and where their use is specially appropriate, detection systems using only thermal detectors are not to be permitted. The detection system is to initiate audible and visual alarms distinct in both respects from the alarms of any other system not indicating fire, in sufficient places to ensure that the alarms are heard and observed on the navigating bridge and by a responsible engineer officer. When the operating compartment is unmanned the alarm is to sound in a place where a responsible member of the crew is on duty.

(2) After installation, the system is to be tested under varying conditions of engine operation and ventilation.

3.2 Fixed Fire-extinguishing Systems

3.2.1 Fixed Fire-extinguishing Systems in Areas of Major Fire Hazard

Main propulsion machinery rooms, special category spaces and open vehicle spaces are to be protected by an approved fixed extinguishing system operable from the control position which is adequate for the fire hazard that may exist. The system is to be capable of local manual control and remote control from the continuously manned control stations.

3.2.2 Fixed Gas Fire-extinguishing Systems

1 In case where the fire-extinguishing medium for the fixed gas fire-extingushing systems is stored outside a protected spaces, it is to be stored in a room which is to be situated in a safe and readily accessible position and is to be effectively ventilated to the satisfaction of the Society. Any entrance to such a storage room is preferably to be direct from the open deck and in any case is to be independent of the protected space. Access doors are to open outwards, and bulkheads and decks which form the boundaries between such rooms and adjoining enclosed spaces are to be gastight, including doors and other closing means of any opening therein. The boundaries of this storage room are to have fire integrity required for a control station in application of **Table 11.2.1**.

2 Fixed gas fire-extinguishing systems are to comply with the requirements in **Chapter 25, Part R of the Rules for the Survey and Construction of Steel Ships**.

3 The use of a fire-extinguishing medium which, either by itself or under expected conditions of use will adversely affect the earth's ozone layer and/or gives off toxic gases in such quantities as to endanger persons is not to be permitted.

3.2.3 Fixed Pressure Water-spraying Fire-extinguishing Systems*

1 Fixed pressure water-spraying fire-extinguishing systems in machinery spaces are to be comply with **Chapter 27, Part R of**

the Rules for the Survey and Construction of Steel Ships.

2 Fixed pressure water-spraying fire-extinguishing systems in special category spaces and open vehicle spaces are to be comply with the requirements otherwise specified.

3.3 Fire Pumps

3.3.1 General

A craft is to be provided with fire pumps and appropriate associated equipment according to the following **3.3.2** to **3.3.5** or alternative effective fire-extinguishing systems.

3.3.2 Fire Pumps

1 Fire pumps are to be provided in accordance with **Table 11.3.1**. Each pump is to have at least two thirds the capacity of a bilge pump as determined by **8.4 in Part 9** but not less than $25m^3/h$. Each fire pump is to be able to deliver sufficient quantity and pressure of water to simultaneously operate the hydrants as required by **3.3.4**.

2 For craft which are required to be provided with two fire pumps and more, the arrangement of the pumps is to be such that in the event of a fire in any one compartment all fire pumps will not be put out of action.

Table 11.3.1 Required Number of Fire Pumps

	150*GT*	300*GT*	1000*GT*
Passenger craft	※1	One Independently driven pump	Two Independently driven pump
Cargo craft	Not required	One Independently driven pump	

Note:

※1: Four buckets

3.3.3 Isolation Valves

Isolating valves to separate the section of the fire main within the machinery space containing the main fire pump or pumps from the rest of the fire main are to be fitted in an easily accessible and tenable position outside the machinery spaces. The fire main is to be so arranged that when the isolating valves are shut all the hydrants on the craft, except those in the machinery space referred to above, can be supplied with water by a fire pump not located in this machinery space through pipes which do not enter this space. The fire main is to be capable of being drained and is to be fitted with valves arranged so that fire main branches can be isolated when the main is used for purposes other than fire-fighting.

3.3.4 Hydrants

Hydrants are to be arranged so that any location on the craft can be reached by the water jets from two fire hoses from two different hydrants, one of the jets being from a single length of hose. In special category spaces and open vehicle spaces, hydrants are be located so that any location within the space can be reached by two water jets from two different hydrants, each jet being supplied from a single length of hose. One hydrant is to be located in the vicinity of and outside each entrance to a machinery space.

3.3.5 Fire Hoses and Nozzles

1 Each fire hose is to be of non-perishable material and have a length of at least 10*m*, not more than 15*m* in machinery spaces and not more than 20*m* for other spaces and open decks. Fire hoses, together with any necessary fittings and tools, are to be kept ready for use in conspicuous positions near the hydrants.

2 In machinery spaces and boiler rooms, a set of a fire hose and a nozzle is to be provided with for each hydrant.

3 Each fire hose is to be provided with a nozzle of an approved dual purpose type (*i.e.* spray/jet type) incorporating a shutoff.

3.4 Portable Fire Extinguishers

3.4.1 Portable Fire Extinguishers in Control Stations, Accommodation and Service Spaces

1 Control stations, accommodation spaces and service spaces are to be provided with portable fire extinguishers of appropriate

types in accordance with **Table 11.3.2**.

2 In addition to **-1** above, at least one extinguisher suitable for machinery space fires is to be positioned outside each machinery space entrance.

3 Portable Fire Extinguishers are to comply with the requirements in **Chapter 24, Part R of the Rules for the Survey and Construction of Steel Ships**.

Table 11.3.2 Required Number of Portable Fire Extinguishers

Number and Type / Applicable spaces	Number				Type of portable fire extinguishers
	Passenger Craft		Cargo Craft		
	<1,000*GT*	≧1,000*GT*	<1,000*GT*	≧1,000*GT*	
Navigation bridge and fire control station	Portable extinguishers are to be located so that no point is spaced more than approximately 15*m* walking distance from an extinguisher. At least two on each deck and at least four in total.	One foam type and another one* CO_2 or dry type, for each space * Two for crafts of 2,000 *GT* and above	At least four in total.	One	Foam, CO_2 or Dry
Corridors		One for each 30*m* of the corridor length or part thereof		One for each 50*m* of the corridor length or part thereof	Foam, CO_2 or Dry
Public spaces		One for each 20*m* of the corridor length or part thereof		-	Foam or Dry
Galley		One		One	Foam or CO_2
Shopping booths and carpenter's shops		One		One	Foam or Dry
Paint lockers	One (outside of each entrances)				Form, CO_2 or Dry
Notes	-	At least five in total	-	At least five in total	-

3.5 Fire Control Plan

3.5.1 Fire Control Plan

1 There are to be permanently exhibited, for the guidance of the master and officers of the craft, fire control plans showing clearly for each deck the following positions:

(1) Control stations;

(2) Sections of the craft which are enclosed by fire-resisting divisions together with particulars of the fire detection and alarms systems, the sprinkler installations, the fixed and portable fire-extinguishing appliances;

(3) Means of access to different compartments and decks in the craft;

(4) Ventilating system including particulars of the fan control positions, the position of dampers and identification numbers of the ventilating fans serving each section of the craft;

(5) Positions of all means of control referred to in **3.1**, **3.2**, **3.3** and **4.1.1-3** of this Part.

2 A duplicate set of fire control plans or a booklet containing such plans is to be permanently stored in a prominently marked weathertight enclosure outside the deckhouse for the assistance of shoreside fire-fighting personnel.

3.6 Fireman's Outfits

3.6.1 Fireman's Outfits

1 Passenger craft, which are for coasting service, are to carry at least one fireman's outfit complying with the requirements of **3.6.3**.

2 Craft having special category spaces and open vehicle spaces are to carry at least two fireman's outfits complying with the requirements of **3.6.3**.

3 The Society may require additional sets of personal equipment and breathing apparatus, due regard to the size and type of the craft.

3.6.2 Storage of Fireman's Outfits

The fireman's outfits or sets of personal equipment are to be so stored as to be easily accessible and ready for use and, where more than one fireman's outfit or more than one set of personal equipment is carried, they are to be stored in widely separated positions.

3.6.3 Fireman's Outfit

A fireman's outfit is to consist of:

(1) Personal equipment comprising:
  (a) protective clothing of material to protect the skin from the heat radiating from the fire and from burns and scalding by steam or gases. The outer surface is to be water-resistant;
  (b) boots of rubber or other electrically non-conductive material;
  (c) a rigid helmet providing effective protection against impact;
  (d) an electric safety lamp (hand lantern) of an approved explosion-proof type with a minimum burning period of 3 *hours*; and
  (e) an axe to the satisfaction of the Society having a handle provided with high-voltage insulation.

(2) a self-contained compressed-air-operated breathing apparatus of an approved type, the volume of air contained in the cylinders of which are to be at least 1,200ℓ, or other self-contained breathing apparatus of an approved type which are to be capable of functioning for at least 30 *minutes*. Two spare charges suitable for use with the apparatus are to be provided for each required apparatus.

(3) For each breathing apparatus, a fireproof lifeline of approximately 30*m* in length and strength is to be provided capable of being attached by means of a snaphook to the harness of the apparatus or to a separate belt in order to prevent the breathing apparatus becoming detached when the lifeline is operated. The lifeline is to be subjected to a test by static load of 3.5*kN* for 5 *minutes*.

Chapter 4 ADDITIONAL REQUIREMENTS FOR MACHINERY SPACES

4.1 Additional Requirements for Machinery Spaces

4.1.1 Fuel and Other Flammable Fluid Tanks and Systems

1 Tanks containing fuel and other flammable fluids are to be separated from passenger, crew, and baggage compartments by vapour-proof enclosures or cofferdams which are suitably ventilated and drained.

2 Fuel oil tanks are not to be located in or contiguous to major fire hazard areas.

However, flammable fluids of a flashpoint not less than 60°C may be located within such areas provided the tanks are made of steel or other equivalent material. The use of aluminium in lubricating oil sump tanks for engines, or in lubricating oil filter housings fitted integral with the engines, is accepted.

3 Every oil fuel pipe which, if damaged, would allow oil to escape from a storage, settling or daily service tank is to be fitted with a cock or valve directly on the tank capable of being closed from a position outside the space concerned in the event of a fire occurring in the space in which such tanks are situated.

4 Pipes, valves and couplings conveying flammable fluids are to be of steel or such alternative material satisfactory to the Society, in respect of strength and fire integrity having regard to the service pressure and the spaces in which they are installed. Wherever practicable, the use of flexible hoses is to be avoided.

5 Pipes, valves and couplings conveying flammable fluids are to be arranged as far from hot surfaces or air intakes of engine installations, electrical appliances and other potential sources of ignition as is practicable and be located or shielded so that the likelihood of fluid leakage coming into contact with such sources of ignition is kept to a minimum.

4.1.2 Exhaust Gas Pipes

1 The exhaust gas pipes are to be arranged so that the risk of fire is kept to a minimum. To this effect, the exhaust system is to be insulated and all the compartments and structures which are contiguous with the exhaust system, or those which may be affected by increased temperatures caused by waste gases in normal operation or in an emergency, are to be constructed of non-combustible material or be shielded and insulated with non-combustible material to protect from high temperatures.

2 The design and arrangement of the exhaust manifolds or pipes are to be such as to ensure the safe discharge of exhaust gases.

4.1.3 Miscellaneous Requirements

Craft are to comply with the following miscellaneous requirements on fire safety measures for machinery spaces:

(1) Means are to be provided in machinery spaces to ensure prevention of accumulation of flammable vapours under normal service condition by positive means of ventilation capable of releasing smoke in the event of a fire.

(2) The number of skylights, doors, ventilators, openings in funnels to permit exhaust ventilation and other openings to machinery spaces is to be reduced to a minimum consistent with the needs of ventilation.

(3) The openings given in **(2)** above are to be provided with closing appliances which are made of steel or other equivalent material and are operable from outside the machinery spaces, where they will not be cut off in the event of a fire in the spaces they serve. The controls are to be easily acceptable as well as prominently and permanently marked and are to indicate whether the shut-off is open or closed.

(4) The doors fitted in boundary bulkheads of main propulsion machinery rooms are to be of self-closing type to prevent the spread of fire to other spaces.

(5) In addition to the requirements given in **(1)** to **(4)** above, periodically unattended machinery spaces are to be provided with fire protection arrangements as considered appropriate by the Society having due regard to the risk of a fire where deemed necessary by the Society.

Chapter 5 PROTECTION OF SPECIAL CATEGORY SPACES

5.1 Protection of Special Category Spaces

5.1.1 Structural Protection

1 Boundaries of special category spaces are to be insulated in accordance with **Table 11.2.1**.

2 The vehicle deck of a special category space or a ro-ro space, including an open ro-ro space, need only be insulated on the underside if required. Vehicle decks located totally within ro-ro spaces may be accepted without structural fire protection, provided these decks are not part of, or do not provide support to, the crafts main load-carrying structure and provided satisfactory measures are taken to ensure that the safety of the craft, including fire-fighting abilities, integrity of fire resisting divisions and means of evacuation, is not affected by a partial or total collapse of these internal decks.

3 Indicators are to be provided on the navigating bridge which are to indicate when any door leading to or from the special category space is closed.

5.1.2 Patrols and Fire Detection

1 A continuous fire patrol is to be maintained in special category spaces unless a fixed fire detection and fire alarm system, complying with the requirements of **3.1.1** of this Part and a television surveillance system are provided. The fixed fire detection system is to be capable of rapidly detecting the onset of fire. The spacing and location of detectors are to be tested taking into account the effects of ventilation and other relevant factors.

2 Manually operated call points are to be provided as necessary throughout the special category spaces and one is to be placed close to each exit from such spaces.

5.1.3 Fixed Fire-extinguishing System

1 Each special category space is to be fitted with an approved fixed pressure water-spraying system for manual operation which is to protect all parts of any deck and vehicle platform in such space, provided that the Society may permit the use of any other fixed fire-extinguishing system that has been shown by full-scale test in conditions simulating a flowing petrol fire in a special category space to be not less effective in controlling fires likely to occur in such a space.

2 Fixed fire-extinguishing systems are to fulfill the following requirement.

(1) the valve manifold shall be provided with a pressure gauge, and each of the valves shall be marked to identify the protected areas

(2) instructions for maintenance and operation of the installation shall be set up in the room where the valves are located

(3) the piping system shall be provided with a sufficient number of drainage valves.

5.1.4 Portable Fire Extinguishers

Portable fire extinguishers are to be located so that no point in the space is more than approximately 20 *m* walking distance from an extinguisher, provided that at least one portable extinguisher is located at each access to such a space. "*No Smoking*" notations are to posted in way of all access to these spaces.

5.1.5 Ventilation System

1 There is to be provided an effective power ventilation system for the special category spaces sufficient to give at least 10 air changes per hour while navigating and 20 air changes per hour at the quayside during vehicle loading and unloading operations. The system for such spaces is to be entirely separated from other ventilation systems and are to be operating at all times when vehicles are in such spaces. Ventilation ducts serving special category spaces capable of being effectively sealed are to be separated for each such space. The system is to be capable of being controlled from a position outside such spaces.

2 The ventilation is to be such as to prevent air stratification and the formation of air pockets.

3 Means are to be provided to indicate in the operating compartment any loss or reduction of the required ventilating capacity.

4 Arrangements are to be provided to permit a rapid shutdown and effective closure of the ventilation systems in case of fire, taking into account the weather and sea conditions.

5 Ventilation ducts, including dampers are to be made of steel or other equivalent material.

5.1.6 Scuppers, Bilge Pumping and Drainage

1 In view of the serious loss of stability which could arise due to large quantities of water accumulating on the deck or decks consequent to the operation of the fixed pressure water-spraying system, pumping and drainage arrangements are to be such as to prevent such accumulation. Scuppers fitted for this purpose are to be so arranged as to ensure that such water is rapidly discharged directly overboard. Alternatively, pumping and drainage facilities are to be provided in additional to the requirements of **Chapter 8 in Part 9**. When it is required to maintain watertight or weathertight integrity, as appropriate, the scuppers is to be arranged so that they can be operated from outside the space protected.

2 Scuppers and drainage pumps fitted in accordance with 1 above are to comply with following requirements:

(1) the amount of water for which drainage is to be provided is to take into account the capacity of both the water spraying system pumps and the required number of fire hose nozzles

(2) the drainage system is to have a capacity of not less than 125% of the capacity specified in **(1)** above

(3) bilge wells are to be of sufficient holding capacity and are to be arranged at the side shell of the ship at a distance from each other of not more than 40*m* in each watertight compartments

5.1.7 Precautions against Ignition of Flammable Vapours

1 On any deck or platform, if fitted, on which vehicles are carried and on which explosive vapours might be expected to accumulate, except platforms with openings of sufficient size permitting penetration of petrol gases downwards, equipment which may constitute a source of ignition of flammable vapours and, in particular, electrical equipment and wiring, are to be installed at least 450 *mm* above the deck or platform. Electrical equipment installed at more than 450 *mm* above the deck or platform are to be of a type approved so enclosed and protected as to prevent the escape of sparks. However, if the installation of electrical equipment and wiring at less than 450 *mm* above the deck or platform is necessary for the safe operation of the craft, such electrical equipment and wiring may be installed provided that it is of a type approved for use.

2 If installed in an exhaust ventilation duct, electrical equipment are to be of a type approved for use. The requirement and wiring, if fitted, are to be of a type approved for use and the outlet from any exhaust duct is to be sited in a safe position, having regard to other possible sources of ignition.

5.2 Protection of Cargo Spaces and Open Vehicle Spaces

5.2.1 General

Cargo spaces and open vehicle spaces, except open deck areas or refrigerated holds, are to be in accordance with the provisions specified in following **5.2.2** through **5.2.5**.

5.2.2 Structural Protection

1 Boundaries of cargo spaces and open vehicle space are to be insulated in accordance with **Table 11.2.1**. The standing deck of the open vehicle space need only be insulated on the underside if required.

2 Indicators are to be provided on the navigation bridge which are to indicate when any door leading to or from the open vehicle space is closed.

5.2.3 Patrol and Fire Detection

1 A continuous fire patrol is to be maintained in cargo spaces and open vehicle spaces unless a fixed fire detection and fire alarm system, complying with the requirements of **3.1.1** of this Part and a television surveillance system are provided. The fixed fire detection system is to be capable of rapidly detecting the onset of fire. The spacing and location of detectors are to be tested taking into account the effects of ventilation and other relevant factors.

2 Manually operated call points are to be provided as necessary throughout the special category spaces and one is to be placed close to each exit from such spaces.

5.2.4 Fixed Fire-extinguishing Systems

Each cargo space is to be protected by fixed fire extinguishing systems specified in **3.2** of this Part. Each open vehicle space, however, is to be protected by the fixed pressure water-spraying system specified in **3.2.3-2** of this Parts.

5.2.5 Portable Fire Extinguishers

Portable fire extinguishers are to be located so that no point in the space is more than approximately 20 *m* walking distance from an extinguisher, provided that at least one portable extinguisher is located at each access to such a space. "*No Smoking*"

notations are to posted in way of all access to those spaces.

Chapter 6 MEANS OF ESCAPE

6.1 Exits and Means of Escape

6.1.1 General

1 Easy, safe and quick accesses from the operating compartment to the passenger accommodation are to be provided. In order to ensure immediate assistance from the crew in an emergency situation, the crew accommodation, including any cabins, is to be located with due regard to easy, safe and quick access to the public spaces from inside the craft.

2 The design of the craft is to be such that all occupants may safely evacuate the craft to the open deck and then into survival craft under all emergency conditions, by day or by night. The positions of all exits which may be used in an emergency, and of all life-saving appliances, the practicability of the evacuation procedure are to be suitable for this purpose.

3 Public spaces, evacuation routes, exits, lifejacket stowage, survival craft stowage, and the embarkation stations are to be clearly and permanently marked and illuminated.

4 Each enclosed public space and similar permanently enclosed space allocated to passengers or crew is to be provided with at least two exits arranged in the opposite ends of the space. Exits are to be safely accessible and are to provide a route to a normal point of boarding or disembarking from the craft.

5 Exit doors are to be capable of being readily operated from inside and outside the craft in daylight and in darkness. The means of operation are to be obvious, rapid and of adequate strength.

6 The closing, latching and locking arrangements for exits are to be such that it is readily apparent to the appropriate crew member when the doors are closed and in a safe operational condition, either in direct view or by an indicator. The design of external doors is to be such as to eliminate the possibility of jamming by ice of debris.

7 The craft is to have a sufficient number of exits which are suitable to facilitate the quick and unimpeded escape of persons wearing approved lifejackets in emergency conditions, such as collision damage or fire.

8 Sufficient space for a crew member is to be provided adjacent to exits for ensuring the rapid evacuation of passengers.

9 All exits, together with their means of opening, are to be adequately marked for the guidance of passengers. Clear markings, including the location of the fire control, is to be provided for the guidance of rescue personnel outside the craft.

10 Footholds, ladders, etc., provided to give access from the inside to exits, are to be of rigid construction and permanently fixed in position. Permanent handholds are to be provided whenever necessary to assist persons using exits, and are to be suitable for conditions when the craft has developed any possible angles of list or trim.

11 At least two unobstructed evacuation paths are to be available for the use of each person. Evacuation paths are to be disposed such that adequate evacuation facilities will be available in the event of any likely damage or emergency conditions, and evacuation paths are to have adequate lighting supplied from the main and emergency sources of power. Doors providing escape from a space are to be situated at opposite ends of the space. Where the doors providing escape from a space are situated in the same end of the space, the distance between those doors is to be greater than the maximum length of the space.

12 The dimensions of passages, doorways and stairways which form part of evacuation paths are to be such as to allow easy movement of persons when wearing lifejackets. There are to be no protrusions in evacuation paths which could cause injury, ensnare clothing, damage lifejackets or restrict evacuation of disabled persons. Requirements of this paragraph do not apply to aisles (fore-aft passageways separating seating areas) or to spaces between adjacent rows of seats.

13 Adequate notices are to be provided to direct passengers to exits.

14 Provision are to be made on board for embarkation stations to be properly equipped for evacuation of passengers into life-saving appliances. Such provision are to include handholds, anti-skid treatment of the embarkation deck, and adequate space which is clear of cleats, bollards and similar fittings.

6.1.2 Means of Escape from Machinery Spaces

1 At least two means of escape from the machinery spaces are to be provided, and they are to be arranged as widely separated as possible. At least one means of escape from a machinery space shall consist of either a ladder leading to a door or hatch (not being a horizontal flush-hatch) or a door located in the lower part of that space and giving access to an adjacent compartment from

which a safe means of escape is provided. However, the Society may dispense with one set of means of escape paying due regard to dimensions and arrangement of the machinery spaces.

2 Stairways, ladders, etc. which are part of means of escape from machinery spaces are to be of ample strength and to be effectively secured to the hull constructions. Raw materials which are easily dehardening or melting such as plastics are not to be used for these equipment.

3 Notwithstanding the above, spaces that are only entered occasionally by crew members may have only one means of escape provided that it is independent of watertight doors.

6.1.3 Means of Escape from Special Category Spaces and Open Vehicle Spaces

1 Means of escape are to be provided at least in the fore, midship and aft part of respective special category spaces and the open vehicle spaces. These means of escape are to be placed in both wings of respective spaces unless these means of escape are placed at centre line of such spaces.

2 Means of escape are to be so located that no point in the space is more than 40*m* walking distance from the means of escape. Where the arrangement of means of escape required by **-1** above cannot comply with this requirement, additional means of escape are to be appropriately so arranged to comply with this requirement.

3 Stairways, ladders, etc., which are part of means of escape from the special category spaces and open vehicle spaces are to be of ample strength and to be effectively secured to the hull constructions. Raw materials which are easily dehardening or melting such as plastics are not to be used for these equipment.

4 Where stores and lockers have only exits facing to special category spaces or open vehicle spaces, the Society may require to provide additional means of escape which directly escape to the outside of the special category spaces or open vehicle spaces paying due regard to dimensions and use of such spaces.

5 Special category spaces used for stowage of motor vehicles are to be provided with walkways having a width of at least 600 *mm* leading to a safe means of escape.

Part 12 LOAD LINE

Chapter 1 GENERAL

1.1 General

1.1.1 Application

Assignment of freeboard and marking of load lines are to be in accordance with the requirements in **Part V of the Rules for the Survey and Construction of Steel Ships**.

Part 13 NAVIGATION BRIDGE VISIBILITY

Chapter 1 GENERAL

1.1 General

1.1.1 Application

Navigation bridge visibility is to be in accordance with the requirements in **Part W of the Rules for the Survey and Construction of Steel Ships**.

Part 14 COMPUTER-BASED SYSTEMS

Chapter 1 GENERAL

1.1 General

1.1.1 Application

Computer-based systems are to be according to relevant requirements in **Chapter 3** and subsequent chapters, **Part X of the Rules for the Survey and Construction of Steel Ships**.

Part 15 SPECIAL REQUIREMENTS FOR CRAFT ENGAGED IN INTERNATIONAL VOYAGE

Chapter 1 GENERAL

1.1 General

1.1.1 Application*

In addition to the requirements specified in **Part 1** to **Part 14 of the Rules**, crafts engaged on international voyages are to be complied with the requirements of *IMO Resolution MSC*.97(73) *THE INTERNATIONAL CODE OF SAFETY FOR HIGH SPEED CRAFT*, as may be amended, in its entirety or other technical requirements which the Society considers to be equivalent to the said international code.

1.2 Others

1.2.1 Portable Atmosphere Testing Instruments for Enclosed Spaces*

Crafts of not less than 500 *gross tonnage* engaged on international voyages (except steel barges, submersibles) are to carry an appropriate portable atmosphere testing instrument or instruments. As a minimum, these are to be capable of measuring concentrations of oxygen, flammable gases or vapours, hydrogen sulphide and carbon monoxide prior to entry into enclosed spaces. Instruments carried under other requirements may satisfy this regulation. Suitable means are to be provided for the calibration of all such instruments.

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GUIDANCE FOR HIGH SPEED CRAFT

Part 1 GENERAL RULES

Chapter 1 GENERAL

1.1 General

1.1.1 Application

1 The wording "to be deemed appropriate by the Society" in **1.1.1-2, Part 1 of the Rules** means to comply with the *IMO* MSC/Circ.1054.

2 With respect to the provisions of the Rules, unless explicitly specified otherwise in the relevant requirements, distances regarding ship length, breadth, depth, and tank length, breadth, height, etc. are to be measured by using moulded dimensions. However, where the effects of plate thickness are not negligible, this requirement is not applicable. For the distance between an independent cargo tank and the hull construction, such distance is to be measured from the external face of the tank.

1.1.5 Craft of Unusual Form or Proportion

1 Craft with unusual large freeboards

(1) "Craft with unusual large freeboards" are the craft which comply with the condition prescribed in **1.4.3.5, Part 1, Part C of the Rules for the Survey and Construction of Steel Ships**.

(2) Craft with unusual large freeboards may be treated as follows in case that the requirements in **Part 7** and **Part 9 of the Rules for High Speed Craft** (hereinafter referred to as "the Rules" in this guidance) apply.

(a) **Chapter 2 in Part 7 of the Rules**:

In determination of "Position of Exposed Decks" prescribed in **2.1.2 in Part 7 of the Rules**, the exposed deck in question may be regarded as follows in accordance with H_D and h_s. In this case, H_D is the vertical distance from an imaginary freeboard deck to the weather deck at side and h_s is the standard height of superstructure determined by the requirements in **V2.2.1 of the Guidance for the Survey and Construction of Steel Ships**.

$h_s \leq H_D < 2h_s$:

Superstructure deck of first tier above an imaginary freeboard deck

$2h_s \leq H_D < 3h_s$:

Superstructure deck of second tier above an imaginary freeboard deck

$3h_s \leq H_D$:

Superstructure deck of third tier above an imaginary freeboard deck

(b) **Chapter 8 in Part 9 of the Rules**:

In determining of the diameters of bilge suction pipes prescribed in **13.5.3, Part D of the Rules for the Survey and Construction of Steel Ships** quoted by **8.4 in Part 9 of the Rules**, D' may be used in place of D in determing the diameters of bilge suction pipes. In this case, D' is the vertical distance from the top of keel to an imaginary freeboard deck (refer to **Fig. 1.4.3-4, Part 1, Part C of the Rules for the Survey and Construction of Steel Ships**).

1.1.8 Crafts Using Low-flashpoint Fuels

In applying **Part GF of the Rules for the Survey and Construction of Steel Ships** with respect to requirement **1.1.8, Part 1 of the Rules**, the wording "docking surveys carried out at the times specified in **1.1.3-1(4)(a), Part B of the Rules for the Survey and Construction of Steel Ships**" in **GF15.4.2, Part GF of the Guidance for the Survey and Construction of Steel Ships** is to be interpreted to mean "Special Surveys carried out at the times specified in **3.1.1-1(3), Part 2 of the Rules for High Speed Craft**".

1.2 Class Notations

1.2.1 General

For the application of **1.2.1, Part 1 of the Rules**, reference is to be made to **A1.2 of the Guidance for the Survey and Construction of Steel Ships**.

Chapter 2 DEFINITIONS

2.1 General

2.1.15 Freeboard Deck

1 "Adequate width" specified in **2.1.15-3, Part 1 of the Rules** is to be determined by taking into account the ship's construction, and operation, and at the minimum, is to accommodate the passages specified in **14.13, Part 1, Part C of the Rules for the Survey and Construction of Steel Ships**.

2 With respect to the provisions of **2.1.15, Part 1 of the Rules**, the freeboard deck on a ship which has openings at the after end and the bottom of cargo spaces (hereinafter referred to as "well deck") can be submerged below the waterline by ballasting for loading/unloading cargoes from such after end openings is to be in accordance with the following.

(1) If such a ship is fitted with weathertight closures for the cargo space(s) and a watertight closure at the stern, the uppermost complete deck may be taken as the freeboard deck.

(2) If such a ship is not fitted with weathertight closures for the cargo space(s) or a watertight closure at the stern, the well deck is to be taken as the freeboard deck. In this case, buoyant spaces in the hull structure above such well decks may be considered as superstructures in accordance with the provisions of **2.1.19** of the Rules.

(3) If such a ship is not fitted with weathertight closures for the cargo space(s) but has a watertight closure at the stern, the uppermost complete deck may be taken as the freeboard deck provided that the calculated freeboard is corrected for any missing buoyancy above the well deck in accordance with **Part V of the Rules**. In this case, the structure of the freeboard deck, where provided within cargo spaces, is to be continuous forward and afterward at the ship's sides and continuous athwartship at the transverse bulkheads, and capable of passage.

2.1.28 Light Weight

With respect to the provisions of **2.1.28, Part 1 of the Rules**, the weight of mediums on board for the fixed firefighting systems (e.g. freshwater, CO_2, dry chemical powder, foam concentrate, etc.) is to be included in the light weight.

Part 2 CLASS SURVEYS

Chapter 1 GENERAL

1.1 Surveys

1.1.1 Registration Surveys

With respect to **1.1.1-2, Part 2 of the Rules**, surveyors are to confirm the asbestos-free declarations and supporting documents specified in **2.1.3-1(9), Part 2 of the Rules**. The wording "materials containing asbestos" means that asbestos is present in the product/material above the threshold value stipulated in Appendix 1 of *IMO* resolution *MEPC*.379(80).

1.1.3 Occasional Surveys

For the occasional surveys specified in **1.1.3(5), Part 2 of the Rules**, the following is to be complied with:

(1) Carriage of Dangerous Goods

For craft engaged on international voyages, with cargo spaces intended for the carriage of packaged dangerous goods, which had been at the beginning stage of construction on or after 1 July 2002 but before 1 January 2011, a survey is to be carried out to verify compliance with requirement 7.13.3 in accordance with tables 7.17-1 and 7.17-3, as specified in Chapter 7 (including the amendments by *IMO Resolution MSC*.271(85)) of "*THE INTERNATIONAL CODE OF SAFETY FOR HIGH SPEED CRAFT* (*IMO Resolution MSC*.97(73))" by the first special survey of the ship on or after 1 January 2011.

(2) Portable Atmosphere Testing Instruments for Enclosed Spaces

For craft of not less than 500 *gross tonnage* engaged on international voyages which had been at the beginning stage of construction before 1 July 2016, it is to be verified that portable atmosphere testing instruments complying with **1.2.1, Part 15 of the Rules** are provided on board by the first survey on or after 1 July 2016.

(3) Crafts Using Low-flashpoint Fuels

(a) For crafts that fall under the following **i)** or **ii)**, a survey is to be carried out to verify compliance with the requirements of **1.1.8, Part 1 of the Rules** before using low-flashpoint fuels or undertaking to use different low-flashpoint fuels than specified:

i) Crafts which convert to using low-flashpoint fuels on or after 1 January 2017; or

ii) Crafts which, on or after 1 January 2017, undertake to use low-flashpoint fuels different from those which they were originally approved to use before 1 January 2017.

(b) For ships that fall under the following **i)** or **ii)**, a survey is to be carried out to verify compliance with the requirements of **GF11.3.1-1**, **GF11.3.1-2**, **GF12.5.2-2** and **GF15.10.1, Part GF of the Guidance for the Survey and Construction of Steel Ships** before using low-flashpoint fuels or undertaking to use different low-flashpoint fuels than specified:

i) Ships which convert to using low-flashpoint fuels on or after 1 July 2019; or

ii) Ships which, on or after 1 July 2019, undertake to use low-flashpoint fuels different from those which they were originally approved to use before 1 July 2019.

(c) For ships that fall under the following **i)** or **ii)**, a survey is to be carried out to verify compliance with the requirements of **11.8.1, Part GF of the Rules for the Survey and Construction of Steel Ships** and **GF11.3.1-2, Part GF of the Guidance for the Survey and Construction of Steel Ships** before using low-flashpoint fuels or undertaking to use different low-flashpoint fuels than specified:

i) Ships which convert to using low-flashpoint fuels on or after 1 January 2024; or

ii) Ships which, on or after 1 January 2024, undertake to use low-flashpoint fuels different from those which they were originally approved to use before 1 January 2024.

1.1.4 Laid-up Craft

Laid-up craft are to be in accordance with **B1.1.8, Part B of the Guidance for the Survey and Construction of Steel Ships**.

1.2 Preparation for Surveys and Others

1.2.2 Preparation for Surveys

1 The preparation for survey specified in **1.2.2, Part 2 of the Rules** includes considerations for dangers. The term "dangers" used here includes improper arrangement of scaffoldings, non-availability of lighting, fire, explosion, electric shock, falling of thinks, harmful gases and oxygen deficiency, etc.

2 Any applicant for survey is to make necessary preparations for survey fittings, cleaning of compartments, freeing from water, scale, dirt, oil residues and gas, sufficient lighting, non-destructive testing equipment and other items of preparation required for tests and inspections according to the purpose of survey. Furthermore, casings, ceilings or linings, and loose insulation, where fitted, are to be removed as required by the Surveyor.

3 Preparations for Special Surveys for Hull are to be in accordance with the following **(1)** to **(3)** in general:

(1) For Special Survey No.1, the followings are to be complied with:

(a) Coal and ballast are to be cleared, articles not permanently attached to the hull are to be removed as far as possible, all limber boards are to be removed, mud boxes are to be opened, strainers of bilge suction pipes are to be exposed and interiors of hull are to be cleaned.

(b) In craft having a single bottom, at least one strake of bottom ceilings on each side of the centreline and in way of bilge are to be removed respectively, and flooring plates in machinery spaces are to be removed where considered necessary.

(c) Where double bottom is fitted, a sufficient amount of ceiling as required by the Surveyor is to be removed and the condition of the top plating is to be examined.

(d) Tanks and compartments are to be thoroughly cleared and cleaned. Furthermore, fuel oil tanks and cargo tanks if considered necessary are to be gas freed and every precaution is to be paid to ensure safety during the survey.

(2) For Special Survey No.2, all the requirements specified in **(1)** above and the following requirements are to be complied with:

(a) Throughout the craft, in way of single bottoms, one strake of ceilings on each side near to the keelson are to be removed respectively.

(b) Throughout the craft, in way of double bottoms and deep water or oil tanks, ceilings at bilge (including limber) and centre line part, lower parts of pillars and bulkhead, shaft tunnels and any other parts where considered necessary by the Surveyor are to be removed.

(3) For Special Survey No.3 and after, all the requirements specified in **(2)** above and the followings are to be complied with:

(a) Almost all of ceilings and linings in holds and flooring plates in machinery spaces are to removed. And, rust of inside and outside of the craft is to be chipped off.

(b) Throughout the craft, an extensive amount of ceiling in way of single bottom, double bottom and deep water or oil tanks are to be removed.

(c) Wood sheeting and deck composition on decks are to be removed as required by the Surveyor. Portions of cement chocks on the craft's sides at bilges and decks are to be removed.

(d) In way of cabin accommodations, the paneling below side scuttles is to be removed, and other paneling is to be removed as required by the Surveyor.

(e) Lubricating oil tanks are to be thoroughly cleared, cleaned and gas freed and every precaution is to be paid to ensure safety during the survey.

4 With respect to **1.2.2-3, Part 2 of the Rules**, the following items are to be agreed upon between thickness measurement company representative and owner's representative during Intermediate or Special Survey meetings. And, documented records of these agreements, including where and when the meeting took place and who attended, are to be maintained.

(1) Reporting of thickness measurements on regular basis to the attending surveyor.

(2) Prompt notification to the surveyor in case of following findings:

(a) excessive and/or extensive corrosion or pitting/grooving of any significance;

(b) structural defects like buckling, fractures and deformed structures;

(c) detached and/or holed structure; and

(d) corrosion of welds.

1.2.5 Procedure for Tests, Wear and Tear, etc.

With respect to **1.2.5-4, Part 2 of the Rules,** surveyors are to confirm at periodical surveys that asbestos-free declarations and supporting documents are provided for any replaced or newly installed fittings, equipment, parts, etc. The wording "materials containing asbestos" means that asbestos is present in the product/material above the threshold value stipulated in Appendix 1 of *IMO* resolution *MEPC*.379(80).

1.2.6 Firms Engaged in Inspections, Measurements and Maintenance

1 The wording "firm deemed appropriate by the Society" in **1.2.6-1, Part 2 of the Rules** refers to firms complying with the requirements of **Chapter 2, 3 or 8, Part 3 of the Rules for Approval of Manufacturers and Service Suppliers** and approved by the Society.

2 The wording "firm deemed appropriate by the Society" in **1.2.6-2, Part 2 of the Rules** refers to any of the following: firms complying with the requirements of **Chapter 6, Part 3 of the Rules for Approval of Manufacturers and Service Suppliers** and approved by the Society; firms approved by the Administration; firms approved by duly authorized organizations acting on behalf of the Administration; or firms approved by other organizations which are acceptable to the Administration.

Chapter 2 CLASSIFICATION SURVEYS

2.1 Classification Survey during Construction

2.1.4 Presence of Surveyor

1 The wording "items specified otherwise by the Society" and the wording "survey methods which it considers to be appropriate" in **2.1.4-1, Part 2 of the Rules** mean to be in accordance with the following **(1)** and **(2)** respectively:

(1) The wording "items specified otherwise by the Society" means surveys of the tests specified in **2.1.4-1(1)**, **(3)**, and **(15), Part 2 of the Rules**.

(2) The wording "the Society may approve other survey methods which it considers to be appropriate" means survey methods which it considers to be able to obtain information equivalent to that obtained through traditional ordinary surveys where the Surveyor is in attendance.

2 The wording "items specified otherwise by the Society" in **2.1.4-2, Part 2 of the Rules** means surveys of the tests specified in **-2(1)** and **(2)(a)**, and the wording "survey methods which it considers to be appropriate" means to be in accordance with **-1(2)**.

3 The wording "the Society may approve other survey methods which it considers to be appropriate" means to be in accordance with **-1(2)**.

4 In applying **2.1.4-5, Part 2 of the Rules**, the test plan related to the astern test specified in **2.3.1(2)** is to be provided by the yard. If specific operational characteristics have been defined by the manufacturer, these are to be included in the test plan.

2.1.6 Documents to be Maintained On Board

The certificates specified in **2.1.6-4, Part 2 of the Rules** are those such as the ones issued for each piece of equipment, device, etc., type approval certificates valid at the time of the Classification Survey, or others applicable. With regard to fire pumps, hose test records after installation on board may be accepted. In addition, unless equipment or devices on board are renewed after the ship has entered service, these certificates need not be updated.

2.1.8 Ship Construction File

Documents to be included in the Ship Construction File stipulated in **2.1.8, Part 2 of the Rules** do not need to be actually in the File nor stored in the same location, provided that the location, status and other necessary information of such documents are addressed in the File.

2.3 Sea Trials and Stability Experiments

2.3.1 Sea Trials

Details of each test to be carried out during sea trials are to be in accordance with the following requirements.

(1) Speed test

The craft's speed is to be measured during navigating with maximum continuous output of main propulsion engines through the course the length of which is known beforehand.

(2) Astern test

The astern test is to be carried out in accordance with the following **(a)** to **(c)**:

(a) While the main propulsion machinery is running ahead at its maximum continuous output, an order for full astern is issued and the reversing operation from ahead run to full astern run is carried out as quickly as possible, and the astern performance and stopping performance of craft are to be verified. In applying this provision, the tests are to be carried out from all control positions where there are multiple control positions for the reversing operation to astern run.

(b) It is to be confirmed that the machinery is functioning normally while the ship is running astern. The main engine is to be kept at a rate of more than 70% of the maximum continuous revolutions until the astern speed (rotational speed in rpm) stabilizes.

(c) For gas-fuelled dual fuel engines, the confirmation specified in **(b)** is to be carried out for all operating modes (gas mode, diesel mode, etc.).

(3) Steering test and change-over test from the main to auxiliary steering gears

The steering gears are to be subjected to the following tests. However, the tests required in **(d)**, **(f)** and **(g)** may be carried out when a craft is being anchored or at dockside.

(a) Tests on the steering capabilities specified in **9.2.2** and **9.2.3, Part 9 of the Rules**. If the ship cannot be tested at the load draught, alternative trial draught conditions will be specially considered.

(b) Running tests of the power units, including transfer between power units.

(c) Tests on the isolation of one power actuating system, checking the time for regaining steering capability.

(d) Tests on the hydraulic fluid recharging system.

(e) Tests on the operation of controls, including tests on the change-over between two control systems, the change-over between the control system and the controller provided in the steering gear compartment, and the change-over between the automatic steering and the manual steering.

(f) Tests on the means of communication between the navigating bridge and the steering gear compartment.

(g) Tests on the functioning of indicators for the alarms, rudder angle and power units required in **Chapter 9, Part 9 of the Rules**.

(4) Turning test

Turning test will carried out while main propulsion engines are running with half of its maximum continuous output to verify that steering gears operate smoothly and in order and that no serious list is occurred. In any inclined condition throughout the turning test, no imersion of deck edge under water is acceptable.

(5) Operating test of machinery installations

Operating test of machinery installations is to be in accordance with the requirement specified in **item 5, Table B2.11, Part B of the Rules for the Survey and Construction of Steel Ships**.

(6) Performance test of windlass

Performance test of windlass is to be in accordance with the requirement specified in **item 6, Table B2.11, Part B of the Rules for the Survey and Construction of Steel Ships**.

(7) Performance test of automatic and remote control systems for main propulsion machinery or the controllable pitch propellers, boilers and electric generating sets

(a) Main propulsion machinery or controllable pitch propellers

i) The main propulsion machinery or 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 from the main control station on the bridge.

ii) The operation tests of the main propulsion machinery or controllable pitch propellers using the bridge control devices are to be carried out as deemed appropriate by the Society in addition to output increase and decrease tests.

iii) In cases where there are two or more control stations for main propulsion machinery or controllable pitch propellers, the tests on transfer of control are to be carried out during ahead and astern operations of the main propulsion machinery or the controllable pitch propellers. In the case where the transfer of control of the remote control devices for main propulsion machinery or the controllable pitch propellers are designed to be carried out in the stopping condition of main propulsion machinery, the above mentioned tests are to be carried out in the stopping condition.

iv) After completion of the test on transfer of control specified in above **iii)**, it is to be shown that the main propulsion machinery or the controllable pitch propellers can be smoothly operated from the respective control stations.

(b) Boilers

i) 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.

ii) In the case where an exhaust gas economizer is used as a source of steam supply to a turbine for driving a generator and the steam supply from a boiler is carried out automatically as in the case of a low power condition in the main propulsion machinery, operation tests of automatic control devices for this system are to be carried out.

(c) Electrical generating sets

In the case where generators which supply electrical power to the load necessary for propulsion of the craft 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.

(8) The accumulation test of a boiler

The accumulation test of a boiler is to be in accordance with the requirement specified in **item 7 Table B2.11, Part B of the Rules for the Survey and Construction of Steel Ships**.

(9) Measurement of the torsional vibration for the shafting systems

Measurement of the torsional vibration for the shafting systems are to be carried out in accordance with the following **(a)** and **(b)**:

(a) Measurement is to be in accordance with the requirement specified in **5.4, Part 9 of the Rules**.

(b) Measurements in either diesel mode or in the gas mode (but not both modes) may be omitted where considered appropriate by the Society based upon relevant torsional vibration calculation sheets of diesel and gas mode.

(10) "Verification of Total Harmonic Distortion (THD) calculation report" stipulated in **2.3.1-1(10), Part 2 of the Rules** refers to the measuring of the Total Harmonic Distortion (THD) value of the main busbar so as to confirm that said value does not exceed the acceptable limit given in the report.

(11) Other tests where deemed necessary by the Society

At least following tests **(a)** to **(d)** are to be included in this test

(a) In craft having multiple propellers or waterjet propulsion systems, the craft's navigating and manoeuvring performance with one or more propellers or waterjet propulsion systems inoperative is to be verified.

(b) When the craft is provided with supplementary means for manoeuvring or stopping, performance test of such means is to be carried out.

(c) In the case of propulsion gears where the total face width (in case of double-helical gears, the central gap is included) exceeds 300 *mm* or where the ratio of the total face width to pitch circle diameter of the pinion exceeds 2, the contact marking of the teeth is to be verified by coating with suitable paint on each teeth flanks thinly and uniformly.

(d) For ships having exhaust gas recirculation systems, running tests of engines are to be carried out with exhaust gas recirculation systems in operation, and the satisfactory operation of the engine and exhaust gas recirculation system is to be confirmed.

2.3.2 Stability Experiments

In applying **2.3.2-3, Part 2 of the Rules**, in cases where the following **(1)** is satisfied and the Administration specially approves the dispensation of inclining tests, such tests may be dispensed with.

(1) A lightweight measurement is to be carried out, and it is to be confirmed that the deviation of lightweight between the following **(a)** and **(b)** does not exceed 2% of the expected value of **(b)**, and the deviation of lightship longitudinal centre of gravity between **(a)** and **(b)** does not exceed 1% of length of the ship between perpendiculars.

(a) Lightweight and lightship longitudinal centre of gravity determined by a lightweight check of the ship.

(b) Lightweight and lightship longitudinal centre of gravity of a lead sister ship, or those values which are determined by detailed calculation regarding differences, where the ship is modified from a lead sister ship.

2.5 Alterations

2.5.1 Requirements of Surveys

1 In applying the requirements specified in **2.5.1, Part 2 of the Rules**, in the case of the "application of modification, etc. which affect or may affect a main particular of a ship" (hereinafter referred to as "application of major conversion"), the following are to apply, except in cases where specified by the Society or Administration:

(1) A "Major conversion", for example, refers to (but is not limited to) the following cases:

(a) Alteration of the dimensions of a ship; for example, the lengthening of a ship by adding a new midbody.

(b) Change of ship type; for example, the conversion from tanker to bulk carrier.

(c) Modification of construction which affects necessary requirements related to ship subdivisions.

(2) In cases were a major conversion is performed, unless otherwise specified in the requirements, the hull structure, machinery and equipment are to comply with requirements in force at the time of alteration. For example, in the case of the lengthening of a ship, the new midbody is to comply with all relevant requirements (for example, longitudinal strength and equipment numbers,

etc.) which are affected by such alteration.

(3) "Requirements in force at the time of alteration" are those requirements, unless otherwise specified, for a conversion constructed after either of the following dates:

(a) the date on which the contract is placed for the conversion; or

(b) in the absence of a contract, the date on which the work identifiable with the specific conversion begins.

2 In applying the requirements specified in **2.5.1, Part 2 of the Rules**, "permitted by the Society" refers to those cases where the Society agrees that it is difficult to apply a new requirement, and the Administration agrees to waive the concerned requirement.

3 The stability after alterations, **2.3.1-5, Part B of the Rules for the Survey and Construction of Steel Ships** is to be followed to determine the need for re-inclining tests, and the need for amending stability information.

4 In applying **2.5.1, Part 2 of the Rules**, the astern response characteristics of ships considered by the Society to have undergone significant repairs which impact the response characteristics of their propulsion systems are to be verified after such repairs are carried out by correspondingly applying the requirements for the astern tests carried out at Classification Surveys during Construction (See **2.3.1, Part 2 of the Rules** and **2.1.4-4.** of this Chapter). The tests are to demonstrate the satisfactory operation of the equipment or system under realistic service conditions at least over the manoeuvring range of the propulsion plant, for both ahead and astern directions. Depending on the actual extent of the repair, the Society may accept a reduction of the test plan.

5 In applying the provisions of **2.5.1, Part 2 of the Rules**, for ships where selective catalytic reduction systems, exhaust gas cleaning systems or exhaust gas recirculation systems are newly installed, applicable surveys to the relevant systems are to be carried out in accordance with **2.1, Part 2 of the Rules**.

Chapter 3 PERIODICAL SURVEYS AND PLANNED MACHINERY SURVEYS

3.1 General

3.1.2 Docking

The approval to the application of In-water Survey specified in **3.1.2, Part 2 of the Rules** is to be subject to the provisions specified in **B6.1.2, Part B of the Guidance for the Survey and Construction of Steel Ships**.

3.1.5 Modification of Requirements of Surveys

"In cases where considered appropriate by the Society" specified in **3.1.5-1, in Part 2 of the Rules** means those cases where the examinations specified in **Table B1.1.6-1, Part B of the Guidance for the Survey and Construction of Steel Ships** are carried out during Periodical Surveys and Planned Machinery Surveys. However, this regulation is not to be applied to surveys required by international regulations or the requirements of flag states.

3.2 Intervals of Periodical Surveys and Planned Machinery Surveys

3.2.1 General

1 In cases where Special Surveys are carried out in advance of the due date of Intermediate Surveys and such Intermediate Surveys are dispensed with in accordance with **3.2.1-3** and **3.2.3-2, Part 2 of the Rules**, then such Special Surveys are to be completed up to and including the due date of the third Annual Surveys.

2 If an Annual or Intermediate Survey is completed before the period specified in **3.2.2** or **3.2.3, Part 2 of the Rules** in accordance with **3.2.1-4, Part 2 of the Rules**, due dates of subsequent Annual Surveys and Intermediate Surveys are assigned in accordance with **3.2.2** and **3.2.3, Part 2 of the Rules** respectively based on new anniversary date. The new anniversary date is to be a date which is not to be more than 3 *months* later than the date on which the moved up Survey was completed. In such cases, where the third new anniversary date after due dates of the Intermediate Survey comes earlier than the expiry date of the Classification Certificate of the ship, the Intermediate Survey is to be carried out 3 *months* either way of the third new anniversary date.

3.5 Special Surveys for Hull

3.5.1 Kinds of Special Survey

For the application of the provisions of **3.5, Part 2 of the Rules**, reference is to be made to those relevant provisions given in **Part B of the Guidance for the Survey and Construction of Steel Ships**.

3.6 Annual Surveys for Machinery

3.6.1 Requirements for Annual Surveys

1 In general examinations specified in **3.6.1, Part 2 of the Rules**, for ships where harmonic filters are installed on the main busbars of electrical distribution systems, except in cases where the filters are installed for single application frequency drives such as pump motors, it is to be ascertained that the harmonic filters are placed in good order and either of the following **(1)** or **(2)** is to be verified.

(1) For ships fitted with facilities to continuously monitor the Total Harmonic Distortion (THD) values experienced by the main busbars as specified in **2.3.13-1, Part H of the Rules for the Survey and Construction of Steel Ships**, records of THD values are to be verified.

(2) For ships other than **(1)** above, correct operation of harmonic filters is to be confirmed by verifying that the maximum Total Harmonic Distortion (THD) value of the main busbar on board the ship is measured under typical seagoing conditions as close as possible to the date of the Annual Survey and the value does not exceed the acceptable limit.

2 In applying **3.6.1, Part 2 of the Rules**, the operation of the ventilation for the machinery spaces is to be confirmed.

3 In applying **3.6.1(1), Part 2 of the Rules**, the following **(1)** to **(8)** are also to be applied.

(1) It is to be confirmed that the normal operation of the propulsion machinery can be sustained or restored even though one of the essential auxiliaries becomes inoperative.

(2) The means for the operation of the main and auxiliary machinery essential for the propulsion and the safety of the ship are to be examined.

(3) The arrangements to operate the main and other machinery from a machinery control room are to be examined.

(4) It is to be confirmed that the machinery, boilers and other pressure vessels, associated piping systems and fittings are installed and protected so as to reduce to a minimum any danger to persons on board, due regard being given to moving parts, hot surfaces and other hazards.

(5) It is to be confirmed that means are provided so that the machinery can be brought into operation from the dead ship condition without external aid.

(6) The electrical installations, including the main source of power and the lighting systems are, as far as practicable, to be examined visually and in operation.

(7) It is to be examined that the precautions provided against shock, fire and other hazards of electrical origin are being maintained.

(8) The condition of any expansion joints in seawater systems are to be visually examined.

4 In applying **3.6.1(2), Part 2 of the Rules**, a general examination of the machinery, the boilers, all steam, hydraulic, pneumatic and other systems and their associated fittings is to be carried out to see whether they are being properly maintained and with particular attention to the fire and explosion hazards.

5 The "reference standards deemed appropriate by the Society" referred to in **3.6.1(7), Part 2 of the Rules** refer to the following **(1)** and **(2)**:

(1) those specified in **3.9.4-1** for oil lubricated shafts; and

(2) those specified in **3.9.4-2** for freshwater lubricated shafts.

3.6.2 Performance Tests

1 In applying **3.6.2, Part 2 of the Rules**, **2.3.2-2 of the Rules for Automatic and Remote Control Systems** is also to be applied for surveys of periodically unattended machinery spaces.

2 In applying **3.6.2(3), Part 2 of the Rules**, the operation of the emergency source(s) of electrical power including their starting arrangements, the systems supplied and, when appropriate, their automatic operation are also to be confirmed as far as practicable.

3 In applying **3.6.2(4), Part 2 of the Rules**, the following **(1)** and **(2)** are also to be applied.

(1) It is to be confirmed that the means of communication between the navigation bridge and steering gear compartment and the means of indicating the angular position of the rudder are operating satisfactorily.

(2) It is to be confirmed that the engine room telegraph, the second means of communication between the navigation bridge and the machinery space and the means of communication with any other positions from which the engines are controlled are operating satisfactorily

4 In applying **3.6.2(5), Part 2 of the Rules**, the following **(1)** to **(4)** are to be applied.

(1) In addition to carrying out the following **(a)** to **(e)** performance tests for main and auxiliary steering arrangements, including their associated equipment and control systems, the said arrangements are to be examined.

(a) Operation tests for the power units including changeover from one to another;

(b) Operation tests for automatic and remote isolation of the power actuating systems specified in **15.6, Part D of the Rules for the Survey and Construction of Steel Ships**;

(c) Tests for supply of the alternative source of power specified in **15.2, Part D of the Rules for the Survey and Construction of Steel Ships**;

(d) Operation tests for the control system including the changeover system; and

(e) Operation tests for the alarm devices, rudder angle indicators and running indicators of power units specified in **Part D of the Rules for the Survey and Construction of Steel Ships**.

(2) It is to be confirmed that with ships having emergency steering positions there are means of relaying heading information and, when appropriate, of supplying visual compass readings to the emergency steering position.

(3) It is to be confirmed that the various alarms required for hydraulic power-operated, electric and electro-hydraulic steering gears are operating satisfactorily.

(4) It is to be confirmed that the re-charging arrangements for hydraulic power-operated steering gears are being maintained.

5 In applying **3.6.2, Part 2 of the Rules**, the tests referred to in **1.2.7, Annex 2.11.1-2, Part H of the Rules for the Survey and Construction of Steel Ships** are to be carried out for ships equipped with accumulator battery systems to which **Annex 2.11.1-2, Part H of the Rules for the Survey and Construction of Steel Ships** is applied.

3.7 Intermediate Surveys for Machinery

3.7.1 General Examinations

For ships equipped with accumulator battery systems to which **Annex 2.11.1-2, Part H of the Rules for the Survey and Construction of Steel Ships** is applied, the conditions of the accumulator battery systems are to be examined in detail with measuring the insulation resistance of main circuit of accumulator battery systems and associated equipment. In addition, it is to be confirmed that the maintenance, management, etc. of such systems are properly carried out in accordance with **1.2.8, Annex 2.11.1-2, Part H of the Rules for the Survey and Construction of Steel Ships**.

3.8 Special Surveys for Machinery

3.8.1 General Examination

For ships equipped with accumulator battery systems to which **Annex 2.11.1-2, Part H of the Rules for the Survey and Construction of Steel Ships** is applied, the conditions of the accumulator battery systems are to be examined in detail with measuring the insulation resistance of main circuit of accumulator battery systems and associated equipment. In addition, it is to be confirmed that the maintenance, management, etc. of such systems are properly carried out in accordance with **1.2.8, Annex 2.11.1-2, Part H of the Rules for the Survey and Construction of Steel Ships**.

3.10 Planned Machinery Surveys

Planned Machinery Surveys are to be subject to the provisions specified in Chapter **B9, Part B of the Guidance for the Survey and Construction of Steel Ships**. However, provision **B9.1.1(4)** is to be applied as follows.

(4) Machinery and equipment (cargo handling appliances, refrigerating installations, bilge separators, pumps for bilge separators, etc.) that comply with Society rules other than the Rules for High Speed Craft, and that are required to have open-up surveys.

Part 3 HULL STRUCTURAL MATERIALS AND THEIR WELDING OR MOULDING

Chapter 4 WELDING OF ALUMINIUM ALLOYS FOR HULL STRUCTURE

4.1 General

4.1.1 Application

With regard to welding of aluminium alloys, it is recommended that reference may be made to the following standards.

(1) *JIS Z* 3604 "Recommended Practice for Inert Gas Shielded Arc Welding of Aluminium Alloy"

(2) The Standards of Japan Light Metal Welding And Construction Association

(a) *LWS Q* 8101 "Aluminium Ship's Quality Standard"

(b) *LWS W* 8101 "Aluminium Shipbuilding Practice Standard"

(3) *AWS Structural Welding Code-Aluminium*

Part 4 REQUIREMENTS FOR GENERAL ARRANGEMENT

Chapter 2 ARRANGEMENT OF WATERTIGHT BULKHEADS

2.1 Arrangements of Watertight Bulkheads

2.1.2 Collision Bulkheads

The expression "accepted by the Society" in **2.1.2-1, Part 4 of the Rules** means that an application submitted together with calculations verifying that no part of the bulkhead deck will be immersed even when the compartment forward of collision bulkhead is flooded under the loading condition (without trim) corresponding to the load line. In this case, the permeabilities used in the flooding calculations are to be in accordance with **Table 4.2.1-1**.

Table 4.2.1-1 Permeabilities of Spaces

Spaces	Permeabilities
Appropriated for stores	0.60
Occupied by accommodation	0.95
Occupied by machinery	0.85
Voids	0.95
Intended for consumable liquids	0 to 0.95 *
Intended for other liquids	0 to 0.95 *

Note:

* The permeability of partially filled compartment is to be consistent with the amount of liquid carried. Wherever damage extends to any tank carrying liquid, it is to be assumed that the content totally flows out of the compartment and is replaced by salt water up to the level of the final plan of equilibrium.
For cargo spaces, suitable permeabilities are to be used depending on the kinds of cargoes.

2.1.4 Hold Bulkheads

"Craft for restricted service" specified in **2.1.4-2, Part 4 of the Rules** mean those craft registered under classification character, affixed with "*Coasting Service*", "*Smooth Water Service*" or other similar notations.

2.1.5 After Peak Bulkheads

1 The definition of "Craft for restricted service" specified in **2.1.5-1, Part 4 of the Rules** is to be referred to **2.1.4** of this Part.

2 The expression "subject to the approval of the Society" in **2.1.5-2, Part 4 of the Rules** means that an application submitted together with calculations verifying that no part of the bulkhead deck will be immersed even when the compartment aft of after end watertight bulkhead is flooded under the loading condition (without trim) corresponding to the load line. In this case, the permeabilities used in the flooding calculations are to be in accordance with **Table 4.2.1-1**.

Chapter 4 ARRANGEMENT OF DOUBLE BOTTOMS

4.1 Double Bottoms in Passenger Craft

4.1.1 General

1 The depth of a double bottom required by **4.1.1-2, Part 4 of the Rules** is not less than *B*/16 in general.

2 The bottom to the turn of the bilge specified in **4.1.1-2, Part 4 of the Rules** is the bottom to the point *X* shown in **Fig. 4.4.1.1-1**.

3 The expression "if the line of intersection of · · · from the middle line." in **4.1.1-2, Part 4 of the Rules** means that any part of double bottoms at each frame section is not lower than the horizontal plane passing through the point *P* shown in **Fig. 4.4.1.1-2**.

Fig. 4.4.1.1-1 Definition of the Turn of the Bilge

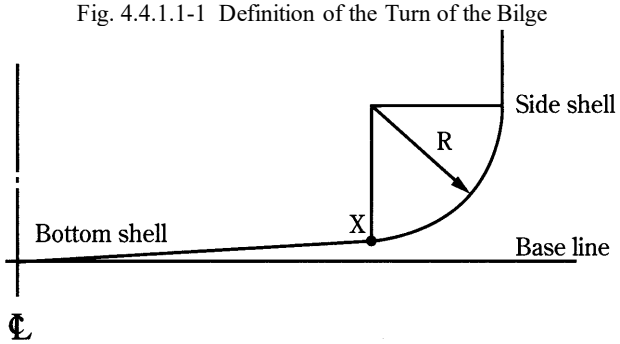
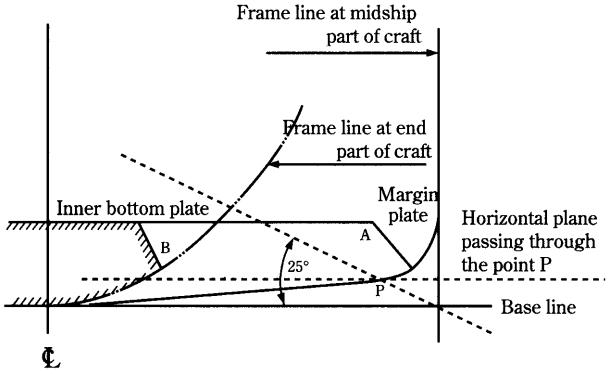


Fig. 4.4.1.1-2 Required Protection Area of Double Bottoms



4.2 Double Bottoms in Cargo Craft

4.2.1 General

1 The depth of a double bottom required by **4.2.1-2, Part 4 of the Rules** is to be referred to **4.1.1-1** of this Part.

2 The bottom to the turn of the bilge specified by **4.2.1-2, Part 4 of the Rules** is to be referred to **4.1.1-2** of this Part.

Part 5 DESIGN LOADS

Chapter 2 DESIGN LOADS

2.1 Application

2.1.2 Special Cases in Application

Design loads for the transverse strength on cross deck structures of craft with twin hulls are given by following **(1)** to **(3)**.

(1) The twin hull transverse bending moment (*See* **Fig. 5.2.1.2-1**)

The twin hull transverse bending moment is obtained from the following formula:

$M_b = 2.5WB'A_f$ $(kN\text{-}m)$

where:

W : Full load displacement as defined in **2.1.14, Part 1 of the Rules**.

B' : Transverse distance between the centre of the two hulls (m).

A_f : Design vertical acceleration at forward perpendicular of the craft as defined in **2.2.1(1), Part 5 of the Rules**.

(2) The twin hull torsional moment (*See* **Fig. 5.2.1.2-2**)

The twin hull torsional moment is obtained from the following formula:

$M_t = 1.25WL_sA_f$ $(kN\text{-}m)$

where:

L_s: Scantling length as defined in **1.2.2, Part 5 of the Rules**.

W and A_f:As specified in **(1)**.

(3) The twin hull vertical shear force (*See* **Fig. 5.2.1.2-3**)

The twin hull vertical shear force is obtained from the following formula:

$F = 2.5WA_f$ (kN)

where:

W and A_f:As specified in **(1)**.

Fig. 5.2.1.2-1 Twin Hull Transverse Bending Moment

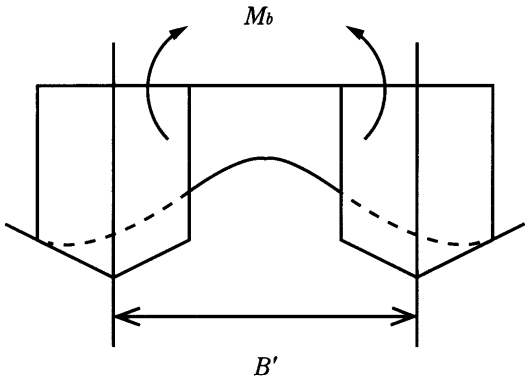


Fig. 5.2.1.2-2 Twin Hull Torsional Moment

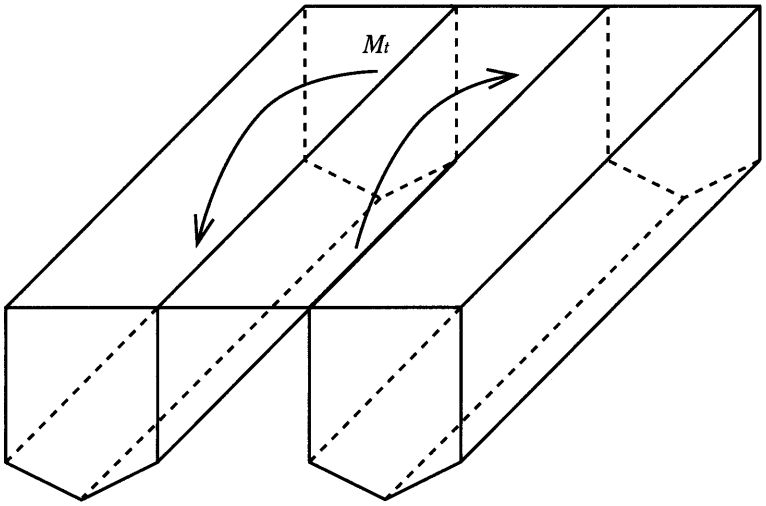
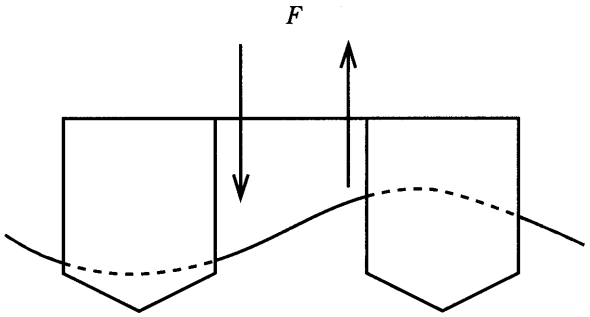


Fig. 5.2.1.2-3 Twin Hull Vertical Shear Force



Part 6 SCANTLING DETERMINATION OF HULL CONSTRUCTION

Chapter 1 HULL CONSTRUCTION FOR STEEL OR ALUMINIUM ALLOYS CRAFT

1.1 General

1.1.1 Application

1 Allowable stress for the transverse strength on cross deck structure of craft with twin hull are shown in **Table 6.1.1.1-1**.

2 Buckling strength on cross deck of craft with twin hull are to be in accordance with the requirements specified in **Chapter 4, Part 6 of the Rules**.

Table 6.1.1.1-1 Allowable Stress

	Allowable Stress
σ_1, σ_2	$0.667\sigma_y$
τ	$0.385\sigma_y$
σ_e	$0.750\sigma_y$

Note:

1. Unit: N/mm^2
2. σ_e: $\sqrt{\sigma_1^2 - \sigma_1\sigma_2 + \sigma_2^2 + 3\tau^2}$

   (The element coordinate system is to be *X*-*Y* rectangular coordinate system)

   where:

   σ_1 : Normal stress in *X*-direction of element coordinate system.

   σ_2 : Normal stress in *Y*-direction of element coordinate system.

   τ : Shearing stress on the *X* face in the *Y*-direction of element coordinate system.
3. σ_y:Yield point or proof stress of the material used.
4. Opening in transverse webs and girders, if any, are to be taken into consideration in evaluating the stress.

1.9 Rudders

1.9.4 Rudder Stocks

The wording "the craft whose maximum speed is not so fast" is a craft of which the value of $V/W^{1/6}$ is not more than 10. In this case, scantlings of rudder stocks of such a craft may be determined by **Chapter 3, Part CS of the Rules for the Survey and Construction of Steel Ships**.

1.10 Shaft Brackets

1.10.1 General

1 The scantling determination of shaft brackets is to be in accordance with following **(1)** through **(3)**.

(1) The boss thickness of shaft brackets is not to be less than that obtained from the following formula or $25mm$, whichever is greater.

$0.104D_b$ (m)

where:

D_b:The internal diameter of boss of shaft bracket (m).

(2) The external diameter of boss of shaft bracket is not to be less than that obtained from the following.

$0.16D_p$ (m)

where:

D_p:The diameter of a propeller (m).

(3) The boss length of shaft bracket is not to be less than that obtained from the following formula.

mD_b (m)

where:

m:Coefficient as specified in following;

For the shaft bracket immediately forward of a propeller: 4

For other intermediate shaft brackets: 2

D_b:As specified in preceding **(1)**.

2 Where the arm of the shaft bracket is of a solid arm made of steel or bronze castings, the scantling of shaft bracket arms is to satisfy with the following formula.

$$C^2t \geq \frac{1}{368}k\frac{Ha}{RD_p} \ (m^3)$$

where:

C : The longitudinal length of cross section of the arm (m). However, if the value exceeds $10t$, the length of the arm is to be taken as $10t$. (*See* **Fig.6.1.10.1-1**)

t : The thickness of cross section of the arm (m). (*See* **Fig. 6.1.10.1-1**)

a : The lever of the arm (m). (*See* **Fig. 6.1.10.1-1**)

H : The maximum continuous output of the engine (kW).

R : The number of maximum continuous revolutions (rpm).

D_p : As specified in preceding **1.10.1-1(2)**.

k : Coefficient corresponding to the tip clearance as given by the following formula.

$$\log k = 1.2 - 3.62\frac{d_0}{D_p}$$

d_0 : The tip clearance (m)

3 The scantling determination of shaft brackets having a hollow cross section and made of steel is to be in accordance with following **(1)** through **(3)**.

(1) The scantling of shaft bracket arms is to satisfy the following formula.

$$2C'(C'+3t')t'' \geq \frac{W}{368}k\frac{Ha}{RD_p} \ (m^3)$$

where:

k, H, $R$and D_p:As specified in preceding **1.10.1-2**.

C' : The longitudinal length of cross section of the arm (m). (*See* **Fig. 6.1.10.1-2**)

t' : The thickness of cross section of the arm (m). (*See* **Fig. 6.1.10.1-2**)

t'' : The shell thickness of the arm (m). (*See* **Fig. 6.1.10.1-2**)

w : Coefficient as specified in following;

For the welded hollow arm: 2.69

For the seamless hollow arm: 1.00

Shaft brackets having the hollow cross section

(2) The thickness t'' of the hollow arm is not to be less than that obtained from the following formula.

$18.2a$ (mm)

where:

a: As specified in preceding **1.10.1-2**.

(3) To avoid cavitation, the connection between C'/t' and V is to be ranged within a safety zone shown in **Fig. 6.1.10.1-3**. In this case, C'/t' and V are as specified in preceding **(1)**. Where V-type shaft bracket is provided, the propeller influence on shaft bracket is to be considered.

4 Where shaft bracket arm made of aluminium alloy or aluminium castings is provided, the values obtained from **-3** are to be multiplied by $402/\sigma_T$, where σ_T is tensile strength of the materials used (N/mm^2).

Fig. 6.1.10.1-1Measurements of C, t and a

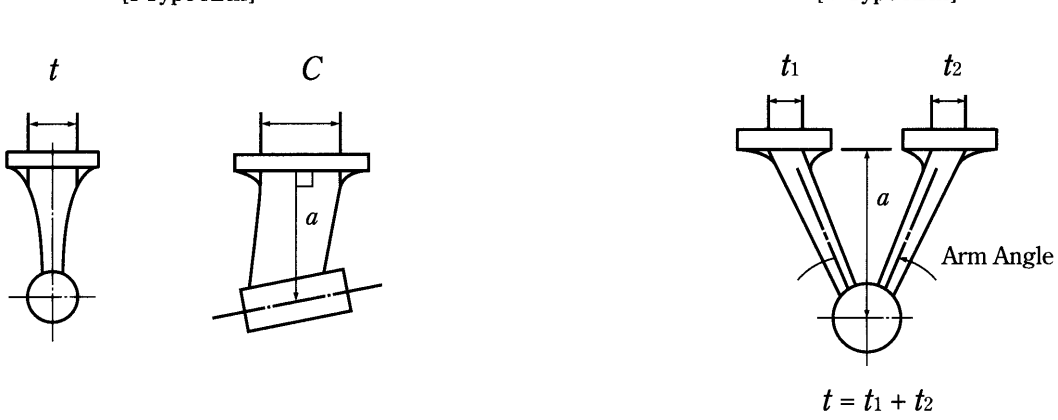


Fig. 6.1.10.1-2Measurement of C', t' and t''

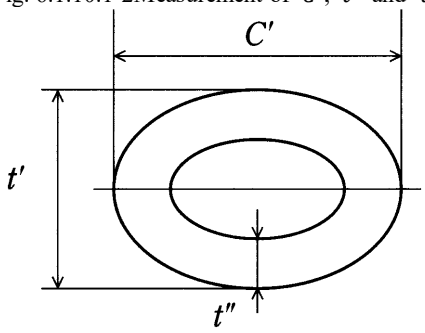
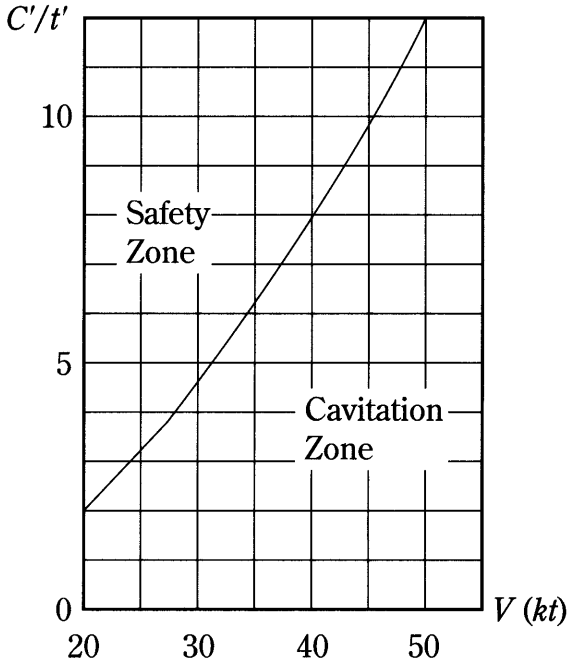


Fig. 6.1.10.1-3Cavitation Zone



1.11 Engine Girders and Floors

1.11.1 General

1 The standard thickness of top plating of engine girders will be determined referring to the following formula.

$$\alpha t_0 + \frac{S}{C} \ (mm)$$

where:

α : As shown in **Table 6.1.11.1-1**

t_0 : As obtained from the following formula.

$$t_0 = 1.1\sqrt[3]{\left(2.5 - \frac{N}{20}\right)H}$$

N : Numbers of cylinder.

H : The maximum continuous output of engine (kW).

S : Spacing of stiffeners (mm).

C : As specified in following.

$H > 1470kW$:100

$H \leq 1470kW$:200−H/14.7

2 The standard web thickness of engine girders will be determined referring to the following formula.

$0.45t_t$ (mm)

t_t:The thickness of top plating of engine girders (mm)

3 The standard web thickness of engine floors will be determined referring to the following formula.

$0.32t_t$ (mm)

t_t:As specified in preceding **-2**.

4 The thickness of structural members of engine girders is not to be less than that given by the following in accordance with the materials used.

Steels: 3.0 (mm)

Aluminium alloys: 4.0 (mm)

5 Where height of engine girders or floors are specially high, the thickness of each structural members is to be increased appropriately.

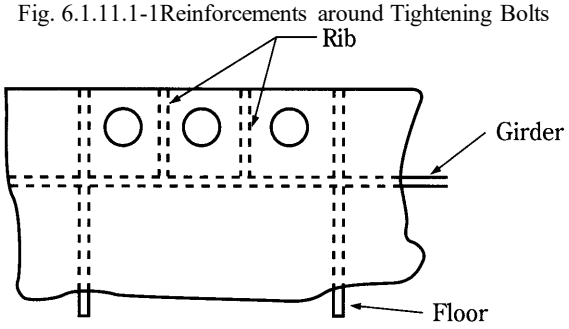
6 The tightening bolts are to be as close to the engine girders as practicable, and ribs are to be fitted suitably around holes of the tightening bolts. (*See* **Fig. 6.1.11.1-1**)

7 The lightening hole is, in principle, not to be arranged on engine girders. Where some lightening holes are arranged on engine girders, the size of the lightening hole is not less than 1/3 of the height of the subject engine girder.

Table 6.1.11.1-1 Values of α

H	α	
	Steels	Aluminium Alloys
H<37	1.00	1.10
37≤H<73.5	0.72	0.90
73.5≤H<515	0.56	0.70
515≤H<1030	0.50	0.63
1030≤H<1470	0.42	0.53
1470≤H	0.35	0.44

Fig. 6.1.11.1-1Reinforcements around Tightening Bolts



Chapter 3 DIRECT CALCULATIONS

3.1 General

3.1.1 General

1 In the case where scantlings of structural members of the hull are determined by direct calculations, the requirements specified in this Chapter are to be applied.

2 In the case where scantlings of structural members of the hull are determined by direct calculations, the kinds of members of which the scantlings can be determined as well as the ranges of application of formulae, in the Rule and Guidance, for determining scantlings of such members are, as a rule, to be previously approved by the Society.

3 Even when the scantlings of structural members of the hull are determined by direct strength calculations, the requirements in **1.4, Part 6 of the Rules** are to be complied with.

4 Even when the plate thickness of structural members are determined by direct strength calculations, the minimum thickness specified in the Rule are to be maintained.

3.2 Analysis Methods

3.2.1 General

1 The analysis methods and programs are to be such that the influences of bending, shearing, axial and torsional deflections can be effectively taken into consideration.

2 The analysis methods and programs are to be such that the behaviours of plane or space structures can be effectively expressed and or displayed under reasonable boundary conditions.

3 The analysis programs are to be such as to be recognized to have a sufficient analysing accuracy. When considered necessary, the Society may require submission of data on the details of the analysis methods, verification of accuracy, etc.

4 When direct strength calculations were executed for determination of scantlings, the materials and data specifying the conditions of calculations and data summarizing their results are to be submitted to the Society.

3.3 Structural Models

3.3.1 Modelling of Structure

1 The model of the structure to be analysed is to include its surrounding members considered to have material influences on the behaviours of the members of which the scantlings are to be determined by direct strength calculations.

2 The structure may be modelled on a two or three dimensional structure by using beam elements, shell elements or hybrid elements. The modelling is to be such that any proper elements chosen from among plate bending elements, membrane elements, beam elements, bar elements, etc., can reproduce the behaviours of the structure with the highest possible fidelity.

3 The scantlings including corrosion allowances which are shown on the plans may be used for modelling.

4 When the degree of division of a member into model elements is insufficient for the determination of scantlings by direct calculations, the member concerned is to be subject to the calculation by remeshing with fine meshes to enable further study on the basis of the results of the analysis.

5 The model and range of structure to be analyzed are to be determined so as to minimize the influence due to longitudinal bending moment of hull girders at the forward and aft end boundaries of the structural model.

3.3.2 Modelling by Using Shell Elements

1 Side shell, longitudinal bulkheads and other similar members subjected to large shearing forces are preferably to be modelled into a two or three dimensional structure by using shell elements.

2 In meshing, proper sizes of meshes are to be selected in accordance with the stress distribution in the model which can be predicted and abnormally large aspect rations of meshes are to be avoided.

3 Girders and similar members having stress gradients along their depth are to be so meshed as to enable their discrimination.

3.3.3 Modelling by Using Beam Elements

1 When modelling into beam elements, the plate of a width equal to 1/10 of span of the member on its each side may, as a rule, be included, provided that the plate to be included is effectively reinforced by other members or is recognized by the Society to have a sufficient thickness, and, in addition, this width equal to 1/10 of the span does not exceed half of the distance to the neighbouring member.

2 When modelling by using beam elements, rigid members are to be provided where constructions of high rigidity such as bracketed constructions at the connections of member corners are employed.

3 When modelling by using beam elements, attention is to be paid to the position of neutral axis. Particularly when modelling on hybrid structure of beam and shell elements, offset beam elements are to be used.

3.4 Design Loads

3.4.1 Classification of Loads

1 The loads due to longitudinal bending moment at the forward and aft end boundaries of the structure model may, as a rule, not be taken into consideration. When these loads are taken into consideration or the influence of these loads can't ignore for reasons of modelling, however, the allowable stress to be applied to the results of calculation is to be determined at the directions of the Society.

2 The design loads to be applied to structural models are to be a combination of internal loads and external loads specified in **3.4.2** and **3.4.3**. In the case, however, where another combination of loads is obviously severer than that specified, the latter may be omitted.

3 When loads other than stipulated in **-2** above are predicted, special considerations are to be required and proper data in this connection are to be submitted to the Society.

4 As for large deep tank boundaries or large cargo tank boundaries, the additional water head (Δh) is to be taken into consideration as deemed necessary by the Society.

3.4.2 Internal Loads

Following loads are to be taken into consideration as internal loads.

(1) Load for Hydraulic Pressure Test

The upper end of water head of a tank being subjected to hydraulic pressure test is to be in accordance with **2.2.2, Part 2 of the Rules**.

(2) Loads due to Cargo

(a) In the case where packaged cargoes (*e.g.*, container) or vehicles are loaded, cargo loads are to be determined in accordance with the designed loading conditions.

(b) In the case where solid bulk cargoes are loaded, the density, loading height and surface of the cargoes are to be determined by giving reference to the preliminary trim calculations, etc. The density, loading height and repose angle of cargoes used in the calculations are to be clearly indicated. If considered necessary, the angle of internal friction of the cargo and the angle of friction between the cargo and wall surface are to be indicated.

(3) Loads due to Water Ballast, etc.

(a) Loads due to water ballast, etc., are to be in accordance with **2.6.2, Part 5 of the Rules**.

(b) For the liquid cargo or water ballast to be loaded in harbours or similar quiet waters, the water head corresponding to the actual loading height may be used as the designed water head.

(c) Except where considered necessary, the loads due to fuel oil, fresh water and similar consumable may not be taken into consideration.

3.4.3 External Loads

The following loads are to be taken into consideration as external loads.

(1) The water pressure under the condition of hydraulic pressure test

The water pressure at the bottom and sides under the condition of hydraulic pressure test is to be the hydrostatic pressure corresponding to the actual draught in case of the hydraulic pressure test.

(2) The external loads for the bottom

(a) The external loads for the bottom are to be in accordance with **2.2, Part 5 of the Rules**.

(b) The external loads for the bottom in harbours or similar quiet waters may be obtained from the following formula.

$10(d + H_w/3)$ (kN/m^2)

where:

H_w:Significant wave height specified in **2.2.1, Part 5 of the Rules**

(3) The external loads for the sides

(a) The external loads for the side are to be in accordance with **2.3, Part 5 of the Rules**.

(b) The external loads for the sides in harbours or similar quiet waters may be obtained from the following formula.

$10(d + H_w/3)$ (kN/m^2)

where:

H_w:Significant wave height specified in **2.2.1, Part 5 of the Rules**

(4) The external loads for the exposed decks

(a) The external loads for the exposed decks are to be in accordance with **2.4.1, Part 5 of the Rules**.

(b) The external loads for the exposed decks in harbours or similar quiet waters may be obtained by taking half the value of the load required in **2.4.1, Part 5 of the Rules**.

3.5 Allowable Stress

3.5.1 Allowable Stress

1 When the loads specified in the preceding **3.4** are to be applied to the structural model according to **3.3** above, the scantlings of members are to be determined so that the values of stress in each of them may not exceed the values given below.

(1) Allowable stress for structural members of steels and aluminium alloys

Corresponding to the structural members, σ_{all} and τ_{all} specified in **1.5** through **1.7, Part 6 of the Rules** are to be applied respectively. Where nothing particular is provided for, the values are to be left to the Society's directions.

(2) Allowable stress for structural members of FRP

Corresponding to the structural members, σ_{all} and τ_{all} specified in **2.5** through **2.7, Part 6 of the Rules** are to be applied respectively. Where nothing particular is provided for, the values are to be left to the Society's directions.

2 When the section modulus of a hull girder contains a fair margin, the permissible value of normal stress lengthwise is to be left to the directions of the Society.

3.6 Deflection of Girders and Transverses

3.6.1 Added Stress

In case where the result of direct strength calculations show that relative deformations on transverses and vertical web supporting longitudinals, longitudinal beams or bulkhead stiffeners or between bulkheads are large, the added stress due to their effects is to be considered.

Chapter 4 BUCKLING CONTROL

4.1 General

4.1.1 General

Where detailed assessment of buckling strength is required, the **8.6.2, Part 1, Part C of the Rules for the Survey and Construction of Steel Ships** may be applied.

Part 7 EQUIPMENT AND PAINTING

Chapter 1 EQUIPMENT

1.1 Anchors, Chain Cables and Ropes

1.1.1 General

1 The wording "at the discretion of the Society" is the case where following conditions are fully satisfied:

(1) A craft is engaged in the specific voyage,

(2) In general, there is no case of anchorage by using bower anchors under the normal operation,

(3) Adequate system of refuge is available in cases of bad weather, and

(4) Adequate system to immediately supply spare bower anchor is available when a craft loses her bower anchor.

2 "The reduction of requirements" specified in **1.1.1-4, Part 7 of the Rules** is the reductions within the extent as following **(1)** and **(2)**:

(1) Required number of bower anchors may be reduced to one.

(2) Steel wire ropes or synthetic fibre ropes may be used in lieu of chain cables provided that the following conditions are satisfied.

(a) At least one length of chain is, in principle, to be fitted between the bower anchor and steel wire ropes or synthetic fibre ropes. However, where steel wire ropes or synthetic fibre ropes can be easily connected to the chain cable on board in cases of emergency anchorage, steel wire ropes or synthetic fibre ropes may be stored apart from chain cables.

(b) The breaking test load for steel wire ropes or synthetic fibre ropes specified in **Chapter 4** or **5, Part L of the Rules for the Survey and Construction of Steel Ships** is not less than the breaking load for chain cables given in **Table 7.1.1, Part 7 of the Rules**. The breaking test load for chain cables is to be in accordance with the requirements specified in **Chapter 3, Part L of the Rules for the Survey and Construction of Steel Ships** according to the diameter. The length of steel wire ropes or synthetic fibre ropes are to be at least equal to the length of chain cables given in **Table 7.1.1, Part 7 of the Rules**.

Chapter 2 HATCHWAYS, MACHINERY SPACE OPENINGS AND OTHER DECK OPENING

2.1 General

2.1.2 Position of Exposed Deck Openings

1 In the application of the requirements of **2.1.2, Part 7** of the Rules, "superstructure decks" include top decks of superstructures, deckhouses, companionways and other similar deck structures.

2 "Exposed raised quarter decks" in the definition of Position I specified in **2.1.2, Part 7** of the Rules refers to exposed superstructure decks lower than h_S specified in **V2.2.1, Part V of the Guidance for the Survey and Construction of Steel Ships** above the freeboard deck.

3 "Exposed superstructure decks" in the definition of Position I specified in **2.1.2, Part 7** of the Rules refers to exposed superstructure decks lower than $2h_S$ specified in **V2.2.1, Part V of the Guidance for the Survey and Construction of Steel Ships** above the freeboard deck.

4 "Exposed superstructure decks located at least one standard height of superstructure above the freeboard deck" in the definition of Position II specified in **2.1.2, Part 7** of the Rules refers to exposed superstructure decks located at least h_S specified in **V2.2.1, Part V of the Guidance for the Survey and Construction of Steel Ships** above the freeboard deck and lower than $2h_S$ specified in **V2.2.1, Part V of the Guidance for the Survey and Construction of Steel Ships** above the freeboard deck.

5 "Exposed superstructure decks located at least two standard heights of superstructure above the freeboard deck" in the definition of Position II specified in **2.1.2, Part 7** of the Rules refers to exposed superstructure decks located at least $2h_S$ specified in **V2.2.1, Part V of the Guidance for the Survey and Construction of Steel Ships** above the freeboard deck and lower than $3h_S$ specified in **V2.2.1, Part V of the Guidance for the Survey and Construction of Steel Ships** above the freeboard deck.

2.3 Closing Means for Access Openings in Superstructure End Bulkheads

2.3.1 Closing Means for Access Openings

Where the sill of access openings is liable to make hindrance to the passage of heavy spare parts or to the getting on and off of the passengers, etc., a removable sill may be used subject to approval by the Society.

2.5 Companionways and Other Deck Openings

2.5.2 Companionways

Grouping into deckhouse and companion:

(1) A structure is regarded as a deckhouse where its inside is always accessible through access openings provided on the top of the structure or through under-deck passageways, even when all access openings in the boundary walls are closed.

(2) A structure is regarded as a companion where its inside is not accessible through any other way, when all access openings in the boundary walls are closed.

Chapter 3 BULWARKS, GUARDRAILS, FREEING ARRANGEMENTS, CARGO PORTS AND OTHER SIMILAR OPENINGS, SIDE SCUTTLES, VENTILATORS AND GANGWAYS

3.1 Bulwarks and Guardrails

3.1.1 General

In **3.1.1-2(2), Part 7 of the Rules**, "measures deemed appropriate by the Society" implies that **(1)** and **(2)** below need to be satisfied.

(1) Stanchions are to be of increased breadth as in **(a)** to **(c)** below, depending on their arrangement. The figure of these stanchions is given in **Fig.3.1.1-1**.

(a) at least every third stanchion is to be of increased breadth : $kb_s \geq 2.9b_s$

(b) at least every second stanchion is to be of increased breadth : $kb_s \geq 2.4b_s$

(c) every stanchion is to be of increased breadth : $kb_s \geq 1.9b_s$

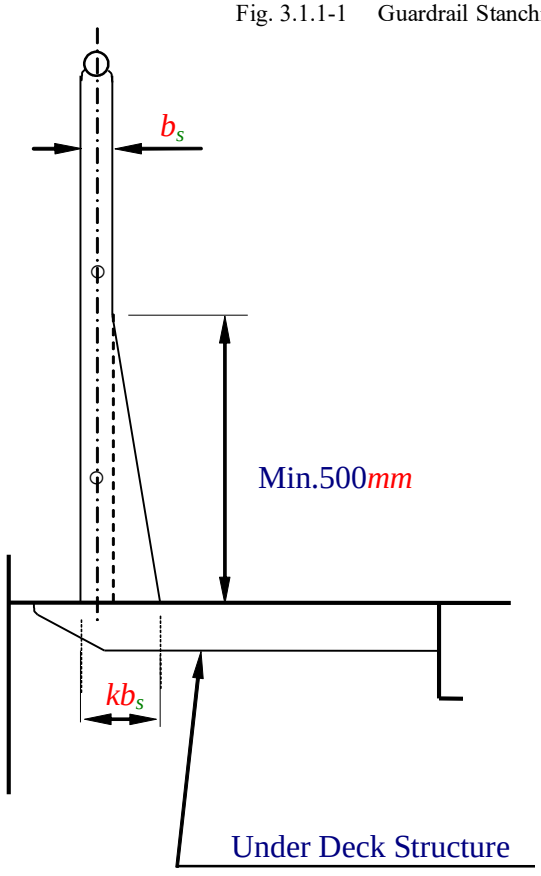
kb_s : increased breath of stanchion (mm)

b_s : breadth of stanchion according to standards approved by the Society.(mm)

Stanchions of increased breadth are to be welded to the deck with double continuous fillet welds and a minimum leg size of 7 mm or as specified by standards approved by the Society.

(2) Stanchions with increased breadth, as described in **(1)** above, are to be aligned with the members below the deck. These members are to be a minimum of 100x12 mm flat bar welded to the deck by double continuous fillet welds. The stanchions with increased breadth need not be aligned with under deck structures for deck plating exceeding 20 mm.

Fig. 3.1.1-1 Guardrail Stanchion (Example)



3.2 Freeing Arrangements

3.2.2 Freeing Port Area

1 A flush-decker having an effective deckhouse is to be considered to have two wells afore and abaft the deckhouse, and each of these wells is required to have a freeing port area as prescribed in **3.2.2, Part 7** of the Rules. The term "effective deckhouse" means a structure having a breadth not less than 80% of the breadth of ship and the width of passageways at its sides does not exceed 1.5 *m*.

2 Where a divisional bulkhead extending from side to side is provided at the forward end of deckhouse, the ship is to be considered to have two wells afore and abaft the bulkhead, irrespective of the breadth of deckhouse, and each of these wells is required to have the freeing port area prescribed in **3.2.2, Part 7** of the Rules.

3 Where freeing ports have rails or other fixtures that reduce the area of the opening, the projected area caused by these fixtures is to be deducted from the actual freeing port area during calculations.

3.2.3 Arrangement of Freeing Ports

In ships without sheer or having very small sheer, the area of freeing ports is to be distributed throughout the whole length of the well.

3.4 Side Scuttles

3.4.1 General

"The special consideration" specified in **3.4.1-2, Part 7 of the Rules** is to be given provided that the following conditions are fully satisfied.

(1) Side scuttles are to be provided in spaces where there is little possibility of damage on side scuttles by contact with cargoes under the normal operations including loading/unloading operations whether side scuttles are protected by suitable means against mechanical damage or not (for example, special category spaces may be regarded as such spaces),

(2) No side scuttle is to be provided in a position below the water line at final equilibrium after flooding stipulated in **Part 8** of the Rules. For cargo craft which are not engaged in international voyage and for restricted service, no side scuttle is to be provided in a position below freeboard deck,

(3) Side scuttles are to be of class *B* side scuttles of fixed type complying with the requirements in **Chapter 7, Part L of the Rules for the Survey and Construction of Steel Ships** or equivalent thereto, and

(4) Such cargo spaces are to be protected by fixed fire-extinguishing systems other than fixed gas fire-extinguishing systems.

3.5 Other Windows

3.5.4 Closing Appliances

The definition of "Craft for restricted service" specified in **3.5.4-2, Part 7 of the Rules** is to be referred to **2.1.4, Part 4 of this Guidance**.

3.6 Ventilators

3.6.3 Closing Appliances

Closing appliances required in **3.6.3, Part 7 of the Rules** are to be of steel or other equivalent materials.

Part 8 BUOYANCY, STABILITY AND SUBDIVISION

Chapter 1 GENERAL

1.1 General

1.1.2 Ice Accretion Allowances

"Ice accretion allowance" specified in **1.1.2, Part 8 of the Rules** is to be in accordance with the provisions of **Annex 1** as attached.

1.3 Intact Stability in the Displacement Mode

1.3.1 Intact Stability for Hydrofoil Craft

"The relevant provisions which will be individually determined by the Society" specified in **1.3.1, Part 8 of the Rules** are to be in accordance with the provisions of **Annex 2** as attached. In this case, the craft is specifically to maintain a heel angle of less than 10 degrees when subjected to the greater of the heeling moments specified in **1.2.1-2** and **1.2.1-4 of Annex 2**.

1.3.2 Intact Stability for Multihull Craft

"The relevant requirements which will be individually determined by the Society" specified in **1.3.2, Part 8 of the Rules** are to be in accordance with the provisions of **Annex 3** as attached.

1.5 Intact Stability in the Transient Mode

1.5.2 Hydrofoil Craft

"The relevant provisions which will be individually determined by the Society" specified in **1.5.2, Part 8 of the Rules** are to be in accordance with the provisions of **Annex 2** as attached.

Chapter 2 REQUIREMENTS FOR PASSENGER CRAFT

2.2 Intact Stability

2.2.2 Intact Stability in the Non-displacement Mode

"Beam wind pressure" specified in **2.2.2, Part 8 of the Rules** means the heeling moment due to wind pressure specified in **1.2.1-4 of Annex 2** as attached.

2.3 Buoyancy and Stability in the Displacement Mode Following Damage

2.3.2 Residual Stability of Multihull Craft

"The residual stability of multihull craft" specified in **2.3.2, Part 8 of the Rules** is to be in accordance with the provisions of **Annex 3** as attached.

Chapter 3 REQUIREMENTS FOR CARGO CRAFT

3.1 General

3.1.1 Application

The definition of "Craft for restricted service" specified in **3.1.1, Part 8 of the Rules** is to be referred to **2.1.4, Part 4 of the Guidance**.

3.2 Buoyancy and Stability in the Displacement Mode Following Damage

3.2.2 Residual Stability

"The residual stability of multihull craft" specified in **3.2.2-1, Part 8 of the Rules** is to be in accordance with the provisions **Annex 3** as attached.

Part 9 MACHINERY INSTALLATIONS

Chapter 1 GENERAL

1.2 General Requirements for Machinery Installations

1.2.1 General

1 The wordings "navigable speed" in **1.2.1-3, Part 9 of the Rules** means a speed at which the ship is capable of steering and being kept navigability for an extended period of time (the period required to get the nearest port for repairs). Normally, 7 *knots* or a speed corresponding to 1/2 of the speed specified in **2.1.8, Part 1 of the Rules** at the ship's full loaded draught, whichever is smaller, may be regarded as a navigable speed.

2 When designing and constructing machinery installations that are adequate for the service for which they are intended in accordance with **1.2.1-2, Part 9 of the Rules**, the properties (e.g. viscosity, cold flow property) of the fuel oils intended to be used by the machinery installations are to be taken into account, and fuel oil heaters and fuel oil coolers are to be provided when deemed necessary.

1.2.4 Fire Protections

1 The "spaces where pre-treatment machinery installations for flammable liquid" in **1.2.4-7, Part 9 of the Rules** means the space where the essential component of following systems are installed:

(1) System of preparing fuel for boilers

(2) System of preparing fuel for main propulsion machinery and auxiliary machinery

(3) System of preparing flammable liquid with the working pressure above 1.6 *MPa*

2 The "other adequate means deemed appropriate by the Society" in **1.2.4-7, Part 9 of the Rules** means the cases provided with both of following **(1)** and **(2)** below;

(1) An independent mechanical ventilation system (self-suction type).

(2) An automatically operated fire-extinguishing system, or combination of a fixed fire detection and fire alarm system and a remotely operated fire-extinguishing system capable of being operated from suitable positions, (excluding fire-extinguishing systems using a dangerous gas such as CO_2), whose systems are to be in accordance with the related requirements specified in **Part R of the Rules for the Survey and Construction of Steel Ships**.

1.3 Tests

1.3.2 Tests after Installation On Board

1 When the propeller is force fitted to the propeller shaft by hydraulic force, the confirmation of the pull-up length specified in **1.3.2(6), Part 9 of the Rules** is to be made assuming that the true relative start point is the point where the pull-up load equals zero on the approximate line drawn in the measured points plotted on the chart of the relation between pull-up length and load.

2 In the force fitting test for keyless propellers, it is to be confirmed that the pull-up length measured according to **-1** above is between the upper and lower limits specified in **7.3.1-1, Part D of the Rules for the Survey and Construction of Steel Ships**, and that the apparent coefficient of friction derived from following formula is not less than 0.1 and below 0.2.

$$\mu_\gamma = \frac{K\frac{K_E}{S} - tan\alpha}{1 + K\frac{K_E}{S}tan\alpha}$$

μ_γ:Apparent coefficient of friction derived from the results of force fitting test.

K:Rate of fitting force to pull-up length, which is derived from the results of force fitting tests in dry-fitting method.

K_E, S, α:Same as those specified in **7.3.1-1, Part D of the Rules for the Survey and Construction of Steel Ships**.

3 Where the propeller is force fitted on the propeller shaft with use of a key, standard pull-up length is generally as follows;

$$L_4 = \frac{2d_p}{tan\alpha} \times 10^{-4}$$

L_4 : Standard pull-up length (mm)

d_p : Diameter of propeller shaft (cone part large end) (mm)

α : Half-angle of the taper at the propeller shaft cone part (deg)

Chapter 2 RECIPROCATING INTERNAL COMBUSTION ENGINES

2.1 General

2.1.1 General

1 The wording "as specified separately by the Society" specified in **2.1.1-2, Part 9 of the Rules** means "in accordance with **Chapter 8, Part 6 of Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**".

2 The wording "the requirements specified otherwise by the Society" in **2.1.1-5, Part 9 of the Rules** means **Annex 1.1.3-3, Part GF of the Rules for the Survey and Construction of Steel Ships**.

2.1.3 Drawings and Data

For the following data, those represented by two sizes in a generic range of turbochargers (i.e. the same components, materials, etc., with the only difference being the size) are acceptable.

(1) The documentation of safe torque transmission specified in **(34)(a), Table 9.2.1(b), Part 9 of the Rules**.

(2) The operation and maintenance manuals listed in **(34)(c), Table 9.2.1(b), Part 9 of the Rules**.

2.1.4 Approval of Reciprocating Internal Combustion Engines

1 In applying **2.1.4, Part 9 of the Rules**, reference for the approval procedures is to be made to **Fig. 2.1.4-1**.

2 The phrase "design approval is to be obtained as specified separately by the Society" specified in **2.1.4-1(1)(a), Part 9 of the Rules** means that the design approval and design appraisal are to be obtained in accordance with **Chapter 8, Part 6 of Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.

3 The wording "the drawings and data of the engine whose approval of use has been obtained" specified in **(1)(c)**, **(1)(d)**, **(2)(a)** and **(2)(b)** of **2.1.4-1, Part 9 of the Rules** means those listed in **8.2.2, Part 6 of Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.

4 The wording "as specified separately by the Society" specified in **2.1.4-1(1)(d), Part 9 of the Rules** means "in accordance with **8.2.2-2, Part 6 of Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**".

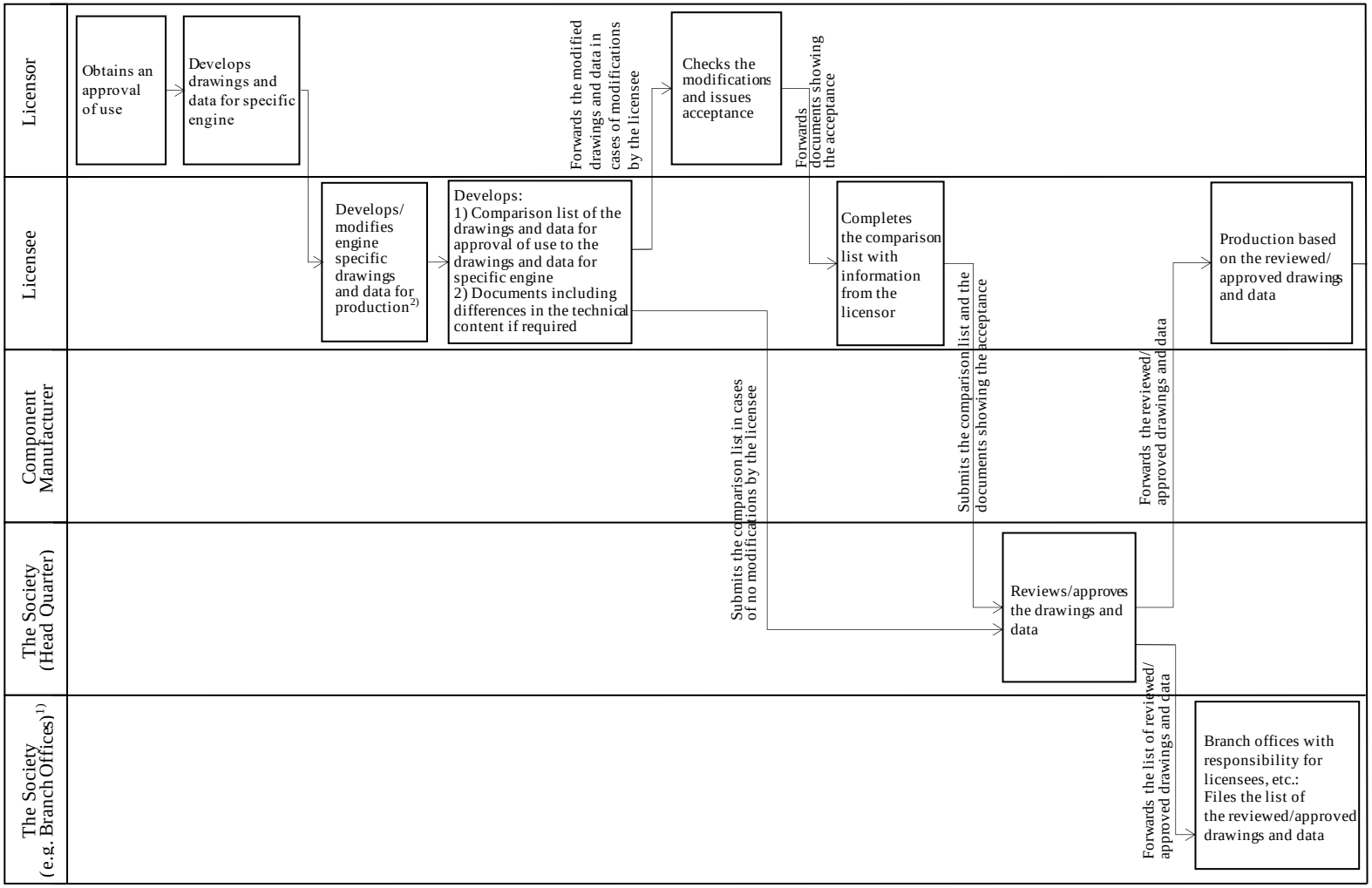
5 In applying **2.1.4-1(2)(c), Part 9 of the Rules**, quality requirements specified by the licensor are to be satisfied.

6 The wording "as specified separately by the Society" specified in **2.1.4-1(4)(a), Part 9 of the Rules** means "in accordance with **8.2.2-4, Part 6 of Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**".

2.1.5 Construction, Installation and General

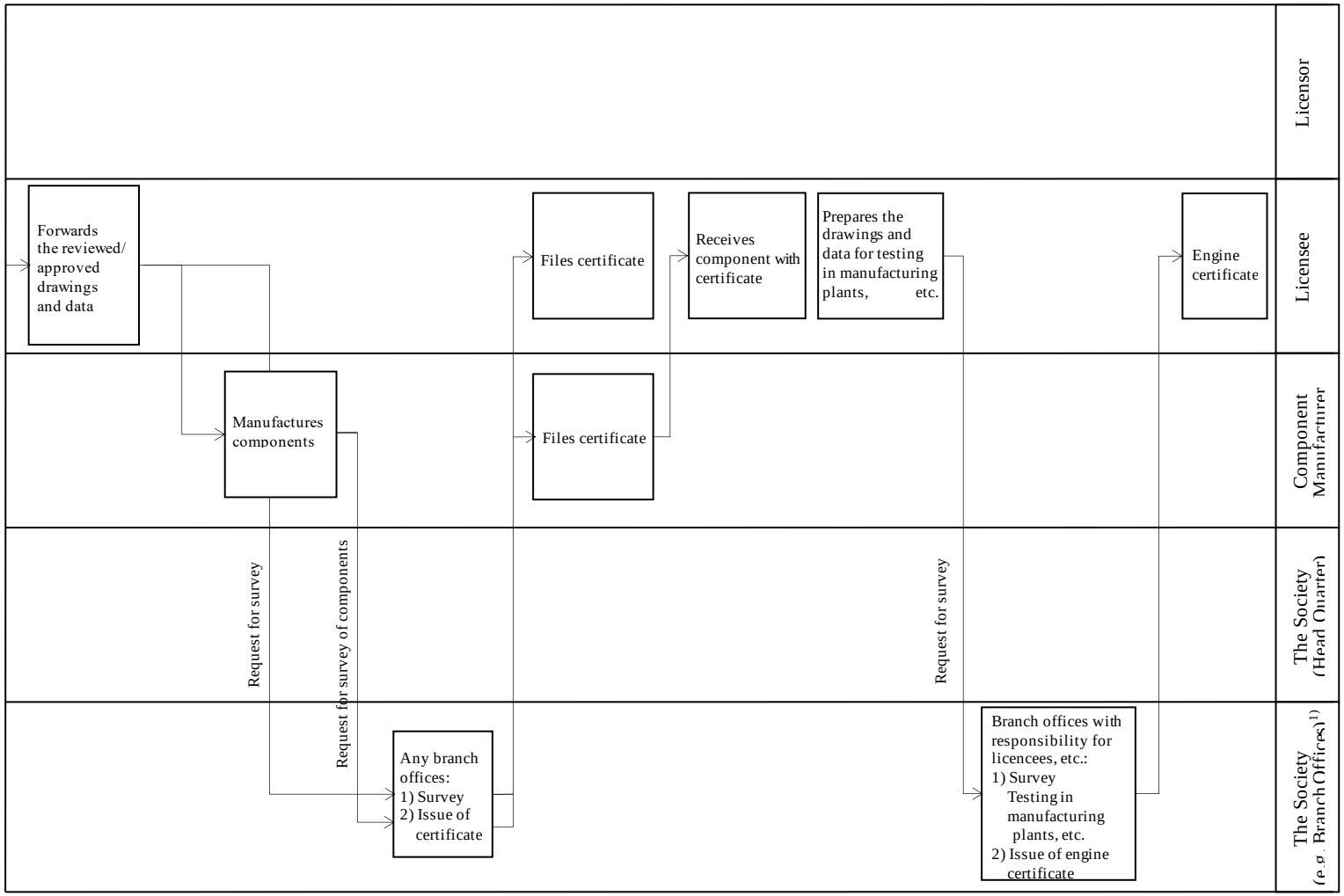
1 With respect to the ambient reference conditions specified in **2.1.5-6, Part 9 of the Rules**, the expected component lifespan of the turbochargers with novel design features or no service records is to be based upon an air inlet temperature of 45°C.

Fig.2.1.4-1 Flow of Approval of Reciprocating Internal Combustion Engines



1) Branch offices with responsibility for licensees and/or component manufacturers in different locations
2) In cases of modifications by the licensee, refer to **(b)** and **(c)** of **2.1.4-1(2), Part 9 of the Rules**

Fig.2.1.4-1 Flow of Approval of Reciprocating Internal Combustion Engines (continued)



Chapter 3 GAS TURBINES

3.1 General

3.1.3 Drawings and Data

"Documents containing strength considerations made for principal components" referred to in **3.1.3(2)(h), Part 9 of the Rules** are to include the following **(1)** and **(2)** documents:

(1) documents showing that mechanical stresses acting on principal components are clear based upon the results of stress analysis or from experimental values, etc. and it is ensured that there is an adequate safety factor for such stresses against the fatigue limit.

(2) documents showing that it has been verified for principle components on which mechanical stresses, thermal stresses, creeps, relaxations, etc. or any combination thereof is applied and that stresses corresponding to differential stresses between those in the static condition of the gas turbine at ambient temperature and those in the condition in which the gas turbine is operating at the maximum continuous output.

3.2 Materials, Construction and Strength

3.2.2 Construction and Installations

1 The restart of gas turbines used as main propulsion machinery specified in **3.2.2-4, Part 9 of the Rules** does not require an automatic restarting function.

2 The phrase "installed so that (...) does not endanger persons and machinery in the vicinity of the gas turbine" specified in **3.2.2-6, Part 9 of the Rules** means that the following **(1)** to **(3)** are, as far as possible, to be located outside of the plane of high speed rotating parts of the gas turbine, taking into account those cases where the casing is unable to contain a blade or another principal component, or any debris in the event of the loss of a blade or the failure of such a principle component.

(1) Fuel oil, lubricating oil and other systems having a fire risk

(2) Fire detection and alarm systems as well as fire extinguishing systems

(3) Areas normally manned in the compartment where the gas turbine is installed

3.4 Associated Installations

3.4.2 Starting Arrangements

1 In cases where the "means" specified in **3.4.2-1, Part 9 of the Rules** is automatic, fuel oil systems, lubricating oil systems and cooling systems, etc. are to be designed so that they can be operated sequentially according to a pre-determined programme when the engine starts or stops. Regarding the sequence and operation related to these systems, attention is to be paid to the following **(1)** to **(7)**.

(1) Lubricating oil pumps are to be in operation before the starting-up and after the stopping of any engine. However, this requirement may be dispensed with in cases where the engine is equipped with roller bearings and the lubricating oil pumps are being driven by the engine.

(2) Combustion chambers are to be pre-purged by a sufficient volume of air before ignition.

(3) The opening of the main fuel valve is not to precede the ignition spark.

(4) The ignition period of each burner (after the main fuel valve has been opened, in the event of ignition failure, the amount of time until the valve is closed.) is not to exceed a pre-determined length of time. The engine starting trial is to be halted in cases where the engine does not start within such a pre-determined time period.

(5) Excessive fuel is not to be supplied to combustion chambers during ignition.

(6) After shutting off the fuel valves, a suitable measure is to be taken to prevent any abnormal combustion or ignition trouble at times of restarting. For example, this could be achieved by opening the drain valves located at positions between the fuel oil

shut off valve and the fuel nozzle.

(7) Starting devices are to be disconnected from gas generators after their running becomes self-sustaining.

2 In cases where the "reservoirs" specified in **3.4.2-2(2), Part 9 of the Rules** are utilized for the "purging" specified in **3.4.2-1(2), Part 9 of the Rules**, the total capacity of the reservoirs is to be such that a capacity necessary for the purging is added.

3.4.4 Fuel Oil Arrangements

The "sufficient consideration" referred to in **3.4.4-1, Part 9 of the Rules** means that provisions such as those in accordance with the following **(1)** and **(2)** are made.

(1) At least two filters are to be fitted in the fuel oil supply lines to the gas turbine and be so arranged that any filter may be cleaned without interrupting the supply of filtered fuel oil to the gas turbine.

(2) Fuel treatment systems, including filtration and centrifuging devices, are to be provided so as to control the level of water and particulate contamination within the limits specified by the manufacturer of the gas turbine.

Chapter 4 POWER TRANSMISSION SYSTEMS

4.1 General

4.1.4 General Construction of Gears

The word "sufficient" in **4.1.4, Part 9 of the Rules** means being designed in accordance with national or international standards such as *JIS*.

Chapter 5 SHAFTINGS, PROPELLERS, WATERJET PROPULSION SYSTEMS AND TORSIONAL VIBRATION OF SHAFTINGS

5.3 Waterjet Propulsion Systems

5.3.4 General

The wording "deemed appropriate by the Society" specified in **5.3.4-2, Part 9 of the Rules for High Speed Craft** means to be in accordance with the following. In the case of a single waterjet propulsion system fitted onboard the ship, however, the system is to be subject to special consideration by the Society:

(1) The minimum diameter of the main shaft is to be not less than the value determined in **6.2, Part D of the Rules for the Survey and Construction of Steel Ships** or, in case of driven by high speed engines, the value determined by the following formula:

$$d_s = k\sqrt[3]{\frac{H}{N}}$$

where:

d_s : Required diameter of main shaft (mm)

H : Maximum continuous output of main engine (kW)

N : Number of revolutions of main shaft at the maximum continuous output (rpm)

k : Values shown in **Table 9.5.3.2-1**

(2) The minimum diameter of the shaft coupling bolts at the joining face of the couplings is to be not less than the value determined by the following formula

$$d_b = 15300\sqrt{\frac{H}{N}\left(\frac{1}{nDT_b}\right)}$$

where:

d_b : Required diameter of shaft coupling bolt (mm)

n : Number of bolts

D : Pitch circle diameter (mm)

T_b : Specified tensile strength of bolt material (N/mm^2)

(3) The thickness of the shaft coupling flange at the pitch circle is not to be less than the required diameter of shaft coupling bolts determined by the formula in **(1)** above. However, it is not to be less than 0.2 times the required diameter of the corresponding shaft.

(4) The fillet radius at the base of the flange is not to be less than 0.08 times the diameter of the shaft, where the fillet is not to be recessed in way of nuts and bolt heads.

(5) The strength of the impeller blade at root is to be determined so that the following formula is satisfied. In this case, the allowable stress value of the material is, in principle, to be 1/1.8 of the specified yield point (or 0.2% proof strength).

$$S \geq \frac{5.8 \times 10^5 H}{Lt^2 ZN} + 2.2 \times 10^{-7} D^2 N^2$$

where:

S : Allowable stress of impeller material (N/mm^2)

H : Maximum continuous output of main engine (kW)

N : Value obtained by dividing the number of revolutions of impeller by 100 (rpm/100)

Z : Number of impeller blades

L : Width of impeller blade at root (mm)

t : Maximum thickness of impeller blade at root(mm)

D : diameter of impeller(mm)

(6) For the torsional vibration of the main shafting systems, the requirements specified in **5.4, Part 9 of the Rules** are to be complied with. In case where the requirements, specified in **(1)** above is applied, the following requirements **(a)** and **(b)** are to

be complied with.

(a) The torsional vibration stresses produced when the revolutions of the engine are within the range exceeding 80% and not exceeding 105% of maximum continuous revolutions are not to exceed that given in the following:

$\tau_1 = A - B\lambda^2 \ (\lambda \leq 0.9)$

$\tau_1 = C \ (0.9 < \lambda)$

where:

τ_1 : Allowable limit of torsional vibration stresses for the range of $0.8 < \lambda \leq 1.05$ (N/mm^2)

λ : Ratio of the number of revolutions to the number of maximum continuous revolutions

A, B and C : Values shown in **Table 9.5.3.2-2**

In case where the specified tensile strength of materials of carbon steel shafts or low alloy steel shafts of Kind 1 exceeds 400 N/mm^2, the value of τ_1 may be increased by multiplying the factor k_m given in the following formula.

$$k_m = \frac{T_s + 160}{560}$$

where:

k_m : Correction factor

T_s : Specified tensile strength of main shaft material (N/mm^2)

(b) The torsional vibration stresses of the main shaft within the range below and at 80% of the maximum continuous revolutions of the engine are not to exceed the following. In the case where torsional vibration stresses exceed the value calculated by the formula shown in **(a)**, the barred speed ranges are to be imposed. In this case, the formula for is for the range of $\lambda \leq 0.9$

$\tau_1 = 2.3\tau_1$

where:

τ_2 : Allowable limit of torsional vibration stresses for the range of $\lambda \leq 0.8$ (N/mm^2)

(7) In addition to **(6)** above, for the main shafting system of the propulsion system, consideration is to be given to natural vibrations due to bending of the shafting system.

(8) The suction water intake duct, impeller casing and nozzle are to have strength according to the design pressure, and consideration is to be given for corrosion.

(9) The reverser is to be such that it provides sufficient power for going astern to secure proper control of the ship in all normal circumstances, and when transferred from ahead to astern runs, it is to have sufficient astern power to provide effective breaking for the ship.

(10) The reverser is to have sufficient strength against the thrust at the maximum astern power output.

(11) The hydraulic system driving the deflector and the reverser is to be duplicated or to be provided with an emergency hydraulic power source, in the case where it is not equipped for each shafting independently.

Table 9.5.3.2-1 Values of k according to Fitting Method

Shaft Material \ Fitting Method		key	spline	flange coupling	force fitting	Other Positions
		Fitting part of shaft with impeller and shaft coupling				
Carbon steel or low alloy steel	Shaft Kind 2	105	108	102	102	105
	Shaft Kind 1	$a_1 = 100$, $a_2 = 80$ in Note	$a_1 = 102$, $a_2 = 82$ in Note	$a_1 = 98$, $a_2 = 78$ in Note		$a_1 = 100$, $a_2 = 80$ in Note
Austentic stainless steel						
Martensite precipitation hardened type stainless steel		80	82	78	78	80

Note:

$200 \leq \sigma_y \leq 400 : k = a_1 - 0.1(\sigma_y - 200)$

$\sigma_y > 400 \quad : k = a_2$

σ_y : yield point or 0.2% proof strength of main shaft material (N/mm^2)

Table 9.5.3.2-2 Values of A, B and C

	Carbon steel or low alloy steel		Austentic stainless steel	Martensite precipitation hardened type stainless steel
	Shaft Kind 1	Shaft Kind 2		
A	24.3	9.0	26.4	39.6
B	24.1	6.2	26.4	37.1
C	4.8	4.0	5.0	9.6

Chapter 7 PIPES, VALVES PIPE FITTINGS AND AUXILIARIES

7.1 General

7.1.2 Materials

The wording "requirements specified otherwise" in **7.1.2, Part 9 of the Rules** means as follows.

(1) In cases where rubber hoses, Teflon hoses or nylon hoses are used for the following pipes, only materials approved in accordance with the **Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use** are to be used.

(a) Pipes of Group I or Group II

(b) Pipes likely to cause fire or flooding in case of their fracture

(2) Only plastics pipes (including vinyl pipes) approved by the Society in accordance with **Chapter 6, Part 6 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use** are to be used.

(3) When aluminium alloy pipes are used, the following requirements are to be complied with:

(a) Aluminium alloy pipes are, as a rule, to be in accordance with the recognized standards deemed appropriate by the Society, and are to be of seemless drawn pipes or seamless extruded pipes.

(b) Aluminium alloy pipes are not to be used for any of the following applications, unless deemed appropriate by the Society:

i) Pipes with a design temperature exceeding 150°C

ii) Any pipe used in areas where it penetrates either "*A*" class division or "*B*" class division.

iii) Piping in which use of copper alloy pipes is prohibited by **Table D12.2, Chapter 12, Part D of the Rules for the Survey and Construction of Steel Ships**.

(c) The required thickness of aluminium alloy pipes subject to an internal pressure is to be determined using the formula in **12.2.1-1, Part D of the Rules for the Survey and Construction of Steel Ships**. In this case, allowable stress (f) is to be of the minimum value of the following values. However, when the design temperature is not in the creep region of the material, no consideration may be required for the value of f_3.

$$f_1 = \frac{R_{20}}{4.0},\ f_2 = \frac{E_t}{1.5},\ f_3 = \frac{S_R}{1.6}$$

where:

R_{20} : Specific minimum tensile strength (N/mm^2) of the material at room temperature (less than 50°C)

E_t : 0.2% proof stress (N/mm^2) of the material at the design temperature

S_R : Mean value of creep breaking stress (N/mm^2) of the material after 100,000 hours at the design temperature

(4) The material not specified in **(1)** to **(3)** above are to be subject to special approval by the Society.

7.5 Construction of Auxiliary Machinery and Storage Tanks

The wording "deemed appropriate by the Society" means following values corresponding to the material:

(1) for stainless steel 2.5 *mm*

(2) for aluminium alloy 4.5 *mm*

(3) other than above the value specially approved by the Society

Chapter 8 PIPING SYSTEMS

8.7 Sounding Pipes

8.7.1 General

With respect to the sounding pipes and liquid level indicators required by **8.7.1-1, Part 9 of the Rules**, the Society may accept the other measures described in the following **(1)** and **(2)**.

(1) For small spaces (i.e. the spaces specified in **D13.5.1-1(2), Part D of the Guidance for the Survey and Construction of Steel Ships**), the omission of sounding pipes and liquid level indicators may be allowed.

(2) For small spaces which are not covered by **D13.5.1-1(2), Part D of the Guidance for the Survey and Construction of Steel Ships** that comply with the following **(a)** and **(b)**, the omission of sounding pipes and liquid level indicators may be allowed.

(a) The spaces are readily accessible.

(b) Other means of checking for the presence of liquid inside the space are provided.

Chapter 10 WINDLASSES AND MOORING WINCHES

10.2 Windlasses

10.2.2 Drawings and Data

1 "Windlass design specifications" specified in **10.2.2(1)(a), Part 9 of the Rules** are to be include the following in addition to windlass particulars:

(1) Anchor and chain cable particulars

(2) Maximum anchorage depth

(3) Performance criteria

(4) Standard or code of practice of compliance

2 "Windlass arrangement plan" specified in **10.2.2(1)(b), Part 9 of the Rules** are to be show all of the components of the anchoring/mooring system. The followings are examples of the components:

(1) Prime movers, shafting, cable lifters, anchors, chain cables, brakes and controls

(2) Mooring winches, wires and fairleads, if they form part of the windlass machinery

(3) Marking of nominal size of chain cable and maximum anchorage depth

3 "Dimensions, materials and welding details of torque-transmitting components and load-bearing components" specified in **10.2.2(1)(c), Part 9 of the Rules** are to comply with the followings:

(1) Information of mooring winches are to be included in case where the mooring winch is one with a windlass.

(2) Proposed materials are to be indicated.

(3) Weld joint designs, the degree of non-destructive examination of welds and post-weld heat treatment are to be indicated.

4 "Drawings and data concerning hydraulic systems" specified in **10.2.2(1)(d), Part 9 of the Rules** are to include the following:

(1) Piping diagram along with system design pressure

(2) Safety valves arrangement and settings

(3) Material specifications for pipes and equipment

(4) Typical pipe joints, as applicable

(5) Technical data and details for hydraulic motors

5 "Calculated strength for torque-transmitting components and load-bearing components" specified in **10.2.2(2)(a), Part 9 of the Rules** are to comply with the following:

(1) It is to be demonstrated that torque-transmitting components and load-bearing components comply with a standard or code of practice recognized by the Society.

(2) Analyses for gears are to be in accordance with a standard recognized by the Society.

6 "Load calculations" specified in **10.2.2(2)(c), Part 9 of the Rules** are to demonstrate that the prime mover is capable of attaining the hoisting speed, the required continuous duty pull and the overload capacity specified in **16.2.4, Part D of the Rules for the Survey and Construction of Steel Ships**.

7 "Operation and maintenance procedures" specified in **10.2.2(2)(e), Part 9 of the Rules** are to show the maximum anchorage depth.

Chapter 12 AUTOMATIC AND REMOTE CONTROL

12.1 General

12.1.1 Scope

In cases where dynamic positioning systems (DPS), which are regarded as part of the automatic and remote control systems of main propulsion machinery, are installed, the requirements of **Chapter 12, Part 9 of the Rules** are to apply.

Part 10 ELECTRICAL INSTALLATIONS

Chapter 1 GENERAL

1.1 General

1.1.5 Drawing and Data

1 "Diagrams of the wiring system" specified in **1.1.5(1)(f), Part 10 of the Rules** are to be include the following information concerning electrical systems of the windlass, as applicable:

(1) Cable specification and size

(2) Motor controller

(3) Protective device rating or setting

2 "Sectional assembly drawings" specified in **1.1.5(1)(g), Part 10 of the Rules** are to be include the information of associated gears.

3 "Total Harmonic Distortion (THD) calculation report" specified in **1.1.5(2)(d)i), Part 10 of the Rules** is to be include the following information:

(1) Results of the calculation of the Total Harmonic Distortion (THD) value experienced when a failure of a harmonic filter occurs

(2) In applying **2.1.2-4, Part 10 of the Rules**, the acceptable limit of the Total Harmonic Distortion (THD) value

4 The "harmonic filter operation guide" specified in **1.1.5(2)(d)ii), Part 10 of the Rules** is to include the following information:

(1) The permitted operating mode of the electrical distribution system while maintaining the Total Harmonic Distortion (THD) values within acceptable limits during normal operation

(2) The permitted operating mode of the electrical distribution system in the case of failure of any combination of harmonic filters

5 Data specified in **-3** and **-4** are to be submitted by the system integrator of the distribution system.

6 In applying **1.1.5(1)** and **(2), Part 10 of the Rules** the drawings and documents referred to in **1.1.3, Annex 2.11.1-2, Part H of the Rules for the Survey and Construction of Steel Ships** are to be submitted, for ships equipped with accumulator battery systems to which **Annex 2.11.1-2, Part H of the Rules for the Survey and Construction of Steel Ships** is applied.

1.2 Testing

1.2.1 Shop Tests

1 In applying **1.2.1-1(7), Part 10 of the Rules,** the tests for cells (or modules), accumulator battery systems and electrical power converters referred to in **Annex 2.11.1-2, Part H of the Rules for the Survey and Construction of Steel Ships** are to be carried out for ships equipped with accumulator battery systems to which **Annex 2.11.1-2, Part H of the Rules for the Survey and Construction of Steel Ships** is applied.

2 The wording "subject to the approval of the Society" in **1.2.1-2, Part 10 of the Rules** means **Part 8 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**. Equipment and cables approved are made public in the List of Approved Materials and Equipment.

3 The wording "to be subjected to type test" in **1.2.1-3, Part 10 of the Rules** means **Part 8 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**. Cables type tested are made public in the List of Approved Materials and Equipment.

4 Cables requiring type test are to be as follows:

(1) Cables used for power feeding systems and power distribution circuits for power, lighting and internal communications and used for control circuits

(2) Flexible cords used for feeding for power systems and power distribution circuits and control circuits

(3) Multicore vinyl insulated cables for 150 *V* electronic equipment

5 Type tests may be carried out for flexible cords, vinyl sheathed cords, insulated cables for switchboards and control equipment, coaxial cables, etc., other than those specified in **-4** in case where request is made by the manufacturer.

Chapter 2 ELECTRICAL INSTALLATION AND SYSTEM DESIGN

2.1 General

2.1.2 Voltage and Frequency

1 In **2.1.2-3, Part 10 of the Rules**, voltage fluctuation in the main switchboard busbars are to be designed by taking into account the voltage drop in the power cables so that the electrical equipment supplied from those switchboards are capable of operating satisfactorily without trouble.

2 In **2.1.2-3, Part 10 of the Rules**, the steady state voltage and frequency of *A.C.* motors is to be considered to change simultaneously, and the fluctuations in such an event in terms of the sum of absolute value of respective ratio of fluctuation are to be within 10%. Further, the limit of fluctuation of voltage and frequency is to be the maximum amplitude of each.

3 The wording "specially approved by Society" given in **2.1.2-4, Part 10 of the Rules** means to satisfy any of the following:

(1) In distribution systems connected with semiconductor converters where the safe operation of other electric devices connected to such distribution systems is maintained by the adoption of suitable methods for decreasing harmonic content effects such as harmonic filters, and Total Harmonic Distortion (*THD*) values do not exceed 8%.

(2) In electric propulsion ships, where the distribution systems connected with propulsion semiconductor converters are closed circuits independent from other internal distribution systems, and Total Harmonic Distortion (*THD*) values do not exceed 10%.

Fig. 2.1.2-1 Application Example of 2.1.2-3.(1)

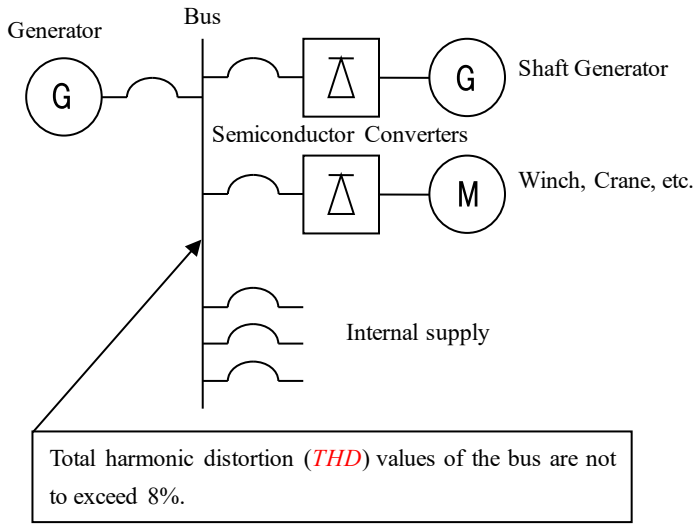
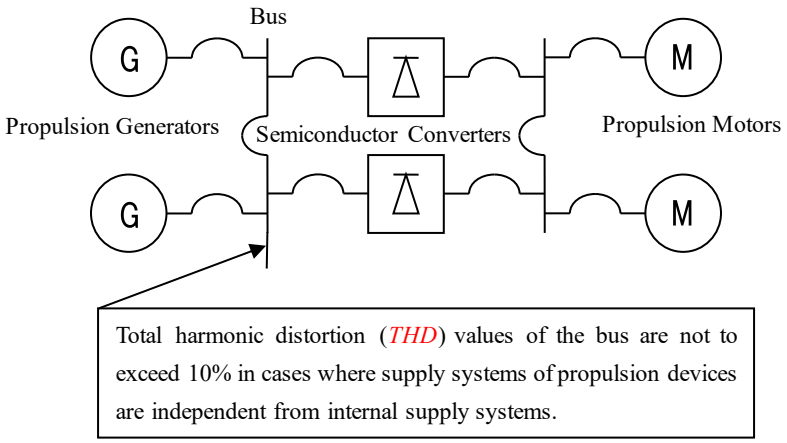


Fig. 2.1.2-2 Application Example of 2.1.2-3.(2)



2.1.3 Construction, Materials, Installations, etc.

1 Electrical equipment is to be so constructed as to be provided for accessibility to all parts requiring inspection, overhauling and repairs.

2 The rotating, reciprocating, high temperature parts and the live parts of the electrical equipment are to be arranged with suitable protections, so that operators and personnel neighbouring these parts may be kept from getting injured.

3 Power source switch of electrical equipment is to be so arranged that the equipment is not charged through control circuits and/or pilot lamps when the switch is in the "*off*" position.

4 In the case where the characteristic letter IP showing the protection type of enclosures in accordance with *IEC* 60529 is used for the protective enclosures of electrical equipment, **Table H2.1.3-6, Part H of the Guidance for the Survey and Construction of Steel Ships** is to be taken into consideration for the selection of degree of protection for the electrical equipment on the basis of the circumstances of the place of installation.

2.1.4 Earthing

1 The following exposed metal parts may not be earthed:

(1) Non-current-carrying metal pars of electrical equipment which are unlikely to be touched by persons during their service

(2) Lamp caps

(3) Shades, reflectors and guards, supported on lampholders or luminaries constructed of, or shrouded in, non-conducting material

(4) Metal parts or screws separated by insulators from the current-carrying part of from earthed non-current-carrying parts which are not charged or earthed under normal service condition

(5) Bearing housing insulated to prevent circulation of current in the bearing

(6) Clips of fluorescent lighting tube

(7) Equipment power supplied at safety voltage

(8) Cable clips

2 Earthing may be made under the requirements as specified below:

(1) All earthing connections are to be made through copper or other corrosion resistant material and to be securely installed to the hull structure. All earthing conductors are to be protected where necessary against mechanical damage and galvanic corrosion.

(2) Where the metal frame or enclosure of electrical equipment is directly fitted to the hull structure, and the surface in contact is clean and free from rust, scale and paint, and bolted firmly, no earthing conductors may provided.

(3) Under any circumstances, a lead cable sheath is not to be used as a sole earthing means.

(4) Nominal cross-sectional areas of all copper earthing conductors are to be as give in **Table 10.2.1.4-1**. In cases where earthing conductors other than copper are used, their conductance is not be of more than that of copper conductors given in the table.

(5) Connections between earthing conductors and the hull structure are to be made in an accessible position, and be secured by a screw of brass or other corrosion resistance material of diameter not less than 4 *mm* which is to be used for this purpose only. In any case, the contact faces are to have a glossy metal surface when screws are tightened.

3 In a power distribution system where one line of the system is earthed and normally of non-current carrying line, the earthing

connection is to be as specified in -2. Note, however, that the upper limit value of 70 mm^2 of the cross-sectional area of the earthing conductor given in Table 10.2.1.4-1 does not apply.

4 The non-current carrying metal parts of portable electrical appliances are to be earthed through plugs and receptacles by means of earthing conductors provided in flexible cables or cords.

Table 10.2.1.4-1 Sizes of Earthing Conductor

<table>
<tr><th>Type of earthing conductor</th><th>Cross-sectional area of associated current-carrying conductor</th><th>Minimum cross-sectional area of copper earthing conductor</th></tr>
<tr><td>Earthing conductor in flexible cable or flexible cord</td><td>Any</td><td>Same as current-carrying conductor up to and including 16 mm^2 or one-half above 16 mm^2 but at least 16 mm^2</td></tr>
<tr><td>Earthing conductor incorporated in fixed cable</td><td>Any</td><td>A) For cables having an insulated earthing conductor:
(a) a cross-section equal to the main conductors up to and including 16 mm^2 but minimum 1.5 mm^2
(b) main conductor when the latter is more than 16 mm^2, but at least 16 mm^2
B) For cables with a bare earth wire in direct contact with the lead sheath:
<table>
<tr><th>Cross-section of main conductor</th><th>Earthing conductor</th></tr>
<tr><td>1 to 2.5 mm^2
3.5 to 6 mm^2</td><td>1 mm^2
1.5 mm^2</td></tr>
</table></td></tr>
<tr><td rowspan="3">Separate fixed earthing conductor</td><td>Not exceeding 2.5 mm^2</td><td>Same as current-carrying conductors subject to a minimum of 1.5 mm^2 for stranded earthing connection, or 2.5 mm^2 for unstranded earthing connection</td></tr>
<tr><td>Exceeding 2.5 mm^2 but not exceeding 120 mm^2</td><td>One-half the cross-sectional area of the current-carrying conductor;
subject to a minimum of 4 mm^2</td></tr>
<tr><td>Exceeding 120 mm^2</td><td>70 mm^2</td></tr>
</table>

2.2 System Design - General

2.2.1 Distribution Systems

The following items are relevant to the equipment specified in 2.2.1-2(2), Part 10 of the Rules.

(1) Electrical equipment for starting and ignition of internal combustion engines

(2) Radio equipment provided with noise suppressing condensers

(3) Equipment of intrinsic safety construction requiring earthing

2.2.2 Insulation Monitoring System

1 The term “distribution system” generally means the following circuits:

(1) The primary distribution circuit directly connected to generator circuit

(2) The secondary distribution circuit connected via insulated transformer with the primary distribution circuit specified in **(1)**. Note, however, that unless otherwise specified the secondary circuits exclusively for specifically designated equipment (*e.g.*, Suez Canal search lights, heaters and lighting circuits provided in cranes, etc.) may be excluded.

(3) Lighting circuits supplied from accumulator batteries or busbars of the feeder panel to which the circuits are connected.

2 The alarm set value of insulation monitoring system is to have an insulation resistance value, as a standard, corresponding to 1/10 of that of the electric circuit in the normal condition for which monitoring is to be made.

3 In the case where the insulation monitoring system is used in common with an earthing lamp, they are to be interlocked against each other.

2.2.11 Circuits for Shore Connection

In the case where a portable phase sequence indicator or a polarity detector is provided on board the ship, those detectors in the shore connection box may be omitted.

2.2.12 Disconnecting Switches of Circuits

In the case where the switches specified in **2.2.12-2, Part 10 of the Rules** are provided on board the ship in a dispensed manner, their wiring connection diagrams are to be displayed in the monitoring room or other adequate spaces.

2.2.13 Remote Stopping of Ventilating Fans and Pumps

"Consideration against the fuse element failure" specified in **2.2.13-2, Part 10 of the Rules** is satisfied if a no-volt alarm, an electrical source indicator, or the like is provided at a normally attended position. In case of **M0** ships, the visual indicator of the alarm at the normally attended position may be displayed as a group alarm where the alarm is included in the centralized monitoring and control system and is individually indicated at the centralized control station (normally unattended).

2.3 System Design - Protection

2.3.5 Protection of Generators

1 The adjusting value of the trip current for the overcurrent tripping device with time delay of generators are to be selected in such a manner that generators can be protected safely from overcurrent according to the thermal capacity of generators and tripping characteristics of the overcurrent tripping device with time delay. Further, in selecting the type and adjusting values for the overcurrent tripping device with long time delay and short time delay of short-circuit protection, consideration is to be taken on their coordination.

2 In the case where preference tripping devices are provided in generator circuits of two or more generators operated in parallel, the adjusting value and time delay characteristics are to be as selected such that the overcurrent tripping device of generators would not come into simultaneous action with the preference tripping device when the latter activates. Further, where this device is expected to operate by rush current motors for essential service, an inter-lock device may be so arranged that this device does not operate under starting condition of the motors.

3 The adjusting values of reverse power protection are to be as specified below as a standard:

(1) Generators driven by turbines: 2 - 6 %

(2) Generators driven by reciprocating internal combustion engines: 6 - 15 %

2.3.7 Protection of Feeder Circuits

In applying **2.3.7-2, Part 10 of the Rules**, where fuses are used as a short-circuit and overload protection device of circuits power supplied at a voltage not exceeding 55 *V D.C.* or 55 *V A.C.* root mean square between conductors, the switches at the power source side of the fuses may be dispensed with.

2.5 Switchboards, Section Boards and Distribution Boards

2.5.1 Location

In the case where steam pipes, water pipes, oil pipes, etc., are inevitably laid in the proximity of switchboards, flanges of these pipes are to be of welded joints or means are to be so provided that no detrimental effects would be exerted on switchboards if a leakage occurs.

2.5.2 Safety Precautions to Operators

The width of broken space to be provided in front of switchboards specified in **2.5.2-5, Part 10 of the Rules** is to be 0.9 *m* or more as a standard. Furthermore, in switchboards so constructed that necessary operation and maintenance can be done from their front, the passageway at the rear side of the switchboards may be omitted.

2.5.3 Construction and Materials

1 The following may be regarded as the "other approved means" specified in **2.5.3-2(2), Part 10 of the Rules**:

(1) Circuit breakers without tripping elements

(2) Disconnecting switchs (including sliding type disconnecting devices)

2 In applying **2.5.3-6, Part 10 of the Rules**, flame-retardant tests for insulating materials are to be carried out in accordance with the following:

(1) Such tests are to be carried out at normal ambient temperatures. The standard size of test specimens is to be 120 *mm* long, 10 *mm* wide and 3 *mm* thick.

(2) Test specimens are to be fastened to thin metal wires so that their longitudinal axes are inclined to an angle of approximately

45 *degrees* to the horizontal and their transverse axes are horizontal.

(3) Conventional Bunsen burners fed with town gas are to be used, the flames of which, when adjusted in still air and in vertical positions, are approximately 125 *mm* long with the blue part of these flames being about 35 *mm* long.

(4) Burner axes are to be set vertically in such positions that the tips of the blue parts of these flames just touches the lower ends of any specimens.

(5) Flames are to be applied five times for 15 *second* intervals for 15 *seconds* between each application, and materials are deemed to be flame-retardant if any burnt or damaged parts of specimens are not more than 60 *mm* long. During such tests, specimens are not to be allowed to burn themselves.

2.5.8 Instrument Scales

"Instrument scales" means the effective measuring range. When an extended scale is required for the starting current as in the case of ammeters for motors, it is not necessary to apply the requirements given in **2.5.8, Part 10 of the Rules** to the extended part.

2.7 Cables

2.7.3 Terminals, Joints and Branches of Cables

1 The wording "in cases where deemed appropriate by the Society" in **2.7.3-1, Part 10 of the Rules** refers to cases where a cable connection is installed by splicing which consists of a conductor connector, replacement insulation, replacement cable sheath, and, where applicable, replacement armour and shielding, and establishes electrical continuity in conductors, armour, or screens, under the following conditions:

(1) In cases where cables are installed in structural sub-assemblies

(2) In cases where circuits are extended or shortened in a ship which will undergo remodeling

(3) In cases where a damaged section of cables is replaced

(4) Splicing is not to be used for propulsion cables and cables in hazardous locations. However, with respect to cables in hazardous locations, cases where Society approval is obtained are excluded

(5) Other cases deemed appropriate by the Society

2 In **-1** above, splicing is to comply with the following **(1)** to **(7)**:

(1) The conductors are to be connected using a compression type butt connector. In such cases, a one-cycle compression tool and proper dies are to be used. Long barrel butt connectors with conductor stops are to be used for conductor sizes of $6mm^2$ or larger.

(2) The splices for multi conductor cables are to be staggered in such away that the connectors for each conductor are not contiguous to the connector of an adjacent conductor. In addition, no more than is necessary to ensure a proper connection of the cable insulation is to be removed.

(3) Replacement insulation that has the same or a greater thickness than that of the cable insulation and the same or better thermal and electrical properties of the cables.

(4) For screened cables, replacement screenings are to be provided and such screenings are to be secured by a method that does not exert more pressure than necessary to establish adequate electrical contact. Screened cables are to have at least a 13*mm* overlap between any replacement shielding material and the original screening material.

(5) Replacement cable sheath materials are to have physical properties that are the same as, or equivalent to, the cable sheath. Replacement cable sheaths are to be centered over the splices and to overlap the existing cable sheaths by at least 51*mm*. Replacement cable sheaths are to be installed so that a watertight seal with the existing cable sheaths is created.

(6) The electrical continuity of any cable armour is to be re-established by a jumper of wire or braid, or replacement armour of the same metal.

(7) For cables with a sheath over the armour, a replacement covering is to be used.

3 The wording "to retain the original electrical, mechanical, flame-retardant and, in cases where necessary, fire-resisting properties of the cable" in **2.7.3-5, Part 10 of the Rules** means that connections and branching of cables are to be made within enclosures with no possibility of any outward spreading of fire by internal short-circuits or other causes. In addition, the type of enclosure is to be selected from those meeting the requirement given in **2.1.3-4** according to installation location.

2.7.4 Precaution against Fire

In the case where installation of cables for essential services in machinery spaces of Category *A* and their casings, galleys,

laundries and other high fire risk areas is unavoidable, these cables are to be laid in insulated steel pipes or steel ducts equivalent to "*A*-60" or more unless fire resistant cables which have passed the test of *IEC Publication* 331 or equivalent thereto are used.

2.8 Accumulator Batteries

2.8.1 General

1 Accumulator batteries of an adequate discharge rate are to be selected according to their application.

2 In the case where alkali batteries are used, the specification including the construction, performance, method of installation, etc., is to be submitted at each time to the Society for approval.

2.8.3 Location

1 Accumulator batteries are not to be located in high temperature or low temperature areas, or areas exposed to steam, water or oil vapour.

2 The term "large batteries" in **2.8.3-2, Part 10 of the Rules** means the accumulator batteries connected to battery charging facilities with an output of 2 *kW* or more. Here, the output of battery charging facilities is to be the product of rated current of the rectifier and nominal voltage of the battery group. Deck boxes may be naturally ventilated. Natural ventilation by means of a duct of ample dimensions, terminating at least 1.25 *m* above in a goose-neck, mushroom-head or the equivalent will be sufficient. Holes for air inlet are to be provided on at least two opposite sides of the box.

3 Accumulator batteries connected to battery charging facilities with a capacity in a range from 0.2 to 2 *kW* are to be placed in a battery box installed within a battery compartment or on the upper deck or upward. In the case where they are unable to be installed in such areas, the following requirements are to be complied with:

(1) To be placed in a storage box or on a shelf provided at an adequate area,

(2) To be placed in an open state within the machinery space, or

(3) To be placed in a compartment with good air ventilation.

4 Accumulator batteries connected to battery charging facilities with a capacity of 0.2 *kW* or less may be placed in an open state at an adequate area or may be placed in a battery box.

2.8.5 Ventilation

1 Where accumulator batteries are arranged in two tiers or more, all shelves are to have not less than 50 *mm* space, front and back, of circulation of air.

2 The capacity of exhaust ventilation of a battery compartment is to be of the value obtained by the following formula or more:

Exhaust capacity $Q = 100 \times I \times n$ (*litre/h*)

I:maximum charging current at end (where no specific limitation is imposed, the charging current in 10 *hours* is to be regarded as the standard)

n:number of batteries

3 It is recommended that the ventilation system for a compartment containing accumulator batteries connected to battery charging facilities with an output of 2 *kW* or more be of the mechanical exhaust-ventilation.

4 The ventilation fans which are of "such a material as to render sparking impossible" specified in **2.8.5-3, Part 10 of the Rules** mean those ventilation fans complying with the requirements of **R4.5.4-1(2) of the Guidance for the Survey and Construction of Steel Ships**. For the purpose of this requirement, protection screens of not more than 13*mm* square mesh are to be fitted in the inlet and outlet ventilation openings of the ducts fitted with such fans on the open deck.

2.8.6 Electrical Installations

Explosion-protected electrical equipment certified as Explosion Class *d*3 and Ignition Group *G*1 or higher as specified in the Recommended Practices for Explosion-Protected Electrical Installations in General Industries (NIIS-TR-NO.39 (2006)) issued by National Institute of Industrial Safety in Japan, may be treated as equivalent to those grouped into Apparatus Group *II*C and Temperature Class *T*1 or higher as specified in *IEC* 60079.

Chapter 4 ADDITIONAL REQUIREMENTS FOR CRAFT CARRYING SPECIAL CARGOES

4.1 Enclosed Cargo Holds for Carrying Motor Vehicles with Fuel in their Tanks for their own Propulsion and Enclosed Compartments Adjoining the Cargo Holds, etc.

4.1.1 Electrical Installations in Enclosed Cargo Holds, etc.

1 The wording "electrical equipment of a type suitable for use in explosive gas atmosphere concerned" in **4.1.1-2, Part 10 of the Rules** means those generally meeting the requirements in **2.9, Part 10 of the Rules** having a construction suitable for use in Zone 1 as specified in *IEC* 60079-14:2013 certified as Apparatus Group *II*A and Temperature Class *T*3 or higher as specified *IEC* 60079 or Explosion Class *d*1 and Ignition Group *G*3 or higher as specified in the Recommended Practices for Explosion-Protected Electrical Installations in General Industries (NIIS-TR-NO.39 (2006)) issued by National Institute of Industrial Safety in Japan, or equivalent thereto. Further, cables complying with the requirements in **4.2.4-5, Part H of Rules for the Survey and Construction of Steel Ships** may generally be regarded as wiring of a type suitable for use in explosive gas atmosphere concerned.

2 The electrical equipment so enclosed and protected as to prevent the escape of sparks specified in **4.1.1-3, Part 10** is to be of the following **(1)** or **(2)**.

(1) The electrical equipment with a protection degree of at least IP55 as defined in **H2.1.3-4**, **Part H of the Guidance for the Survey and Construction of Steel Ships.**

(2) The electrical equipment suitable for use in Zone 2 and with a temperature class of at least *T*3 as defined in *IEC* 60079.

3 The platforms with openings of sufficient size permitting penetration of petrol gases downwards means, for example, grating deck.

4 A wording "a type approved by the Society" in **4.1.1-4, Part 10 of the Rules** means that specified in **-1**.

Part 11 FIRE PROTECTION, DETECTION, EXTINCTION AND MEANS OF ESCAPE

Chapter 1 GENERAL

1.1 General

1.1.1 Application

The definition of "Craft for restricted service" specified in **1.1.1-1, Part 11 of the Rules** is to be referred to **2.1.4, Part 4 of the Guidance**.

1.1.3 General Requirements

1 "Enclosed sleeping births" specified in **1.1.3(1), Part 11 of the Rules** mean spaces which are used for living spaces isolated by walls, doors and/or curtains, and which behaviours of passengers or crews inside can not be watched by crew on duty regardless of the existence of bed, floor area or capacity. Where enclosed sleeping births are arranged, doors are to be fitted with no locking devices.

2 The cases which are "specially approved by the Society" specified in **1.1.3(1), Part 11 of the Rules** means in the case where following conditions are fully satisfied:

(1) A fixed fire detection and fire alarm system complying with **Chapter 29, Part R of the Rules for the Survey and Construction of Steel Ships** is to be installed in any enclosed sleeping births. However, where a compartment is divided into some small personal enclosed sleeping births by curtains, the requirement of the installation of a fixed fire detection and fire alarm system may be decided individually based upon a compartment having such small births.

(2) Two means of escape from enclosed sleeping births are, in principle, to be provided.

1.2 Definitions

1.2.1 Application

"Being ensured in accordance with the test procedures deemed as appropriate by the Society" specified in provisions of **1.2, Part 11 of the Rules** means that materials are approved by the Society in accordance with the provisions specified in **Chapter 1, Part 4 of the Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use**.

Chapter 2 FIRE PROTECTION

2.1 Classification of Space Use

2.1.1 Classification of Space Use

"Small fuel oil tanks" specified in **2.1.1(3), Part 11 of the Rules** mean fuel oil tanks with a capacity not more than 100*l*.

2.3 Fire-resisting Divisions

2.3.1 Protection of Areas of Major Fire Hazard

1 The case "where the omission of any such division would not affect the safety of craft" means the case where no spaces used for passengers, crews and means of escape is arranged above areas of major fire hazard with no limit and the destruction or deterioration of the local strength of such spaces by a fire does not affect the essential strength of the hull for a period of structural fire protection time.

2 For side shell plating which is a part of boundaries of areas of major fire hazard and is required to be insulated by fire-resisting divisions in accordance with **2.3.1-1, Part 11 of the Rules**, the structural extension of insulation is to be 300 *mm* or more below the water line at the lightweight condition.

Chapter 3 FIRE DETECTION AND EXTINCTION

3.2 Fixed Fire-extinguishing Systems

3.2.3 Fixed Pressure Water-spraying Fire-extinguishing Systems

The wording "the requirements otherwise specified" specified in **3.2.3, Part 11 of the Rules** means those specified in **R20.5.1 in Part R of the Guidance for the Survey and Construction of Steel Ships**.

Chapter 4 ADDITIONAL REQUIREMENTS FOR MACHINERY SPACES

4.1 Additional Requirements for Machinery Spaces

4.1.1 Fuel and Other Flammable Fluid Tanks and Systems

The use of materials other than steel may be accepted as a "material satisfactory to the Society" specified in **4.1.1-4, Part 11 of the Rules** provided that the material complies with the requirements in **R4.2.2-11 of Part R of the Guidance for the Survey and Construction of Steel Ships**.

Part 15 SPECIAL REQUIREMENTS FOR CRAFT ENGAGED IN INTERNATIONAL VOYAGE

Chapter 1 GENERAL

1.1 General

1.1.1 Application

1 With regard to requirement stipulated in 7.4.1.3 of *THE INTERNATIONAL CODE OF SAFETY FOR HIGH SPEED CRAFT*, the following **(1)** through **(3)** are to be complied with.

(1) 7.4.1.3 of *THE INTERNATIONAL CODE OF SAFETY FOR HIGH SPEED CRAFT* is intended to apply to all enclosed spaces and open cargo and ro-ro decks, except as defined following **(a)** and **(b)**.

(a) Spaces considered as being of no fire risk and open decks (except open cargo and ro-ro decks) need not comply with this requirement. In this context, spaces of no fire risk are those containing no ignition sources and only insignificant combustible materials (in addition to the combustible hull structure). Lights and bilge alarm devices may be accepted in these spaces if smoke detection is provided.

(b) Dedicated storage rooms for gas fire-extinguishing systems may also be considered as spaces of no fire risk.

(2) Insulation systems approved as a 30-min or 60-min fire-resisting division, as per 7.2.1 of *THE INTERNATIONAL CODE OF SAFETY FOR HIGH SPEED CRAFT*, need not be qualified as a fire-restricting material, provided that the insulation is non-combustible, as per the *IMO FTP* Code.

(3) In case where fire-restricting materials are used for floors, the following insulation systems may be applied:

(a) for areas where a sprinkler system is not provided, a design with the deck of fibre-reinforced polymers covered by a non-combustible board or insulation faced with an approved floor covering according to the *IMO FTP* Code, Annex 1, Parts 2 and 5, may be accepted; and

(b) for areas where a sprinkler system is provided, a floor design with a floor covering approved according to the *IMO FTP* Code, Annex 1, Parts 2 and 5, applied directly on the deck constructed of fibre-reinforced polymers, may be accepted.

2 With regard to requirement stipulated in 7.4.2.3 of *THE INTERNATIONAL CODE OF SAFETY FOR HIGH SPEED CRAFT*, the following **(1)** through **(4)** are to be complied with.

(1) Protection time

The structural fire protection time of main load bearing structures located within areas of major fire hazard (classified as *A*) and areas of moderate fire hazard (classified as *B*), and load bearing structures supporting control stations are to, as a minimum, be the same as that required by Tables 7.4-1 and 7.4-2 of *THE INTERNATIONAL CODE OF SAFETY FOR HIGH SPEED CRAFT* (as applicable), for the divisions enclosing the space where these supports are located. In accordance with 7.4.1.1 of *THE INTERNATIONAL CODE OF SAFETY FOR HIGH SPEED CRAFT* in no case is the structural fire protection time to be less than 30 *minutes*. Load bearing structures made of steel, other than those constituting the divisions dealt with in Tables 7.4-1 and 7.4-2 of *THE INTERNATIONAL CODE OF SAFETY FOR HIGH SPEED CRAFT* (as applicable), need not be insulated.

(2) Extent of structural fire protection

The structures considered are to be all load-carrying structures within areas of major and moderate fire hazard (classified as *A* or *B*) as well as all structures (irrespective of where they are located) which are necessary to support control stations. The vertical extent of structure supporting control stations is to be considered all the way down to and including spaces within the hull(s). However, all structures within voids in the hull can be exempted from this consideration.

(3) Fire testing

Approvals from the standard fire test according to the *IMO FTP* Code, Annex 1, Part 11 for a bulkhead or deck of a given

material can be applied for protection of pillars of the same material. The structural fire protection time is to be considered to be the same as that achieved in the fire test.

(4) Load case

When load carrying capability calculations are performed for an assumed fire within a space, all insulated or un-insulated steel structures, including pillars, as well as fire insulated aluminium and FRP structures in the space may be included; un-insulated aluminium and FRP structures are not to be included. A single fire concept (the assumption that only one major fire will occur at a time) can be applied where a fire is only presumed to originate in one enclosed space and not propagate to another enclosed space.

3 As for the requirements for dead craft conditions and restoration from the dead craft conditions specified in 9.1.5 of *THE INTERNATIONAL CODE OF SAFETY FOR HIGH SPEED CRAFT*, the following **(1)** through **(3)** are to be complied with.

(1) Dead craft condition for the purpose of Regulation 9.1.5 is to be understood to mean a condition under which the main propulsion plant and auxiliaries are not in operation and, in restoring the propulsion, no stored energy is assumed to be available for starting and operating the propulsion plant, the main source of electrical power and other essential auxiliaries. It is assumed that means are available at all times to start the emergency generator or one of the main generators when the main source is arranged according to paragraph 12.7.2.

(2) Where the emergency source of power is an emergency generator which complies with section 12.4, or a main generator meeting the requirements of paragraph 12.7.2, it is assumed that means are available to start this generator and consequently this generator may be used for restoring operation of the main propulsion plant and auxiliaries where any power supplies necessary for engine operation are also protected to a similar level as the starting arrangements.

(3) Where there is no emergency generator installed or an emergency generator does not comply with section 12.4, the arrangements for bringing main and auxiliary machinery into operation are to be such that initial charge of starting air or initial electrical power and any power supplies for engine operation can be developed on board the craft without external aid. If for this purpose an emergency air compressor or electric generator is required, these units are to be powered by a hand-starting oil engine or a hand-operated compressor. The arrangements for bringing main and auxiliary machinery into operation are to have a capacity such that the starting energy and any power supplies for engine operation are available within 30 *minutes* of a dead craft condition.

4 As for the application of 9.8 of *THE INTERNATIONAL CODE OF SAFETY FOR HIGH SPEED CRAFT*, the following requirements are to be complied with.

(1) On monohulls, propeller shaft and bearings of at least one main engine, when passing through the aft machinery space, are to be protected as following **(a)** or **(b)**.

(a) Steel shaft bearings are to be protected by water spray.

(b) Shafts made of composite material (FRP) are to be protected by the following **i)** or **ii)**.

i) Passive fire protection for 60 minutes duration

ii) A water spray system and able to transmit the full torque of the propulsion engine after a standard fire test of 7 *minutes*

1.2 Others

1.2.1 Portable Atmosphere Testing Instruments for Enclosed Spaces

The wording “suitable means are to be provided for the calibration of all such instruments” in **1.2.1, Part 15 of the Rules** refers to portable atmosphere testing instruments being calibrated on board or ashore in accordance with the manufacturer’s instructions together with corresponding calibration records being kept. In this regard, the calibration of portable atmosphere testing instruments does not include any pre-operational accuracy tests as recommended by the manufacturer.

Annex 1 ICE ACCRETION APPLICABLE TO ALL TYPES OF CRAFT

1.1 Icing Allowances

1.1.1

For craft operating in areas where ice accretion is likely to occur, the following icing allowance should be made in the stability calculations:

(1) 30 kg/m^2 on exposed weather decks and gangways;

(2) 7.5 kg/m^2 for projected lateral area of each side of the craft above the waterplane;

(3) the projected lateral area of discontinuous surfaces of rail, sundry booms, spars (except masts) and rigging and the projected lateral area of other small objects should be computed by increasing the total projected area of continuous surfaces by 5% and the static moments of this area by 10%;

(4) reduction of stability due to asymmetric ice accumulations in cross-structure.

1.1.2

For craft operating in areas where ice accretion may be expected:

(1) Within the areas defined in **1.2.1(1)**, **(3)**, **(4)** and **(5)** known to have icing conditions significantly different from those in **1.1.1**, ice accretion requirements of one half to twice the required allowance may be applied.

(2) Within the area defined in **1.1.1(2)**, where ice accretion in excess of twice the allowance required by **1.1.1** may be expected, more severe requirements than those given in **1.1.1** may be applied.

1.1.3

Information should be provided in respect of the assumptions made in calculating the condition of the craft in each of the circumstances set out in this Annex for the following:

(1) duration of the voyage in terms of the period spent in reaching the destination and returning to port; and

(2) consumption rates during the voyage for fuel, water, stores and other consumables.

1.2 Areas of Icing Conditions

1.2.1

In the application of **1.1**, the following icing areas (*See* **Fig.1**) **(1)** through **(5)** should apply:

(1) The area north of latitude 65°30′*N*, between longitude 28°*W* and the west coast of Iceland ; north of the north coast of Iceland ; north of the rhumb line running from latitude 66°*N*, longitude 15°*W* to latitude 73°30′*N* longitude 15°*E*, north of latitude 73°30′*N* between longitude 15°*E* and 35°*E*, and east of longitude 35°*E*, as well as north of latitude 56°*N* in the Baltic Sea.

(2) The area north of latitude 43°*N* bounded in the west by the North American coast and the east by the rhumb line running from latitude 43°*N*, longitude 48°*W* to latitude 63°*N*, longitude 28°*W* and thence along longitude 28°*W*.

(3) All sea areas north of the North American continent, west of the areas defined in subparagraphs **(1)** and **(2)** of this paragraph.

(4) The Bering and Okhotsk Seas and the Tartary Strait during the icing season.

(5) South of latitude 60°*S*.

1.3 Special Requirements

1.3.1

Craft intended for operation in areas where ice accretion is known to occur should be:

(1) designed to minimize the accretion of ice; and

(2) equipped with such means for removing ice as the Administration may require.

Fig. 1

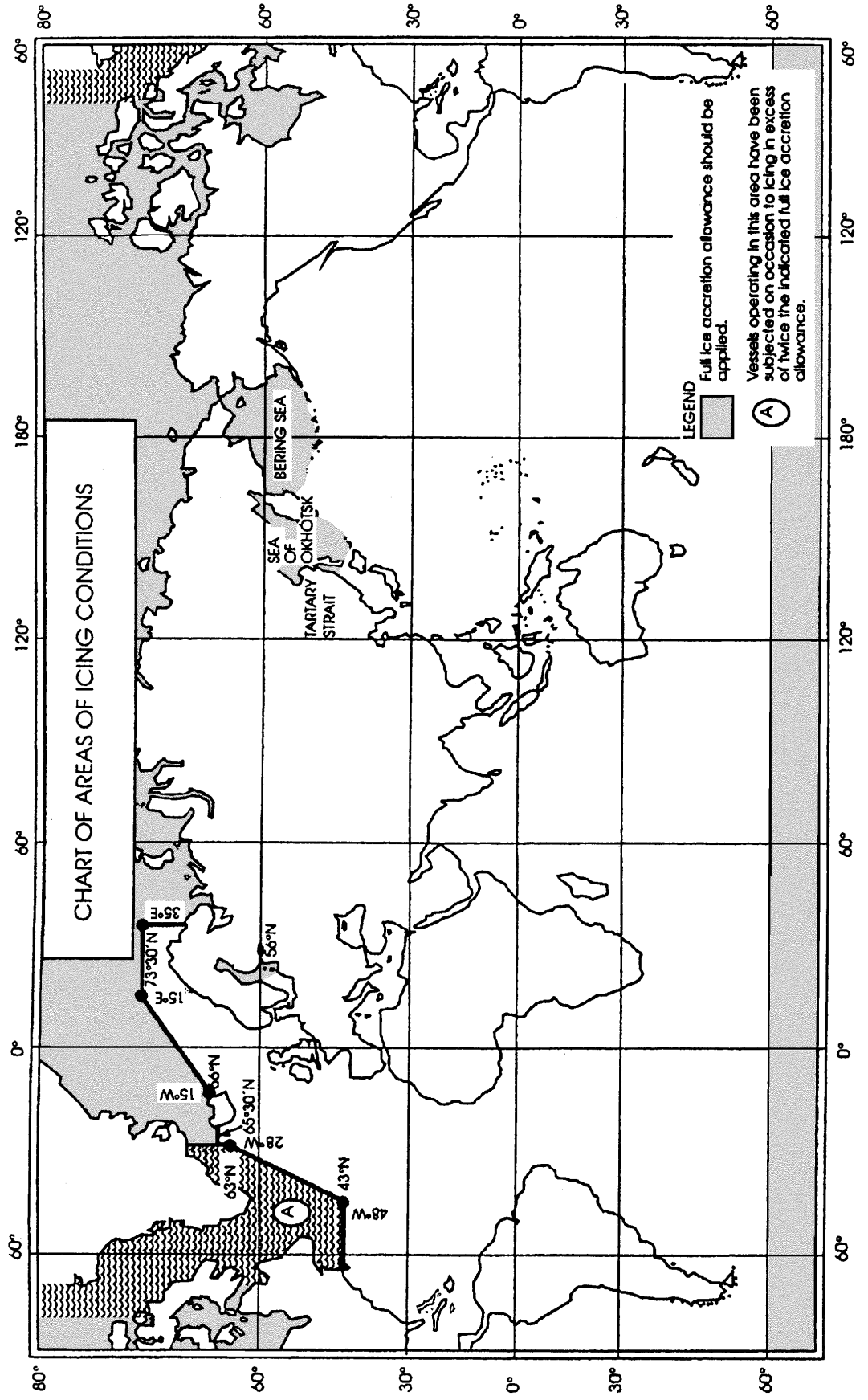


CHART OF AREAS OF ICING CONDITIONS
LEGEND
Full ice accretion allowance should be applied.
Vessels operating in this area have been subjected on occasion to icing in excess of twice the indicated full ice accretion allowance.
A
BERING SEA
SEA OF OKHOTSK
TARTARY STRAIT
35°E
73°30'N
15°E
56°N
15°W
65°30'N
28°W
43°N
43°N
48°W
80°
60°
30°
0°
30°
60°
120°
180°

Annex 2 METHODS RELATING TO THE INTACT STABILITY INVESTIGATION OF HYDROFOIL CRAFT

1.1 General

The stability of these craft should be considered in the hull-borne, transient and foil-borne modes. The stability investigation should also take into account the effects of external forces. The following procedures are outlined for guidance in dealing with stability.

In addition, "hull-borne mode" has the same meaning as "displacement mode" defined in **2.1.30, Part 1** of the Rules and "foil-borne mode" has the same meaning as "non-displacement mode" defined in **2.1.31, Part 1** of the Rules.

1.2 Surface-piercing Hydrofoils

1.2.1 Hull-borne Mode

1 The stability should be sufficient to satisfy the provisions of **1.3** and **1.4, Part 8 of the Rules**.

2 Heeling Moment due to Turning

The heeling moment developed during manoeuvring of the craft in the displacement mode may be derived from the following formula:

$$M_R = 0.196(V_O^2/L)\Delta KG \quad (kN\text{-}m)$$

where:

M_R= moment of heeling;

V_O= speed of the craft in the turn (m/s);

Δ= displacement (t);

L= length of the craft on the waterline (m);

KG= height of the centre of gravity above keel (m).

This formula is applicable when the ratio of the radius of the turning circle to the length of the craft is 2 to 4.

3 Relationship between the Capsizing Moment and Heeling Moment to Satisfy the Weather Criterion

The stability of a hydrofoil boat in the displacement mode can be checked for compliance with the weather criterion K as follows:

$$K = M_C/M_V \geq 1$$

where:

M_C:minimum capsizing moment as determined when account is taken of rolling.

M_V:dynamically applied heeling moment due to the wind pressure.

4 Heeling Moment due to Wind Pressure

The heeling moment M_V is a product of wind pressure P_V the windage area A_V and the lever of the windage area Z.

$$M_V = 0.001P_V A_V Z \quad (kN\text{-}m)$$

The value of the heeling moment is taken as constant during the whole period of heeling. The windage area A_V is considered to include the projections of the lateral surfaces of the hull, superstructure and various structures above the waterline. The windage area lever Z is the vertical distance to the centre of windage from the waterline and the position of the centre of windage may be taken as the centre of the area. The values of the wind pressure (in pascals) associated with Force 7 Beaufort scale, depending on the position of the centre of windage area, are given in **Table 1**.

Table 1 Typical Wind Pressures, 100 Nautical Miles from Land for Beaufort Scale 7

Z above waterline (m)	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
P_V (Pa)	46	46	50	53	56	58	60	62	64

Note:

These values may not be applicable in all areas.

5 Evaluation of the Minimum Capsizing Moment M_C in the Displacement Mode

The minimum capsizing moment is determined from the static and dynamic stability curves taking rolling into account.

(1) When the static stability curve is used, M_C is determined by equating the areas under the curves of the capsizing and righting moments (or levers) taking rolling into account, as indicated by **Fig. 1**, where θ_Z is the amplitude of roll and *MK* is a line drawn parallel to the abscissa axis such that the shaded areas S_1 and S_2 are equal.

M_C=*OM*, if the scale of ordinates represents moments.

M_V=*OM*×Displacement, if the scale of ordinates represents levers.

(2) When the dynamic stability curve is used, first an auxiliary point *A* should be determined. For this purpose the amplitude of heeling is plotted to the right along the abscissa axis and a point A' is found (*see* **Fig. 2**). A line AA' is drawn parallel to the abscissa axis equal to the double amplitude of heeling ($AA' = 2\theta_Z$) and the required auxiliary point *A* is found. A tangent *AC* to the dynamic stability curve is drawn. From the point *A* the line *AB* is drawn parallel to the abscissa axis and equal to 1 radian (57.3 degrees). From the point *B* a perpendicular is drawn to intersect with the tangent in point *E*. The distance *BE* is equal to the capsizing moment if measured along the ordinate axis of the dynamic stability curve. If, however, the dynamic stability levers are plotted along this axis, *BE* is then the capsizing lever, and in this case the capsizing moment M_C is determined by multiplication of ordinate *BE* (in metres) by the corresponding displacement in tones

$$M_C = 9.81 \cdot \Delta \cdot BE \quad (kN\text{-}m)$$

(3) The amplitude of rolling θ_Z is determined by means of model and full-scale tests in irregular seas as a maximum amplitude of rolling of 50 oscillations of a craft traveling at 90 degrees to the wave direction in sea state for the worst design condition. If such data are lacking the amplitude is assumed to be equal to 15 degrees.

(4) The effectiveness of the stability curves should be limited to the angle of flooding.

Fig. 1 Static Stability Curve

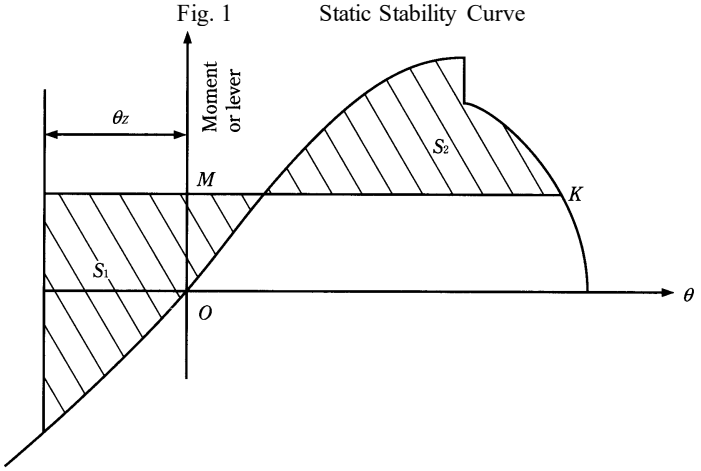
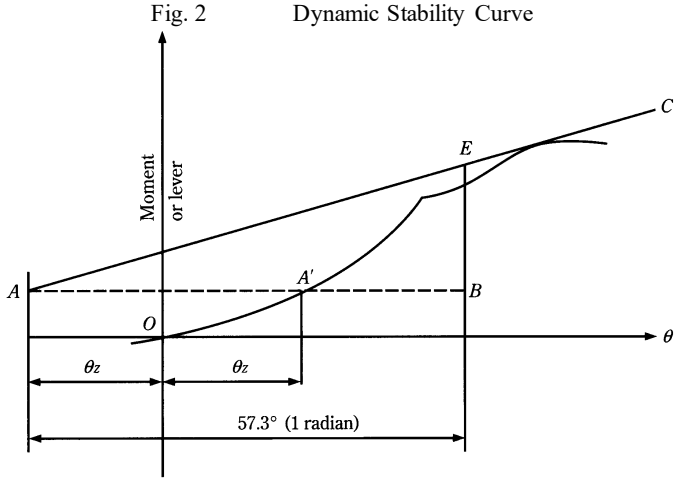


Fig. 2 Dynamic Stability Curve



1.2.2 Transient and Foil-borne Modes

1 The Stability should Satisfy the Provisions of **1.4** and **1.5, Part 8 of the Rules**.

2 Transient and Foil-borne Modes

(1) The Stability in the Transient and Foil-borne Modes should be Checked for All cases of Loading for the Intended Service of the Craft.

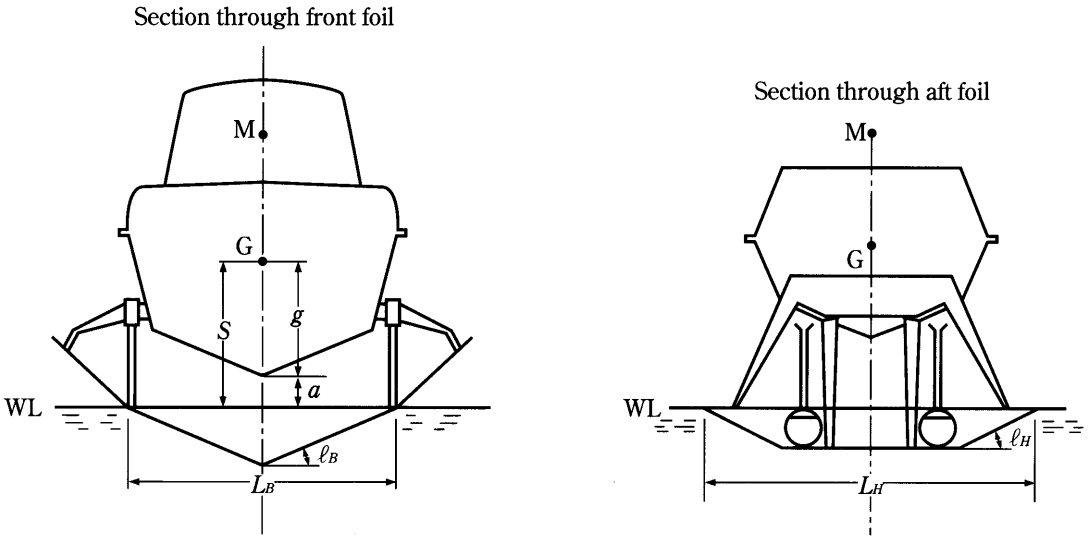
(2) The stability in the transient and foil-borne modes may be determined either by calculation or on the basis of data obtained from model experiments and should be verified by full-scale tests by imposition of a series of known heeling moments by off-centre ballast weights, and recording the heeling angles produced by these moments.

When taken in the hull-borne, take-off, steady foil-borne and settling to hull-borne modes, these results will provide an indication of the values of the stability in the various situations of the craft during the transient condition.

(3) The angle of heel in the foil-borne mode caused by the concentration of passengers at one side should not exceed 8 degrees. During the transient mode the angle of heel due to the concentration of passengers on one side should not exceed 12 degrees. The concentration of passengers should be determined by the Society, having regard to the guidance given at **Annex 3**.

3 One of the possible methods of assessing foil-borne metacentric height (GM) in the design stage for a particular foil configuration is given in **Fig. 3**.

Fig. 3



Notes:

$$GM = n_B\left(\frac{L_B}{2\tan l_B} - S\right) + n_H\left(\frac{L_H}{2\tan l_H} - S\right)$$

where:

n_B= percentage of hydrofoil load borne by front foil

n_H= percentage of hydrofoil load borne by aft foil

L_B= clearance width of front foil

L_H= clearance width of aft foil

a= clearance between bottom of keel and water

g= height of centre of gravity above bottom of keel

l_B= angle at which front foil is inclined to horizontal

l_H= angle at which aft foil is inclined to horizontal

S= height of centre of gravity above water

1.3 Fully Submerged Hydrofoils

1.3.1 Hull-borne Mode

1 The stability in the hull-borne mode should be sufficient to satisfy the provisions of **1.3** and **1.6, Part 8 of the Rules**.

2 Paragraphs **1.2.1-2** to **-5** of this Guideline are appropriate to this type of craft in the hull-borne mode.

1.3.2 Transient Mode

1 The stability should be examined by the use of verified computer simulations to evaluate the craft's motions, behaviour and responses under the normal conditions and limits of operation and under the influence of any malfunction.

2 The stability conditions resulting from any potential failures in the systems or operational procedures during the transient stage which could prove hazardous to the craft's watertight integrity and stability should be examined.

1.3.3 Foil-borne Mode

The stability of the craft in the foil-borne mode should be in compliance with the provisions of **1.4, Part 8 of the Rules**. The provisions of paragraph **1.3.2** of this Annex should also apply.

1.3.4

Paragraphs **1.2.2-2** of this Guideline should be applied to this type of craft as appropriate and any computer simulations or design calculations should be verified by full-scale tests.

Annex 3 STABILITY OF MULTIHULL CRAFT

1.1 Stability Criteria in the Intact Condition

A multihull craft, in the intact condition, should have sufficient stability when rolling in a seaway to successfully withstand the effect of either passenger crowding or high-speed turning as described in 1.1.4. The craft's stability should be considered to be sufficient provided compliance with this paragraph is achieved. Alternatively another method of assessment may be employed, as provided for in 1.1.4, Part 8 of the Rules.

1.1.1 Area under *GZ* Curve

The area (A_1) under the *GZ* curve up to an angle θ should be at least:

$$A_1 = 0.055 \times 30^\circ/\theta \ \ (m\text{-}rad)$$

where θ is the least of the following angles:

(1) the downflooding angle;

(2) the angle at which the maximum *GZ* occurs; and

(3) 30 degrees

1.1.2 Maximum *GZ*

The maximum *GZ* value should occur at an angle of at least 10 degrees.

1.1.3 Heeling due to Wind

The wind heeling lever should be assumed constant at all angles of inclination and should be calculated as follows:

$$HL_1 = (P_i AZ)/(9\,800\Delta) \ \ (m) \ (\textit{See Fig. 1})$$

$$HL_2 = 1.5HL_1 \ \ (m) \ (\textit{See Fig. 1})$$

where:

P_i= 500 (Pa)

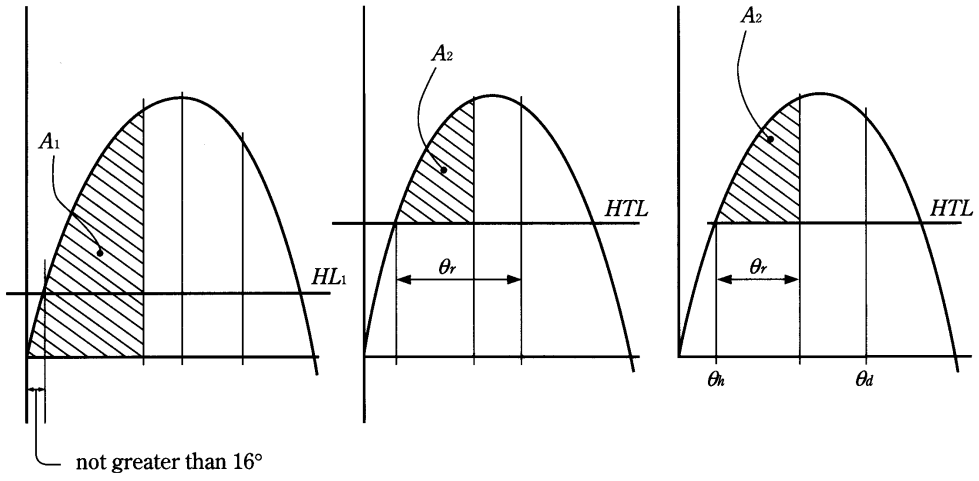
A= projected lateral area of the portion of the craft above the lightest service waterline (m^2)

Z= vertical distance from the centre of A to a point one half the lightest service draught (m)

Δ= displacement (t)

Fig. 1 Intact Stability

MULTIHULL CRAFT CRITERIA



HL_1 = Heeling lever due to wind

HTL = Heeling lever due to wind + gusting + (passenger crowding or turning)

1.1.4 Heeling due to Passenger Crowding or High-speed Turning

Heeling due to the crowding of passengers on one side of the craft or to high speed turning, whichever is the greater, should be applied in combination with the heeling lever due to wind (HL_2).

(1) Heeling due to Passenger Crowding

When calculating the magnitude of the heel due to passenger crowding, a passenger crowding lever should be developed using the assumptions stipulated in **2.1, Part 8 of the Rules**.

(2) Heeling due to High-speed Turning

When calculating the magnitude of the heel due to the effects of high speed turning, a high-speed turning lever should be developed using the following formula:

$$TL = Vo^2(\mathrm{KG} - d/2)/(gR) \quad (m)$$

where:

TL= turning lever (m)

Vo= speed of craft in the turn (m/s)

R= turning radius (m)

KG= height of vertical centre of gravity above keel (m)

d= mean draught (m)

g= acceleration due to gravity (m/s^2)

1.1.5 Rolling in Waves (Fig. 1)

The effect of rolling in a seaway upon the craft's stability should be demonstrated mathematically. In doing so, the residual area under the GZ curve (A_2), *i.e.* beyond the angle of heel (θ_h), should be at least equal to 0.028 *m-rad* up to the angle of roll θ_r. In the absence of model test or other data θ_r should be taken as 15 degrees or an angle of ($\theta_d - \theta_h$), whichever is less. The determination of θ_r using model test or other data is to be made using the method for determination θ_Z in **1.2.1-5(3), Annex 2**.

1.2 Criteria for Residual Stability after Damage

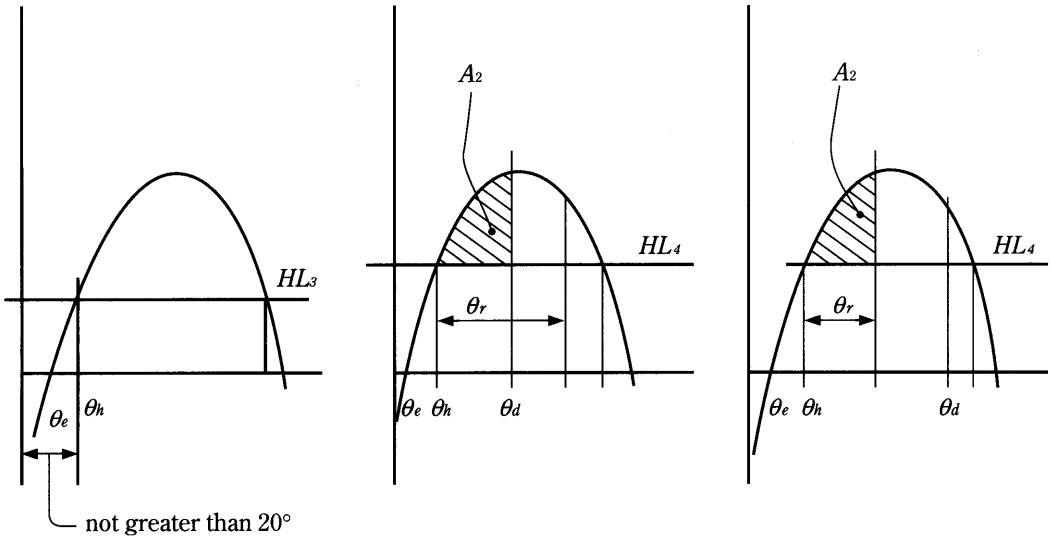
1.2.1

The method of application of criteria to the residual stability curve is similar to that for intact stability except that the craft in the final condition after damage should be considered to have an adequate standard of residual stability provided:

(1) the required area A_2 should be not less than 0.028 *m-rad*. (**Fig. 2** refers); and

(2) there is no requirement regarding the angle at which the maximum GZ value should occur.

Fig. 2 Damage Stability



Notes:

HL_1= Heeling lever due to wind

HTL=Heeling lever due to wind + gusting + (passenger crowding or turning)

HL_3 = Heeling lever due to wind

HL_4 = Heeling lever due to wind + passenger crowding

θ_m = Angle of maximum GZ

θ_d = Angle of downflooding

θ_r =Angle of roll

θ_e =Angle of equilibrium, assuming no wind, passenger crowding or turning effects

θ_h =Angle of heel due to heeling lever HL_1, HTL, HL_3 or HL_4

$A_1 \geq$ Area required by **1.1.1**

$A_2 \geq$ 0.028 *m-rad*

1.2.2

The wind heeling lever for application on the residual stability curve should be assumed constant at all angles of inclination and should be calculated as follows :

$$HL_3 = (P_d AZ)/(9800\Delta)$$

where:

P_d = 120 (Pa)

A = projected lateral area of the portion of the craft above the lightest service waterline (m^2)

Z = vertical distance from the centre of A to a point one half of the lightest service draught (m)

Δ = displacement (t)

1.2.3

The same values of roll angle should be used as for the intact stability.

1.2.4

The downflooding point is important and is regarded as terminating the residual stability curve. The area A_2 should therefore be truncated at the downflooding angle.

1.2.5

The stability of the craft in the final condition after damage should be examined and shown to satisfy the criteria, when damaged as stipulated in **1.6, Part 8 of the Rules**.

1.2.6

In the intermediate stages of flooding, the maximum righting lever should be at least 0.05 m and the range of positive righting lever should be at least 7 degrees. In all cases, only one breach in the hull and only one free surface need to be assumed.

1.3 Application of Heeling Levels

1.3.1

In applying the heeling levers to the intact and damaged curves the following should be considered:

(1) for intact condition:

(a) wind heeling lever - steady wind (HL_1); and

(b) wind heeling lever (including gusting effect) plus either the passenger crowding or speed turning levers whichever is the greater (HTL).

(2) for damage condition:

(a) wind heeling lever - steady wind (HL_3); and

(b) wind heeling lever plus heeling lever due to passenger crowding (HL_4).

1.3.2 Angles of Heel due to Steady Wind

1 The angles of heel due to steady wind when the heeling lever HL_1, obtained as in **1.1.3**, is applied to the intact stability curve should not exceed 16 degrees; and

2 The angle of heel due to steady wind when the heeling lever HL_3, obtained as in **1.2.2**, is applied to the residual stability curve, after damage, should not exceed 20 degees.